Research Report
434

A GUIDE TO PREPARING RESEARCH REPORTS AND TECHNICAL TALKS

KYP-76-50, HPR-PL-1(11), Part III-B

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16. Abstract

This manual has been prepared to provide guidance to writers of technical reports which are to be issued by the Division of Research, Kentucky Bureau of Highways. Concepts of technical report writing are presented. Specific instructions concerning the preparation and submission of reports for review are also presented. Appendices included provide rules for grammar, punctuation, etc. which cause engineer-writers particular problems.

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INTRODUCTION

Activities of the Division of Research, Kentucky Bureau of Highways, can be traced to early beginnings in 1914 and the establishment of the Road Materials Testing Laboratory at the University of Kentucky under the leadership of D. V. Terrell. Recognition of the research function and assignment within the highway organization dates from 1941 and a bilateral agreement between the Department of Highways and the University of Kentucky to construct and operate a materials research laboratory on the University of Kentucky campus.

Since the beginning of the "modern" era of research within the Bureau of Highways, many reports have been issued by the Division of Research or its predecessors. The major product, of course, of a research organization is its reports, which eventually lead to changes or modifications in operating procedures of the Department. In the early years, only one or two reports were issued each year. As staff and budget gradually increased, productivity as measured by number of reports has also gradually increased. Currently (1975), the Division is typically issuing some 30 to 35 or more major reports each year.

With the significant number of reports being issued by the Division, and because of the relatively small staff available for review and reproduction, it is becoming increasingly necessary that authors of reports prepare drafts which will facilitate the review and reproduction processes. Therefore, there is an obvious and great need for guidance and instruction to authors of reports.

This manual contains no new material. All of the information is readily available in numerous papers and books concerning the English language, grammar, writing in general, and writing of technical reports in particular. This manual does contain some information which might be more directly useable by authors within the Division of Research. Material has been very liberally borrowed from a number of sources (1, 2, 3, 4, and 5); significant modifications and briefings of this material have been made to meet the needs of this agency. Accordingly, the effort required to process the reports from draft stage to final stage would also be greatly facilitated. This, of course, could shorten the timelag between the writing of the report and its general availability to potential users. Since this timelag can often run into several months, any time savings would be significant. Study engineers should read this report very carefully and understand all guidelines and instructions. It would be advisable for each author, at the time of preparing for writing a report, to review this guide and to use it as a checklist for preparing drafts for review.

AN EFFECTIVE REPORT

A report should be organized so a reader can get what he needs from it, whether what he needs is only the title, the abstract, the summary, a detailed report, or a detailed report with supporting materials. A good report moves in several stages from the very general (the title) to the very specific (the appendices). Each appendix is full of specific detail; the report itself contains some detail from the appendices but is primarily devoted to generalizations based on the details in the appendices or study files; the summary, the abstract, and the table of contents all cover the same ground as the report but each is more general than the body of the report; the most abstract of all is the title.

A good report is built of layers or levels of abstraction. The farther one gets into it, the more detail he finds:

First level	Title
Second level	Abstract and Table of Contents
Third level	Summary
Fourth level	Body of Report
Fifth level	Appendices

Looking at the structure of the report from a distance, one would see a pyramid (see Figure 1). The number of items which make up each level decreases as one goes up the ladder of abstraction, or to the top of the pyramid.

Some specialized reports may require additional sections. These are easily fitted into the pattern described in Figure 1. To determine where a section belongs, one need only think of its purpose, its relation to the rest of the report, and the use to which it will be put.

Sometimes reports are best written backwards, that is, built from the lowest level of abstraction. Even impulses and inspiration along with much detail may be included at this stage. Before one begins to write, he will naturally have done a great deal of research. The information he gathers may ultimately be presented in the appendices. When his data begin to take some form, he can start on the report itself. It is helpful to start planning (prepare an outline) the report before all research and experimentation has been completed; planning the report often brings to the surface significant gaps in thinking or in data. When all the materials have been gathered, the writer can begin on the body of the report in earnest. Then he can write the summary and, after that, the abstract. Some people save the highest level of abstraction, the title, for last, using only a working title while the report is in progress.

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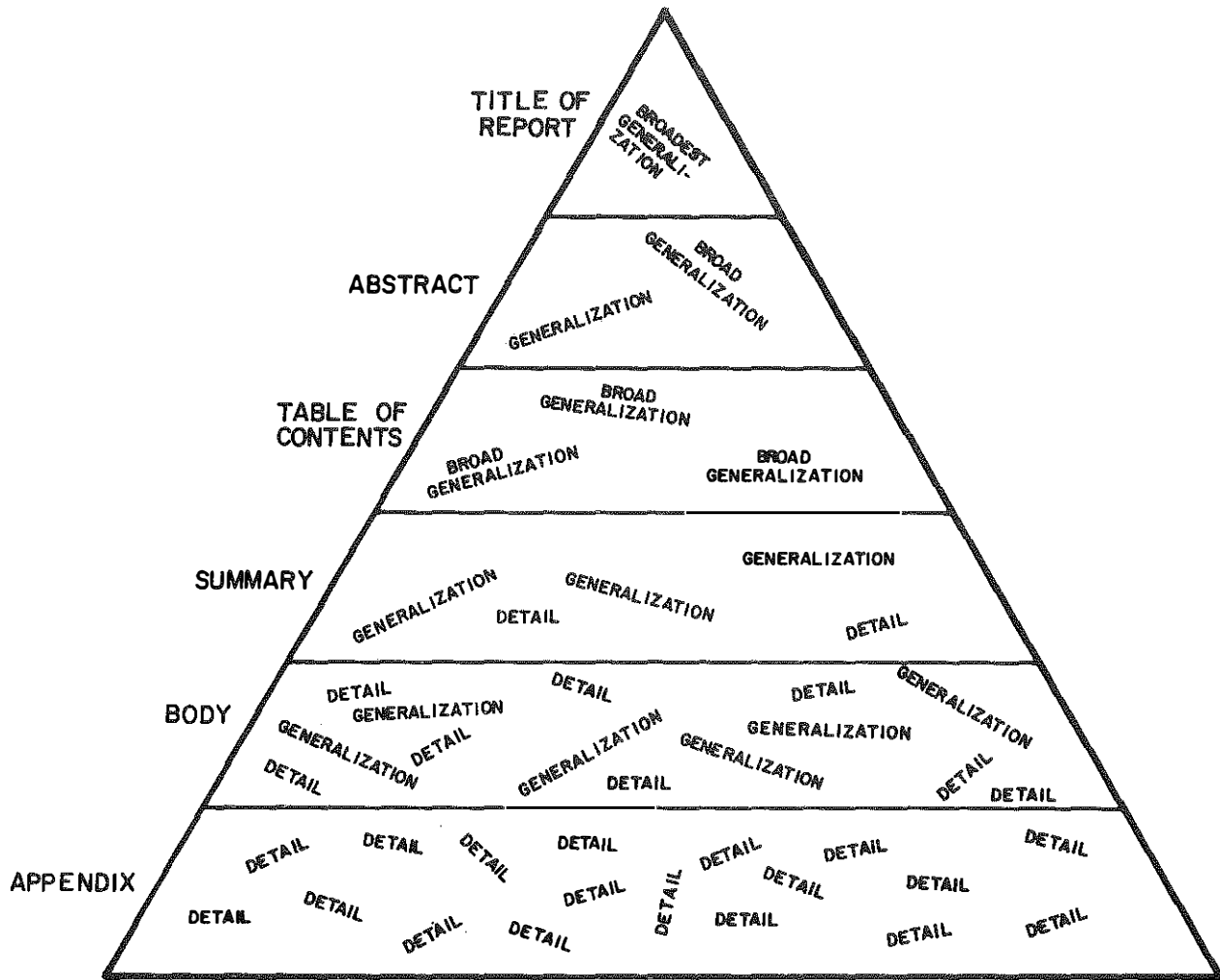DETAIL
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Figure 1.   The Pyramid of Abstraction for a Technical Report.

ORGANIZING AN EFFECTIVE REPORT

Inexperienced report writers frequently ask about the "proper" sequence for the sections of the report. There is no one best sequence. Every aspect of any communication is governed finally by the material to be communicated, the person or group communicating, the audience at which the communication is aimed, and the purpose which it is intended to serve.

Reports prepared by and for the Division of Research, Kentucky Bureau of Highways, shall generally be organized in the following manner:

Cover
Letter of Transmittal
Technical Report Standard Title Page Form DOT
    F 1700.7 (this contains an Abstract)
Title Page
Table of Contents (optional)
List of Figures (optional)
List of Tables (optional)
Executive Summary (optional)
Body of Report
    Introduction
    Review of Literature
    Methodology
    Results and(or) Discussion or Interpretation
       of Results
    Summary and(or) Conclusions and
       Recommendations
    References
    Bibliography
    Appendix or Appendices

Flexibility of organization is necessary so that the many purposes of reports issued by this organization can be fulfilled. The above outline of report organization is intended only as a guide or series of suggestions to stimulate organized thinking. However, to insure uniformity of format of reports, the outline should be used to the extent possible. This does not preclude omitting items not needed nor inserting other items that may be needed to properly account for the nature of the material to be presented or the background or interests of the reading audience. When outline items are omitted or added, it should be done with the clear understanding of the impact upon the reader and done so no necessary material or discussion is omitted and no superfluous or uninteresting, unrelated material is included.

As a guide to the nature of the information to be included in each of the outline items cited, the following sections present the parts of the report in more detail. The details will be far from complete. Nevertheless, they may throw some light where the inexperienced author most often blunders.

Cover

The cover shall indicate that the source of the report is the Division of Research, Bureau of Highways, Kentucky Department of Transportation, Lexington, Kentucky. The cover shall also indicate the report title, the name(s) of the author(s), and the report number. The report number must appear in the upper left-hand corner of the cover. Placement of the other items as well as the use of artwork will be with the approval of the Assistant Director in charge of reproduction. The cover to this manual illustrates the placement of items as currently approved and is a typical example of artwork used on covers.

Letter of Transmittal

After a report is completed, there is one more device for making sure a particular reader does not miss any part of the report that may be especially useful to him. A cover letter summarizing briefly those aspects in which a particular reader will be most interested can direct him to the relevant passages. However, the writer should be sure he knows the recipient's interest well. The letter of transmittal is prepared by the Director of Research to forward a report to the appropriate office(s). The letter may be used to explain additional circumstances, add information of some interest or significance, or to make recommendations or suggestions.

The Technical Report Standard Title Page

US Department of Transportation Form DOT F 1700.7 (for example, see the standard title page of this report) shall be used to comply with requirements of the Federal Highway Administration as well as the National Technical Information Service. The NTIS serves as a national depository for technical papers and reports. Items 4, 5, 7, 8, 9, 11, 13, 15, 16, and 17 on DOT F 1700.7 will be completed by the author. Most of these items are self-explanatory. Item 8 is the report number assigned by the Division of Research at the time of reproduction. The number 999 shall be used until the report number is assigned. Item 9 should read as follows:

Division of Research
Kentucky Bureau of Highways
533 South Limestone Street
Lexington, Kentucky 40508.

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Item 11 is the study number for which the report was prepared and can be obtained from the appropriate work program. If the study is a participating study, Item 15 shall contain the note, "Prepared in cooperation with the US Department of Transportation, Federal Highway Administration". Item 15 shall also contain the study title, which can be obtained from the appropriate work program. The report title and study title do not necessarily have to be the same. Item 17 shall contain a listing of keywords which might be useful in information storage and retrieval systems.

Title Page

The "title of the report" is a single abstraction based upon hundreds, or even thousands, of specific details in the appendices. Even at the very top of the pyramid, however, the writer must be careful not to be too general, too abstract. If the title is so general that it does not indicate the precise subject covered, the report may not be read. On the other hand, the title should be short. The proper balance between degree of generalization and shortness of title is often difficult to achieve.

The title page shall include: report number (assigned by the Assistant Director), report title, study number (including the work program number), author(s) and their titles, research agency, disclaimer clause, and date of report. The disclaimer clause for federally funded study reports shall be:

The contents of this report reflect the views of the author(s) who is(are) responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official views or policies of the Bureau of Highways or Federal Highway Administration. This report does not constitute a standard, specification, or regulation.

For non-participating studies, no reference shall be made to the Federal Highway Administration in the disclaimer (see title page of this report for example).

Abstract

The level below the title is the abstract, a very brief summary of the contents of the report. An abstract can either describe or inform. A descriptive abstract merely gives the topics and sub-topics of a report, much as a table of contents does.

An informative abstract is much more useful. It states the problem, briefly explains how the investigation was conducted, and mentions important conclusions and recommendations.

An abstract is generally held to 100 or 200 words. If it is longer, it ceases to serve its purposes. Many organizations type abstracts on index cards for filing in a central catalog. Others circulate a regular bulletin composed entirely of the abstracts of reports published during the period. In some organizations, top management personnel regularly see only these bulletins. Then if they want a report, they send for it.

Table of Contents

At about the same level of abstraction as the descriptive abstract is the table of contents. An outline of the report, it indicates major headings and subheadings. Occasionally it will even list sub-subheadings. Thus, the reader may use it not only to find the various sections of the report but also to see how the report is organized. The table of contents almost always follows the abstract, but usually precedes the summary. It may be supplemented by special tables of contents for illustrations, figures, or charts.

The table of contents should list the principal headings and subheadings as they appear in the report and reference the page number on which each appears. Separate lists of illustrations and tables may be included following the contents if any or all are considered essential. Lengthy illustration or table captions shall be abbreviated (shortened) in these lists.

Executive Summary

Since very little can be said in 100 or 200 words, reports usually require a summary in addition to an abstract. Introductory summaries serve a double purpose. They provide a reasonably complete resume of a report for those who cannot read it all. They also help the person who will read the entire report. In any complex mechanism, the function of individual parts is difficult to understand unless one understands the mechanism as a whole; thus the function of individual parts of a complex report may be difficult to follow unless one has obtained an overview of the entire report. A good summary provides such an overview.

Reports are often read and acted upon by individuals who do not have time to delve into the details of the report but may wish to assign subordinates to do so. However, the administrator must be aware of the contents of the report -- thus the importance of the summary. The executive summary should be simple and concise. Statements should be brief and include the reason(s) for the study, objective(s), a highly condensed version of procedures used in conducting the study, definite findings or conclusions derived, and suggestions for implementation. The information should be presented in such a manner that significance of the work can be assimilated quickly and provide a basis for administrative decisions.

In general, the summary should contain only a minimum of background and should proceed as quickly as possible to describe what was learned. Considering that the report itself may not be readily accessible to the reader, put into the summary what is considered to be the most valuable contributions the report makes, including the most significant conclusions and some mention of interesting techniques or concepts. There is no room, of course, for all the detail. In any case, include enough so the reader can determine whether he should exert himself to get a copy of the report for closer study.

Note that the summary is not actually a part of the report itself; duplication of portions of the report need not be avoided. For example, do not hesitate to include sentences lifted unchanged out of any part of the report.

The reader of a report will frequently begin by reading the summary to get a quick review of the contents. A summary reproduces the main points of the report. It should be written so it can stand alone.

Body of the Report

The report itself is at the next level of abstraction. It supplies more detail than the abstract, summary, or table of contents. The format of the body of the report is left to the option of the writer. This format may, in part, be influenced by the type of activity being reported and(or) the individual, office, or agency to whom the report is primarily addressed. General principles of good English and consistency will be followed. Guides and illustrations to aid improving the written report are contained in the appendices to this manual.

The body of a report shall document completely all data gathered, analyses performed, and results obtained. Reference to previous reports of a study is considered suitable documentation and serves to minimize repetition. The body of final reports should, however, contain sufficient information to be straightforward and understandable. Each reference shall be made by an Arabic number enclosed in parentheses and the number for each shall be the order in which they first appear in the report. Pages shall be numbered consecutively beginning with the number 2 for the page following the first page of the introduction and concluding on the last page contained in the report. Page numbers shall be placed at the lower center of the page on draft copies.

Introduction and Review of Literature – The first section of the body of the report is the introduction, a discussion of the purpose and background of the study which has been made. It tells not only what the problem was and why the study was undertaken but also what limitations, if any, were imposed. It should describe the current situation and state of knowledge or even opposing viewpoints. Where relevant (i.e., when a review of literature section is not used), it also includes a history of the problem, a short summary of earlier studies, a summary of the required technical background, and a definition of the way each important term will be used. When the report does not include a separate section on procedure, a brief discussion of it may also appear in the introduction. In short, the introduction should give the reader the background he needs to understand, evaluate, and use what follows.

The volume of literature of every branch of technology is greater than ever before and continues to expand. This demands increased skill and energy on the part of the author of technical papers, for he must be more critical of himself when he writes and more critical of others when he reads. The introduction and(or) review of literature, then, is a very important part of any scientific paper. It must (within a few paragraphs) cover a great deal of information about a variety of significant aspects, and it must do so in a clear manner.

The introduction is usually concerned with answering many questions. The writer should select the appropriate questions and answer them as completely as possible:

A. How did the study originate?
  1. Who originated the idea (what individual or group)?
  2. What conditions led to the proposal of the work?
  3. When did the study begin and end?
  4. Is it still in progress?
B. Former works of similar description:
  1. Is the study original?
  2. Is the study a modification of former work?
  3. Is the study a continuation of other work?
  4. Is the study a duplication of the techniques of other work?
  5. Is the study essentially contradictory to former work?
  6. Is the study essentially a preliminary study leading to an extensive piece of work?

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C. Extent (or Scope) of the study:
   1. Exactly what is presented, or covered?
   2. What agencies are involved?
   3. What is the geographical location of the project?
   4. What type of work is the study?
      a. Is it a critical review?
      b. Is it composed almost entirely of laboratory experiments?
      c. Is it composed principally of observations made in the field? Is it an inspection?
      d. Is it a large-scale experimental-type work done in the field?
      e. Is it a report on the progress of a large research program (one that covers months, or years)?

A typical introduction consists of three sections. Frequently the three sections are found in three paragraphs, but such sharp separation is not essential. One of the sections may require two or more paragraphs, or all three sections may be contained in one paragraph.

Begin by describing enough of the background to show where or how the problem arose and its importance. The author should actually know the background well enough to write it accurately, with the emphasis placed correctly. If the writer is not sure, he should reread the references or go to his supervisor (or to whatever expert is available) and ask him to discuss the whole subject. In general, do whatever is necessary to obtain sufficient background to compose an opening that will not confuse the reader with inaccurate or off-key statements. It may be that a thorough review of the background, with enough detail to clarify the precise contribution of the report, would be much too long to be included in the introduction. In such a case, summarize it in this first section of the introduction and provide a separate chapter (review of literature) for the detailed background (or perhaps give the background detail at appropriate points throughout the paper, depending on the nature of the material).

Having indicated where the problem exists, or, in general, what the background is, state broadly what it is the writer has tried to contribute by his research. Indicate here along what general lines the work has progressed.

The reader is now aware of what the writer has tried to do and why. It is usually desirable at this point to add a final portion to the introduction, in which the writer states more specifically what types of tests and analyses were made, the ranges of variables considered, and similar information that broadly defines the nature and extent of the investigation. The reader will thereby get an insight into the scope and thoroughness of the research and will know what to expect as he reads onward.

Methodology -- This section should contain brief but concise descriptions of the materials and means by which the work was accomplished. Each test procedure should be explained to the satisfaction of the reader, not of the author. The writer should recognize that, although the reader will perhaps have a partial knowledge of the subject, the reader must be adequately informed before he can fully appreciate the work set forth. If well-known standardized methods have been used, they need only be mentioned and not described in great detail. However, any departure from the normal manner of conducting a test should be recorded in this section.

Normally, the final portions of the introduction will have provided sufficient insight into the nature of the study so little or no argument for choice of equipment or technique is needed. In such a case, simply give a straightforward description of the equipment or methodology. If, however, some particular ingenuity was involved, be sure the presentation makes the matter clear, but not braggingly; but the writer must not present something new with so little emphasis (as if it were obvious or well known) that the contribution cannot be recognized. The same rule applies to any part of the paper; a reader becomes very bewildered when he cannot ascertain from the discussion what is old and what is new.

Results and Discussion -- There are many different methods of expressing results. These results may be artificially created by experimentation, or they may be a consequence of the natural occurrence of events. In the former condition, the experimenter is both creator and observer, and this arrangement very often facilitates the task of interpreting the data. In the latter case, the observer may not be the creator. Therefore, the means by which he can express the results of his observations are limited -- limited to his ability to convey to others an accurate description of what has taken place. In view of these difficulties, the author should avail himself of methods such as photography, the periodic collection of memoranda in a small notebook (a study diary provides an important and useful record of dates, observations, photographic identifications, etc.), drawings, and tabular summaries. Such procedures are indispensable to the rough drafting of material for a technical paper.

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Some authors prefer, wherever possible, to present all their experimental results (in the form of charts or tables) first, in a section entitled Results, and then to discuss them; others prefer to discuss their results as they are presented. Sometimes the subject matter develops in such a way that one or the other method is obviously to be preferred. Although this part of a report is normally the most important part, adequate presentation depends mainly on careful and logical analysis of the material rather than on rules of report writing.

In the introduction, the problem and what was hoped to be accomplished or contributed was described. This introduction should be kept in mind in the presentation of the data; show by the discussion how these data shed light on the problem or, in general, to what extent the originally stated objectives were achieved. Some authors also find it helpful to prepare a list of the main points that were developed in the investigation (these are, essentially, the final conclusions of the report) and then to aim the results and discussion sections to bring out these points.

Organization along some such line is essential. Avoid a rambling, disorganized presentation. Above all, avoid the ponderous revelation of unenlightening trivia. Carefully avoid casual digressions from the main theme and purpose of the study. Digress only to record a discovery or observation which is believed to be of great significance in other subject areas and which cannot be disclosed elsewhere in a suitable manner. Make the reader aware of any discourses which are, in this way, unrelated to the purpose and objectives stated at the beginning of the report.

Summary and(or) Conclusions and Recommendations

A section devoted to conclusions or recommendations, or both, generally follows the results and(or) discussion section(s) of a report. Here all separate conclusions recorded in earlier sections are brought together, usually listed in decreasing order of importance. They may be analyzed briefly, if necessary, so the reader who is interested only in the conclusions is not left with a mere listing which he must organize into a meaningful whole. The recommendations section indicates action that should be taken on the basis of the study being reported.

The section or chapter on conclusions should present actual findings of the study. Supporting information or data for the conclusions should be presented in the report body and appropriately referenced under conclusions. If findings of the study were indefinite or inconclusive, a simple statement to that effect should be included at the beginning of the

section or chapter on conclusions. Suggestions or specific methods for implementation should also be discussed in this portion of the report.

The results and discussion will already have presented the main contributions of the study. It has become standard practice, however, to gather together these main contributions and enumerate them in a final section called Conclusions. Essentially, the conclusions state concisely (seldom more than two sentences per conclusion) what has been concluded from the research. They are the answer to "So you have done some research. What did you find out?" They should be written with little or no reference to the body of the report, as a favor to those readers who like to go directly from the introduction to the conclusions to see how it turned out. An additional purpose in making them approximately self-sufficient is to minimize the possibility of a misunderstanding if they are quoted. (For similar reasons, incidentally, it is generally desirable that figures and tables be reasonably self-explanatory.)

Sometimes the research turns out in such a way that enumerating sharply drawn conclusions is practically impossible. In such cases, a short discussion of the problem and what was learned and the opinions of the author should be given under conclusions. Sometimes, however, the original problem, as stated in the introduction, remains essentially unanswered (as when the experimental technique turned out to be less useful than originally expected). A frank discussion of the situation, together with possible suggestions for future research, is preferable in such cases to drawing uninteresting or irrelevant conclusions. Such a final section is generally entitled Concluding Remarks.

Sometimes the technical report merely describes equipment or procedures, or it tabulates design data obtained by standard methods. Neither conclusions nor concluding remarks is usually appropriate or desirable for such a paper. If a closing section is desired, it might be a resume, in which the information is briefly sketched and the charts or tables containing the data are indicated.

References and(or) Bibliography

Certain reports may also require a list of references, which lists sources of information specifically referred to in the report, or a bibliography, which lists sources of information relevant to the study. Documents cited in the text are to be included in the list of references. Those references shall be made by a number enclosed in parentheses, and the number for each shall be the order in which they first are cited in the text. A bibliography may be included to provide supplementary information or listing of pertinent documents that were not cited in the text. Bibliographic entries shall be made

alphabetically by the author's last name. In the event there is no author, entry shall be made alphabetically by title of the article. Reference and bibliographic entries shall be arranged as author, title, identifying number, source, and date.

Appendices

The appendix, always the final section, represents the lowest level of abstraction. Here the interested reader can find the wealth of detail which supports the writer's conclusions and recommendations. It may contain charts, graphs, tables, drawings, pictures, glossaries of terms, and any other materials required for a full understanding of the situation covered in the report. If it contains many items, the appendix should have its own table of contents.

A problem is how much of the supporting evidence (tables, graphs, and so on) should appear in the text and how much should be relegated to the appendix (appendices). The only valid generalization that can be offered is that the text should be as uncluttered as possible. There are always special situations.

Most readers prefer to have generalizations presented in words. Short tables, of course, are often useful to support arguments; but if too many are used, they will not only break up each page, making it hard to read, but also lengthen the report. By packaging a report so that his reader can examine the text and appendices at the same time, the author can move almost all such materials out of the text.

Appendices should contain sufficient supporting information so that all the work reported may be checked. When more than one appendix is used, they shall be designated as Appendix A, Appendix B, etc. Each appendix shall be titled. Extensive tabular data and large maps, charts, and figures all belong here. However, this section is not to be regarded as a "catch-all" for masses of superfluous information. Appendix material should be selected with the same care that is applied to other parts of the report.

Tabular and Graphical Displays

The inexperienced writer tends to present his numerical results in the form of tables, usually because he has studied the results so thoroughly he can see significant trends from the numbers themselves. The reader is much less familiar with the results and may fail to see from tables the trends that seem so obvious to the author. In general, visual presentation by means of charts or curves will put across the points much more effectively. Furthermore, considerable thought should be given to the question of how to plot results so their message will be most easily grasped. Crowding too many curves on one figure should be avoided so the reader

can easily identify each curve as it is discussed in the text.

State clearly in the text what each table or figure shows and how the table or figure shows it. Avoid referring to a table or figure in so casual a manner that the reader himself must determine how the table or figure is related to the discussion.

Tables -- Each table should stand alone, but be accompanied by an adequate description of the material contained therein. The textual description normally should precede the table and serve as an introduction to the data to follow. Although tables are to be discussed separately, the writer must make an effort to maintain continuity of the text by arranging this kind of information in an orderly and intelligible sequence.

Small tables may often be combined into one large table. If this is done, then the descriptions of each are also combined. When the volume of tabular results is such that it tends to obstruct the reader in any way, these data should be relegated to an appropriate section of the appendices.

Tables shall be numbered consecutively, in the order of first reference in the text, with Arabic numerals. All tables should be referred to as discussed in the text. Tables shall be captioned as briefly as possible and capitalized letters shall be used throughout the caption. The caption should begin flush with the left-hand margin of the table. All words in column headings shall be capitalized and columns shall be separated sufficiently and run to indicate clearly which heading goes with which column. Tables should be laid out so the length-to-width dimensions appear balanced on the printed page. Tables which result in one dimension very much greater than the other should be avoided. Drafts for tables should be submitted in "hand-written" form using soft, dark pencils to obtain a readily legible copy. Care must be taken to have the material copied exactly line for line as it should appear in the typed form. This is particularly important in the column headings. It is necessary to provide the tabulation of data in both the English and SI systems of measurement.

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Figures -- Figures shall be numbered consecutively with Arabic numerals, in the order in which they are first referenced in the text. No figure not referenced in the text should be included in the report. Do not use the abbreviation *Fig.* in text references, captions, and tables of contents or list of figures. Captions should be consistent for capitalization and punctuation. Figure captions shall be typed on separate page(s) and attached to the rough draft for review. This listing would also be used for the **List of Figures** to be included in the table of contents. Each figure shall be appropriately labeled so the correct caption may be placed therewith during reproduction. For that purpose, figure numbers shall be penciled on the lower, right corner of the page. Photographs are often comparative one with another with respect to time. It is important that the date, location, and orientation of each photograph of a highway, a landform, a structure, etc. be given in the caption. Photographs showing magnified views require scales. Do not use scotch tape on photographs. Do not write on the front or back of photographs in areas which are to be reproduced. Multicolored illustrations require a separate sheet for each color for reproduction purposes. Register marks shall be used on each overlay for use in alignment. Graphs shall not be prepared on fine grid paper; the fine lines do not reproduce.

Drawings shall be submitted in penciled form exactly as they are to be drafted. Do not leave it to the draftsman to second guess the author. The drawing should be centered on the page, preferably 8 1/2 x 11 inches (216 x 279 mm). It is also necessary to account for the indication of scales and other information in terms of both the English and SI systems of measurement. The legend must leave no question in the reader's mind as to the identification of things shown, including units of measure and properly-titled ordinates and abscissae. Captions and information should be contained in the drawing so it may be adequately identified, even if removed from the report, as many readers will do.

Equations -- Equations shall be numbered consecutively with Arabic numerals in parentheses at the right-hand margin. Symbols shall be identified in the text after their first use and in a separate list of symbols. In final form, numerators and denominators will be separated by a slant line (i.e., equations will be written in linear form), and that system shall be used in the rough draft. Equations shall be indented or centered on the line immediately following the first text reference.

EXPRESSION OF THOUGHTS

Words

Only a few remarks are needed with regard to choice of words. Avoid using a rare word unless it is essential. Do not use a common word in a rare usage; it will mystify the reader without even suggesting he consult an unabridged dictionary. Foreign words and phrases should not be used; whatever elegance or subtlety they may add to the paper is probably lost on the reader, who will merely find the paper that much more difficult to follow. These remarks, of course, do not refer to the technical words of civil and transportation engineering. Be sure, however, that the technical words are not merely the jargon of this agency, because such language can be meaningless to workers at another agency.

Emphasize clarity and easy readability, and save ornamentation for other occasions. Use specific and concrete words whenever possible. Check the spelling of words about which you are doubtful -- particularly compound words (see APPENDIX A).

Sentences

One cannot prescribe for sentences "do" and "don't" rules that are as simple and obvious as those for words. To present the material as clearly as possible is still the basic guide, and the following few suggestions, of fairly general applicability, will exemplify the approach.

The length of a sentence should generally not exceed about 35 words, unless it is broken up (as by semicolons) into two or three distinct and logically consecutive parts. Any sentence presents the reader with the task of first identifying its constituent phrases, and then bearing them all in mind while their logical interrelation crystallizes. Forcing him to bear in mind and fit together more than about ten phrases (each of about three words) is unnecessarily cruel.

An equally important rule is that a sentence should generally contain some indication as to how it is related to the preceding sentence or to the development of the paragraph. This indication is usually near the beginning of the sentence. For example, in the first three sentences of this paragraph, the opening phrases ("An equally important rule," "This indication," and "For example") all serve to show relationship to what has gone before. Omitting such tie-in wording may not essentially alter the main content of the sentence, but it forces the reader to determine for himself how the sentence fits

into the train of thought. In general, remember to indicate by appropriate wording how a sentence is related to the preceding sentence. Take the reader by the hand, and lead him step by step along the path by which the topic is developed. Practice the principle of parallelism -- like ideas require like expression. Make phrases of equal rank also alike in structure.

Make every effort to eliminate ambiguous phraseology. Unfortunately the English language offers many opportunities for ambiguity, as in the following well-known pitfall:

Time flies. You can't. They fly too fast.

where the reader is confounded by the third sentence until he goes back and reinterprets the first two sentences. The writer should ask himself as he writes each word, phrase, or sentence whether its meaning would be clear or whether it has a chance of being momentarily misunderstood.

Frequently a particular fact or idea must be stated more than once in a report; for example, it may be given in the introduction and then also in the methodology and in the results. Rather than treating it every time as new material, it might be introduced with a phrase such as "As has already been mentioned" or "Here, again, the fact that ..."; otherwise the reader may wonder whether his memory is playing tricks. Such introductory phrases are not always essential, but their omission can sometimes be very annoying.

Keep the thoughts of sentences moving; eliminate "padding." Make transitions between sentences smooth. Do not include too many ideas in a single sentence. Do not use twisted or complicated sentences so as to avoid awkward punctuation (see APPENDIX B) and(or) fuzzy, misleading, or double meanings. Sentences must be structured according to rules of grammar (see APPENDIX C). If the writer cannot analyze and diagram a sentence and properly identify all parts of the sentence and their relationship to other parts, the sentence is probably wrong and should be simplified and(or) reorganized. Do not accept a sentence having doubious structure. The sentence should be written so the reader can get the sense in a single reading.

Paragraphs

The main characteristic of the clear paragraph has already been mentioned; namely, that the relation of each sentence to the preceding or following one be clear, as by means of transition words or phrases. In addition, it may be desirable to indicate definitely the relationship of each paragraph to the preceding or the following one. Usually the relationship to preceding material is indicated in the opening sentence or sentences of the paragraphs; and relationship to following material is indicated in the final sentence or sentences of the paragraph. In any case, make sure the reader is not required to proceed very far into the paragraph (say, beyond the second sentence) before the general subject matter becomes apparent. Do not make him read on and on while wondering just how the paragraph fits into the report. The author is in a much better position than is the reader to organize the material; and the responsibility both for organizing it and for showing the organization rests on the writer.

Do not make paragraphs too long. Just as a sentence with too many phrases is difficult to grasp as a unit, so is the paragraph with too many sentences. A long paragraph should not, of course, be broken up into shorter ones by arbitrary subdivision. If a paragraph becomes very long, either simplify the idea or break up the idea into smaller units, with a paragraph for each. On the other hand, avoid the use of one-sentence paragraphs. If there is only one sentence in the paragraph, it suggests that the idea or subject is not sufficiently developed to be included in the report or that the sentence should be placed in another paragraph. Remember that a paragraph is an "episode" in a story and like a "scene" in a movie.

OUTLINES

An outline is an arrangement in summary or skeleton form of the material with which the writer proposes to deal. With the study question or objective and the conclusion in mind, and the preliminary analysis as a guide, the writer should prepare an outline. The study question or objective may not appear in exactly the same words anywhere in the final report, but it will be a constant and useful guide in (1) keeping the writer on the right track and away from irrelevancies and (2) suggesting points to be included and their proper order.

Outlines are valuable in two principal ways. First, the outline is *synoptic*; it permits the writer to view his material all together, to test it for unity and coherence. Second, it requires the conscientious writer to look at what he is doing and to see his material as a total pattern. It allows him to discover faulty presentation, wrong proportion or emphasis, gaps or omissions in his thinking, discursiveness (getting off the track or including irrelevant material), lack of co-ordination and parallelism between parts, and other defects.

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The Paragraph Outline

The simplest, least formal of the three kinds of outline is the paragraph outline. It is also perhaps the least useful in performing the function of the outline as explained above. It consists of a series of numbered sentences or phrases, each of which indicates the subject matter to be covered in one paragraph of the composition. The sentences or phrases should be parallel in form and equal in importance. After they are all set down, they may be renumbered to improve the order of presentation, always an important consideration.

The paragraph outline aids the writer in brief, tight compositions. It is suitable for letters (the points to be taken up in each successive paragraph being noted before the letter is written or dictated); for brief reports (especially somewhat informal ones), for brief talks, and for short informative articles.

The Sentence Outline

Like the topical outline, the sentence outline shows all the material the writer intends to cover, point by point, in proper order, and arranged to show logical relationships and relative importance. The sentence outline is sometimes called an analytical outline. Its purpose is to control the content and structure of a composition and to secure unity and coherence. The sentence outline differs from the topical outline in providing a complete sentence for every heading and subheading instead of just a phrase. The sentence outline has the advantage of forcing the writer to think his points out more fully and to express them as whole sentence units.

Since a sentence outline is often difficult to make early in the preparation of the report, some writers may prefer to proceed without one. A *preliminary sentence outline*, however, may be made by putting the conclusions of the preliminary synthesis into complete sentences, grouping them as needed, and arranging them on the proper levels of division. As he proceeds, the writer will probably discover relationships among his materials and possibilities for better arrangement that he did not foresee when he made his first sentence outline; but eventually he should arrive at a set of generalizations, and subgeneralizations that will be included in the report. The sooner this *final sentence outline* can be stated, the sooner the writer will have his material under control; and he will not have it under control until he can put his unifying generalizations, on each level of division, into complete sentences.

The Topical Outline

A topical outline is one in which the divisions and subdivisions of a piece of writing -- that is, the parallel and co-ordinate points or ideas expressed by the writer -- are shown by brief topical headings and(or) phrases that are expressed in strict parallel form. Because it is the most thorough and systematic, the topical outline is by far the most useful kind in compelling the writer to master his material and present it in a logical and clear manner. A topical outline should be made for every research report. Such an outline shows the structure of the whole composition and, when it is well done, achieves both orderliness and clearness. The structure is determined largely by the nature of the material and by the needs of the reader. The topical outline stresses the *material*, the *content*, point by point and *not the paragraphing*. Only by conscientious outlining can the writer test the structure and clarity of his work.

The preliminary analysis serves as a basis for this outline, but to make the report more useful to the reader, further analysis -- more division, regrouping of data, rearrangement of the order of parts -- must usually be undertaken. The writer should not be content until he has made the best outline he can, but he will find that, while he is writing the report, he will almost inevitably have to make further changes. The main points of the discussion are those *parallel and co-ordinate* steps or divisions of the whole discussion by means of which the writer intends to cover his ground. Note that all main points are parallel and co-ordinate with each other. They are parallel both in *form* and in *meaning* -- that is, they are equal to each other in importance and together they add up to the writer's whole discussion. They are expressed in exactly parallel grammatical form -- a series of nouns or of nouns plus modifiers, a series of gerunds, or some other kind of parallel series. There must always be *at least two* main points and *at least two* points of any subdivision. The result of a division cannot be one. Therefore, an outline must never contain an *I* or *1* without *at least* a corresponding *(parallel and co-ordinate) II* or *2* nor an *A* or *a* without *at least* a corresponding *B* or *b*. There *will be as many points or divisions, two or more*, as are needed to cover the larger point or whole subject.

In a topical outline there may be subdivision in some places and not in others; furthermore the number of points resulting from subdivision is not always the same. This means that subdivision of any given point is a separate consideration from subdivision *anywhere else*. This principle holds at any level of division or subdivision, but the division must be logical, orderly, and adequate at any level. Points are divided or subdivided when the clearness, accuracy, and adequacy of the treatment of the subject demands it, not in accordance with some arbitrary requirement. All division or subdivision must be systematic.

INSTRUCTIONS FOR PREPARATION OF DRAFTS OF REPORTS

Systems of Measurements

The fundamental schema to be used for expressing measurements in reports issued by this agency will be the English pound-foot-second system. However, the International System (SI) will also be used as a secondary indication of measurements. In textual material, the English units will be given first, followed by the SI units in parentheses. Figures may require double axes -- one for English units and one for SI units. Tabular data may also require double entries to indicate both the English and SI units of measurements. ASTM Designation E 380, Metric Practice Guide *(5)*, will be used and followed in all respects for indicating SI units and for making conversions from the English to the SI systems.

On occasion, this agency will prepare a report which is to be published by some other agency or group such as the Transportation Research Board, the American Society of Civil Engineers, the Institue of Traffic Engineers, etc. Often such organizations have their own guidelines for the use of systems for indicating measurements. In such cases, the guidelines of those organizations will be followed.

Check List

A. General

1. Drafts of reports shall be double spaced (on 8 1/2-x 11-inch (216- x 279-mm) paper, typed on one side only) and proofed (see APPENDIX D) by the author(s) prior to submission. Each draft shall be arranged in the order in which the author(s) desires and shall include all tables, illustrations, and lists to be included in the final report. Drafts shall be submitted to the Assistant Director of Research for review prior to finalizing for reproduction. The following should be included:
   - a. Technical Report Standard Title Page (including Abstract)
   - b. Title Page
   - c. Table of Contents
   - d. Executive Summary
   - e. Report
   - f. References and(or) Bibligraphy
   - g. Appendices
2. Pages numbered.
3. Words.
   - a. Use dictionary to check spellings.
   - b. See APPENDIX A for compound words.

4. Sentences and Paragraphs.
   - a. Reread to eliminate unnecessary and(or) awkward constructions.
   - b. See APPENDIX B for rules for punctuation.
   - c. See APPENDIX C for rules of grammar.
5. Numerals (see APPENDIX E).

B. Tables
1. Penciled copy, exactly as to be typed.
2. English and SI units.

C. Figures (see APPENDIX F)
1. Drawings in penciled form, properly located on the page, exactly as to be drafted. To the extent practical, limit drawings in size to 8 1/2 x 11 inches (216 x 279 mm).
2. Use no scotch tape on photographs.
3. Do not write on photographs (front or back) with hard pen or pencil.

THE TECHNICAL TALK

The engineer has often been subjected to the lecturer who buries his face in his papers and, in an expressionless voice, reads long involved sentences while waving vaguely toward hopelessly complicated charts. One may wonder why any rational person would commit such an atrocity; yet many research engineers actually seem to have no better concept of what a technical talk should be. Needless to say, the talk, like the printed report, should convey information.

Simplicity

Normally, 10 to 20 minutes will be allowed to present to visiting scientists a review of the research. A first reaction is to insist that more than 20 minutes is needed. This argument will be rejected, however. Long and brilliantly comprehensive sentences are concocted, all numerical results are organized so they can be presented in rapid-fire order, and 15 slides are selected, each crammed with detailed information. Unfortunately, when the prepared speech is first read, it takes nearly 30 minutes instead of 20. The lecturer is not very disturbed, however, because he is confident that, with a little practice, he will be able to increase his speaking rate until the delivery time is down to the required 20 minutes.

All that is missing is consideration for the central figure -- the audience. After 2 minutes of the talk, he will be rapidly developing mental indigestion; after 5 minutes, he will have lost the thread of the discussion; and during the remainder of the talk, he will simply concentrate on hating the speaker or on trying to sleep. Considering that the listener will probably hear about 15 talks during the day, on a variety of subjects in perhaps none of which he is expert, and considering that such a person can hope to learn in one day (learn, that is, so he will remember it for a long time) only a small portion of what is exposed to him, the futility of trying to cram detailed information into him is obvious. Actually, the lecturer's mission will usually be successfully accomplished if the listener is left with a fairly clear impression of the nature of the work and of the most significant results or contributions.

In preparing a talk, then, the first task does not consist of gathering together all of the data, but rather in thinking over the subject and deciding just what fundamental progress has been made, or what new fundamental ideas have been developed, that the lecturer wishes to give his hearer to carry away with him. Details such as numerical data have their place, of course, in the technical talk; but it must be made clear whether the numbers are of such fundamental importance that they should be remembered as such, whether they are presented for comparison with other numbers, as in showing trends or in showing agreement between theory and experiment, or whether they are presented merely to show the thoroughness or scope of the work.

The lecturer should next consider how to organize the presentation with utmost simplicity and logic, so as to maximize the probablity that the hearer will absorb the story. As to whether the allotted time is adequate, the question need not concern the speaker. He should be able to describe his work in any specified amount of time, be it 1 minute or 1 hour; all that is required is the presentation be as informative and understandable a story as possible within the allotted time.

Choice of Language and General Approach to Presentation

As a result of years of experience in conversation, both technical and nontechnical, each researcher has developed a speaking style that is not too demanding of either his own or the listener's mental processes and that serves satisfactorily to convey ideas; and this speaking style, in general, is entirely different from that of a printed technical report. Such language and the indicated mannerisms (pauses, hand motions, and so on) are more characteristic of some people than of others. There is no objection to the speaker having and expressing his own personality; and it is definitely not suggested that he try to imitate anyone else's mannerisms or style of speech. In general, merely reading or reciting a carefully written technical report does not constitute a technical talk.

The technical talk is not merely a technical report that is short enough to read or recited in, say, 20 minutes; rather, it is a monologue, presented in whatever conversational, or perhaps teaching, manner is natural to the speaker, in which he tries his very best to get across a few basic ideas to the audience. Since the man in the audience cannot reexamine any sentence or paragraph he finds confusing, every thought must be clear enough to be understood the first time. If the thought is a difficult one, it is best to repeat it -- in the identical words or in different words and with a slightly different approach. Even an awkward hesitation, while groping for the right word (just as in normal conversation), may have some value in that it excites the hearer's interest while he tries sympathetically to guess the desired word. Avoid, however, affecting excessive casualness or extemporaneousness, since the effectiveness of the talk can be spoiled by the appearance of carelessness in its preparation or lack of earnestness in its presentation.

In general, the talk should not be written out during its preparation. The inexperienced speaker will usually be unable to write anything but the formal sentences of the typical printed report, so that his talk is ruined from the moment he puts pencil to paper. It should be composed entirely in the speakers mind; and, as he composes each sentence, he should make the hand motions, hesitations, and facial expressions that will accompany it. At the same time, he should ask whether it will be clear; and if not sure, he needs to struggle with it further. After the speaker is satisfied with the opening sentences, the conclusions, and a few other especially critical sentences, he may write them down to assure having them exactly as composed. Do not try to improve them as they are written, however, for they will surely be spoiled.

The question as to whether the talk should be memorized will now be seen as rather irrelevant and misleading. After the speaker has composed and rehearsed the talk so that in two successive rehearsals (alone or with a friend) he is satisfied with it, the speaker may be sure the final talk will be satisfactory. Some speakers will, by this time, have essentially memorized every word and gesture, while others will remain quite flexible as to detail. There is very little chance he will forget anything important, and no more than a small card outlining the main points should be taken to the speaker's stand.

In the technical talk, the contents are of paramount importance; the speaker is merely the medium through which they are presented. If comments of an audience after a technical conference has adjourned are considered, it would be found that oddities of presentation, such as strange accents, speech defects, nervousness, or even grotesque eccentricities of manner seem to go virtually unnoticed so long as they do not interfere with intelligibility; bitter criticism is applied to speakers who read incomprehensible papers. The speaker is not required to give a polished performance, but only a clear one. The listeners are not interested in judging the speaker. They want only to understand what he is telling them.

Visual Aids

The technical talk should resemble as closely as possible the description of the work that might be given to the speaker's friend. Just as he might be shown the apparatus or plots, perhaps using the blackboard and making an explanatory sketch, the speaker should also use the same or similar visual aids in a technical talk. Instead of being shown on paper or on the blackboard, the illustrative material will normally be on charts or slides, prepared in advance with all necessary accuracy, clarity, and neatness. Do not consider, however, that such previous preparation saves much time in the presentation, or that a chart may be presented with nothing more than a vague gesture and casual remark.

Actually, the charts and slides form the backbone of the talk, and each must be presented with utmost effort at clarity. State the subject of the slide, say what the abscissas and ordinates are, explain, if necessary, the special significance of these abscissas and ordinates and of the method of plotting. If the origin is not at the juncture of the scales, mention that fact also. Run the pointer along each curve as it is described and tap sharply with the pointer at any point on the curve to which special attention is called. Furthermore, the language used while discussing the slides should be appropriate to the use of the pointer.

Make every effort to keep charts and slides simple. The purpose is to get across a few basic ideas rather than to present large quantities of information.

The number of slides and charts to prepare depends on many factors and can hardly be prescribed by formula. Nevertheless, it may be of interest to note that experienced speakers seem to use, on the average, about one slide for every 2 or 3 minutes of their talks. Presumably, if fewer slides are used, helpful illustrative material may be needlessly sacrificed, too much may be crowded onto each slide; if more slides are used, too much information is being presented. "Two to 3 minutes per slide," of course, is hardly the type of rule to be followed strictly (some slides, in special circumstances, may be displayed for only 15 to 20 seconds); it is mentioned here only as a guide to the inexperienced speaker. The only rule that is absolutely basic is that the material should be presented as clearly as possible.

Organization and Contents

The organization and contents of a technical talk are, in general, similar to those of the written report, although a certain degree of flexibility is permissible for the purpose of increasing clarity or of maintaining interest. Thoroughness, completeness, and rigor may have to be sacrificed in order not to present the hearers with more than they can assimilate. Emphasis will be on no more than a very few topics, and all the incidental material that would be meticulously detailed in a printed report will be largely eliminated from the talk. Of course, the language and manner are especially important -- while curtailing remarks on experimental techniques, the speaker must nevertheless give his audience a feeling of reasonable confidence in the results.

Technical talks frequently seem to be organized around slides or other visual material. The talks seem to consist only of descriptions and discussions of the slides, and even the introduction and the conclusions may depend on slides. There is no objection to such a presentation, so long as the speaker gets his message across. Do not conclude from such talks, however, that the slides were prepared first and the talk was then composed around them. Slides and charts should be composed along with the talk, not before it. Avoid preparing them first and them trying to decide what to say about them, because a considerable loss of smoothness and logic may result.

The Printed Version

If a printed version of the talk is to be included in published proceedings of the meeting, write it in the more formal style of printed reports; but by no means feel obliged to carry over the same language and coverage into the talk itself. The printed version may, indeed, include data and discussion that had to be omitted from the talk, and may even include figures and tables that were not used in the talk. Such extensions of the paper should be held within bounds, however; published proceedings of technical meetings are not usually intended as substitutes for normally issued reports.

REFERENCES

1. S. Katzoff, **Clarity in Technical Reporting**, Second Edition, National Aeronautics and Space Administration, 1964.

2. W. M. Schutte and E. R. Steinberg, **Communication in Business and Industry**, Holt, Rinehart and Winston, 1960.

3. **Style Manual**, U.S. Government Printing Office, January 1973.

4. C. V. Wicker and W. P. Albrecht, **The American Technical Writer**, American Book Company, 1960.

5. **Metric Practice Guide**, Designation: E 380, American Society for Testing and Materials, 1972.

APPENDIX A

RULES FOR COMPOUND WORDS
(Modified from Reference 3)

General

1. A compound word is a union of two or more words, either with or without a hyphen. It conveys a unit idea that is not as clearly or quickly conveyed by the component words in unconnected succession. The hyphen is a mark of punctuation that not only unites but separates the component words and thus facilitates understanding, aids readability, and insures correct pronunciation. Word forms constantly undergo modification. Two-word forms first acquire the hyphen, later are printed as one word, and not infrequently the transition is from the two- to the one-word form, bypassing the hyphen stage.

Rules cannot be applied inflexibly. Exceptions must necessarily be allowed. However, current language trends point to closing up words which, through frequent use, have become associated in the readers' minds as units of thought.

2. In general, omit the hyphen when words appear in regular order and the omission causes no ambiguity in sense or sound.

> blood pressure
> book value
> day laborer
> living costs
> palm oil
> patent right
> real estate
> training ship

3. Except after the short prefixes *co, de, pre, pro,* and *re,* which are generally printed solid, a hyphen is used to avoid doubling a vowel or tripling a consonant.

> cooperation
> deemphasis
> preexisting
> anti-inflation
> micro-organism
> semi-independent
> brass-smith
> ultra-atomic
> shell-like
> hull-less

4. Print as one word compass directions consisting of two points, but use a hyphen after the first point when three points are combined.

> northeast
> southwest
> north-northeast
> south-southwest

Unit modifiers

5. Print a hyphen between words, or abbreviations and words, combined to form a unit modifier immediately preceding the word modified, except as indicated in Rule 6. This applies particularly to combinations in which one element is a present or past participle.

> Baltimore-Washington road
> English-speaking nation
> fire-tested material
> guided-missile program
> high-speed line
> long-term loan
> lump-sum payment
> part-time personnel
> rust-resistant covering
> 1-inch diameter; 2-inch-diameter pipe
> a 4-percent increase

6. Where meaning is clear and readability is not aided, it is not necessary to use a hyphen to form a compound. Restraint should be exercised in forming unnecessary combinations of words used in normal sequence.

> atomic energy power
> bituminous coal industry
> durable goods industry
> flood control study
> land use program
> natural gas company
> per capita expenditure
> portland cement plant
> public utility plant
> soil conservation measures

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7. Print without a hyphen a compound predicate adjective or predicate noun the second element of which is a present participle.

> The duties were price fixing.
> The effects were far reaching.
> The shale was oil bearing.
> The area was used for beet raising.

8. Print without a hyphen a compound predicate adjective the second element of which is a past participle; omit the hyphen in a predicate modifier of comparative or superlative degree.

> The area is drought stricken.
> The paper is fine grained.
> The boy is freckle faced.
> This material is fire tested.
> The cars are higher priced.
> The reporters are best informed.

9. Print without a hyphen a two-word modifier the first element of which is a comparative or superlative.

> better drained soil
> higher level decision
> larger sized stone
> lower income group
> but uppercrust society
> uppercase type
> lighter-than-air craft
> higher-than-market price

10. Do not use a hyphen in a two-word unit modifier the first element of which is an adverb ending in *ly*; do not use hyphens in a three-word unit modifier the first two elements of which are adverbs.

> heavily laden ship
> unusually well preserved specimen
> very well defined usage
> often heard phrase
> but ever-rising flood
> still-lingering doubt
> well-kept farm

11. Where two or more hyphened compounds have a common basic element and this element is omitted in all but the last term, the hyphens are retained.

> 2- to 3- and 4- to 5-ton trucks
> 2- by 4-inch boards, but 2 to 6 inches wide
> 8-, 10-, and 16-foot boards
> long- and short-term money rates
> but twofold or threefold, not two or threefold
> intrastate and intracity, not intra-state and -city
> American owned and managed companies

12. Do not use a hyphen in a unit modifer consisting of foreign phrase.

> bona fide transaction
> ex officio member
> per capita tax
> prima facie evidence

13. Do not print a hyphen in a unit modifier containing a letter or a numeral as its second element.

> article 3 provisions
> class II railroad
> grade A milk
> point 4 program

14. Do not print a hyphen between the I, US, or KY and the number in a highway route designation, except when it is used as an unit modifier.

> I 75
> KY 15
> but I-75 traffic
> US-25E landslide

15. Do not use a hyphen between independent adjectives preceeding a noun.

> big gray cat
> a fine old southern gentleman

Prefixes, suffixes, and combining forms

16. Print solid combining forms and prefixes, except as indicated elsewhere.

17. Use a hyphen or hyphens to prevent mispronunciation, to insure a definite accent on each element of the compound, or to avoid ambiguity.

> anti-hog-cholera serum
> co-op
> mid-ice
> non-tumor-bearing tissue
> re-cover (cover again)
> re-treat (treat again)
> un-ionized
> un-uniformity

18. Use a hyphen to join duplicated prefixes.
> re-redirect
> sub-subcommittee

19. Print with a hyphen the prefixes *ex, self,* and *quasi.*

>ex-governor
>ex-trader
>self-control
>self-educated
>quasi-academic
>quasi-corporation

Numerical compounds

20. Print a hyphen between the elements of compound numbers from twenty-one to ninety-nine and in adjective compounds with a numerical first element.

>twenty-one
>twenty-first
>24-inch ruler
>8-hour day
>10-minute delay
>3-to-1 ratio
>.22-caliber cartridge
>2-cent-per-pound tax
>four-in-hand tie
>two-sided question

21. Print a hyphen between the elements of a fraction, but omit it between the numerator and the denominator when the hyphen appears in either or in both.

>one-thousandth
>two-thirds
>two one-thousandths
>twenty-three thirtieths
>twenty-one thirty-seconds
>three-fourths of an inch

Scientific and technical terms

22. Do not print a hyphen in scientific terms (names of chemicals, diseases, animals, insects, plants) used as unit modifiers if no hyphen appears in their original form.

>carbon monoxide poisoning
>guinea pig raising
>hog cholera serum
>methyl bromide solution
>stem rust control
>whooping cough remedy

23. Print a hyphen between the elements of technical compound units of measurement.

>horsepower-hour
>kilowatt-hour
>light-year
>passenger-mile

but vehicle mile

APPENDIX B

RULES FOR PUNCTUATION
(Modified from Reference 3)

General

1. Punctuation is a device to clarify the meaning of written or printed language. Well-planned word order requires a minimum of punctuation. The trend toward less punctuation calls for skillful phrasing to avoid ambiguity and to insure exact interpretation. The general principles governing the use of punctuation are: (1) if it does not clarify the text, it should be omitted and (2) in the choice and placing of punctuation marks, the sole aim should be to bring out more clearly the author's thought. Punctuation should aid in reading and prevent misreading.

The colon is used

2. Before a final clause that extends or amplifies preceeding matter.

Give up conveniences; do not demand special privileges; do not stop work: these are necessary while we are at war.

Railroading is not a variety of outdoor sport: it is service.

3. To introduce formally any matter which forms a complete sentence, question, or quotation.

The following question came up for discussion: What policy should be adopted?

He said: [if direct quotation of more than a few words follows].

4. In bibliographic references, between place of publication and name of publisher.

Congressional Directory. Washington: U.S. Government Printing Office.

5. To separate book titles and subtitles.

Financial Aid for College Students: Graduate
Germany Revisited: Education in the Federal Republic

The comma is used

6. To separate two words or figures that might otherwise be misunderstood.

Instead of hundreds, thousands came.
Instead of 20, 50 came.
February 10, 1929.
In 1930, 400 men were dismissed.
To John, Smith was very kind.

7. After each of a series of coordinate qualifying words.

short, swift streams
but   short tributary streams

8. To set off parenthetic (non-restrictive) words, phrases, or clauses.

Mr. Jefferson, who was then Secretary of State, favored the location of the National Capital at Washington.
It must be remembered, however, that the government had no guarantee.
It is obvious, therefore, that this office cannot function.
The atom bomb, which was developed at the Manhattan project, was first used in World War II.
Their high morale might, he suggested, have caused them to put success of the team above the reputation of the college.
The restriction is laid down in title IX, chapter 8, section 15, of the code.

but:

The man who fell [restrictive clause] broke his back.
The dam which gave way [restrictive clause] was poorly constructed.
He therefore gave up the search.

9. To set off words or phrases in apposition or in contrast.

Mr. Green, the lawyer, spoke for the defense.
Mr. Jones, attorney for the plaintiff, signed the petition.
Mr. Smith, not Mr. Black, was elected.
James Roosevelt, Democrat, of California.

10. After each member within a series of three or more words, phrases, letters, or figures used with and, or, or nor.

red, white, and blue
horses, mules, and cattle; but horses and mules and cattle
by the bolt, by the yard, or in remnants
a, b, and c
six, seven, and ten
neither snow, rain, nor heat
2 days, 3 hours, and 4 minutes (series); but
        2 days 3 hours 4 minutes (age)

11. Inside closing quotation mark.
> He said "four," not "."
> "Freedom is an inherent right," he insisted.
> Items marked "A," "B," and "C," inclusive,
> were listed.

12. To separate thousands, millions, etc., in numbers of four or more digits.
> 4,230   50,491   1,000,000

The comma is omitted
13. Between month and year in dates.
> June 1938
> 22d of May 1938
> February and March 1938
> January, February, and March 1938
> January 24 A.D. 1938
> 150 B.C.
> Labor Day 1966
> Easter Sunday 1966
> 5 January 1944 (military usage)

14. Between two nouns one of which identifies the other.
> The Children's Bureau's booklet "Infant
> Care" is a bestseller.

15. Wherever possible without danger of ambiguity.
> $2 gold
> $2.50 U.S. currency
> $3.50 Mexican
> Executive Order No. 21
> General Order No. 12; but General Orders,
> No. 12
> Public Law 85-1
> My age is 30 years 6 months 12 days
> John Lewis 2d (or II)
> Martin of Alabama; Martin of Massachusetts;
> but Robert F. Kennedy, of New York;
> Kennedy of Massachusetts (duplicate
> names of Senators or Representatives in
> U.S. Congress)
> Carroll of Carrollton; Henry of Navarre (places
> closely identified with the persons); but
> John Anstruther, of New York; President
> Hadley, of Yale University
> James Bros. et al.; but James Bros., Nelson
> Co., et al. (last element of series)

The dash is used
16. To mark a sudden break or abrupt change in thought.
> He said -- and no one contradicted him -- "The
> battle is lost."
> If the bill should pass -- which God forbid!
> -- the service will be wrecked.
> The auditor -- shall we call him a knave or
> a fool? -- approved an inaccurate
> statement.

17. Instead of commas or parentheses, if the meaning may thus be clarified.
> These are shore deposits -- gravel, sand, and
> clay -- but marine sediments underlie
> them.

18. Before a final clause that summarizes a series of ideas.
> Freedom of speech, freedom of worship,
> freedom from want, freedom fear -- these
> are the fundamentals_ of moral world
> order.

Ellipsis are used to indicate omissions by
19. Three periods; four periods, when sentence is brought to a close.

20. A line of asterisks (or periods) indicates an omission of one or more entire paragraphs.

Parentheses are used
21. To set off matter not intended to be part of the main statement or not a grammatical element of the sentence, yet important enough to be included.
> This case (124 U.S. 329) is not relevant.
> The result (see Figure 2) is most suprising.
> The United States is the principal purchaser
> (by value) of these exports (23 percent
> in 1955 and 19 percent in 1956).

22. To enclose a parenthetic clause where the interruption is too great to be indicated by commas.
> You can find it neither in French dictionaries
> (at any rate, not in Littre) nor in English.

23. To enclose an explanatory word not part of the statement.

> the Erie (Pa.) News; but the News of Erie, Pa.
>
> Portland (Oreg.) Chamber of Commerce; but Washington, D.C., schools.

24. To enclose letters or numbers designating items in a series, either at beginning of paragraphs or within a paragraph.

> The order of delivery will be (a) food, (b) clothing, and (c) tents and other housing equipment.
>
> You will observe that the sword is (1) old fashioned, (2) still sharp, and (3) unusually light for its size.
>
> Paragraph 7(B) (1) (a) will be found on page 6.

25. A reference in parentheses at the end of a sentence is placed before the period, unless it is a complete sentence in itself.

> The specimen exhibits both phases (Plate 14, A, B).
>
> The individual cavities show great variation. (See Plate 4.)

The period is used

26. After legends and explanatory matter beneath illustrations. However, legends without descriptive language do not require periods.

> Figure 1. Schematic Drawing.
>
> Figure 1. Continued.
>
> but Figure 1 (no period)

The period is not used

27. After the initials for technical society designations.

> AASHTO
> ASTM
> ASCE
> TRB

Quotation marks are used

28. To enclose any matter following the terms *entitled, the word, the term, the column marked, designated, classified, named, endorsed,* or *signed;* but are not used to enclose expressions following the terms *known as, called, so-called,* etc., unless such expressions are misnomers or slang.

> Congress passed the act entitled "an act * * *."
>
> After the word "treaty," insert a comma.
>
> Of what does the item "Miscellaneous debts" consist?
>
> The column "Imports from foreign countries" was not * * *.
>
> The document will be marked "Exhibit No. 21"; but The document may be made exhibit No. 2.
>
> The check was endorsed "John Adamson'"
>
> It was signed "John."
>
> Beryllium is known as glucinium in some European countries.
>
> It was called profit and loss.
>
> The so-called investigating body.

29. At the beginning of each paragraph of a quotation, but at the end of the last paragraph only.

30. To give greater emphasis to a word or a phrase. (For better typographical appearance and legibility, such use of quotation marks should be kept to a minimum.)

Quotation marks are not used

31. To enclose extracts that are indented or set in smaller type, or solid extracts in leaded matter; but indented matter in text that is already quoted carries quotation marks.

The semicolon is used

32. To separate clauses containing commas.

> Donald A. Peters, president of the First National Bank, was also a director of New York Central; Harvey D. Jones was a director of Oregon Steel Co. and New York Central; Thomas W. Harrison, chairman of the board of McBride & Co., was also on the board of Oregon Steel Co.

> Reptiles, amphibians, and predatory mammals swallow their prey whole or in large pieces, bones included; waterfowl habitually take shellfish entire; and gallinaceous birds are provided with gizzards that grind up the hardest seeds.

> Yes, sir; he did see it.
> No, sir; I do not recall.

33. To separate statements that are too closely related in meaning to be written as separate sentences, and also statements of contrast.

> Yes; that is right.
> No; we received one-third.
> It is true in peace; it is true in war.
> War is destructive; peace, constructive.

34. To set off explanatory abbreviations or words which summarize or explain preceding matter.

> The industry is related to groups that produce finished goods; i.e., electrical machinery and transportation equipment.

> The project involved three metal producers; namely, Jones & Laughlin, Armco, and Kennecott.

35. The semicolon is to be avoided where a comma will suffice. (See Rule 10.)

> Regional offices are located in New York, N.Y., Chicago, Ill., and Dallas, Tex.

APPENDIX C

RULES OF
GRAMMAR AND SENTENCE
CONSTRUCTION

TYPES OF WRITING

Reports usually fall into one of three types of writing: description, exposition, and argumentation. The more the writer knows about each one and its demands, the easier will be his task of organization. First, the author should be familiar with the aim of each. The purpose of description is to make the reader see, of exposition to make him understand, and of argument to convince him an idea is true. Second, the author should know the methods and techniques of each. However, it should be realized that few reports are wholly one type of writing or another, and most contain elements of all three.

Description

The aim of description is to bring a scene, a condition, or an object before the readers' eyes through the use of vivid detail and sensory language. A dramatic context aids in developing the dominant impression essential to a description. This impression is the main mood to create, the central attitude to establish. Angle of visiion is an important aspect of a description. When the writer describes, he must do so from a certain vantage point. Hence, the angle from which the writer describes something controls what will be included.

Another important aspect of description is selection of detail. Choose only those details relevant to the dominant impression. They must be set forth in such a way that they form a sequence that makes a single point. Illogical or irrelevant details not only detract from the unity of purpose but also destroy the mood or atmosphere the writer seeks to develop. Be careful not to overload the report with superfluous details, so that the reader becomes confused or bored, or to include too few, so he is unable to visualize what the author wants him to see. Furthermore, organize details in such a way that they present a clear pattern.

The organization of a description varies with the material and with the purpose. If the subject to be described is a person, begin with his physical features and proceed to his actions, ideas, and the impression he makes on others. If it is a place, dwell on those details that create a unified mood. If it is a building, focus on one outstanding architectural aspect or move from the ground floor to the top floor or from the right side to the left. The main thing is to have an appropriate plan which will achieve the objective in stimulating the reader to see what the author is writing about and, after seeing it, to come to some understanding of the point being made.

Exposition

The type of writing most often used in technical writing is exposition, explaining either what something is or why it happens or how it works. Although description is used in such reports, the primary purpose is to discuss the topic in order to reach a conclusion. The author is dealing with ideas now rather than objects. The appeal is more to the mind than to the senses. Present the topic in a clear and direct manner with as much explanation and as many illustrations as needed to support the points. The goal is the transmission of the writer's ideas and knowledge so that they can be understood. There are three kinds of exposition most commonly used: comparison and contrast, definition, and analysis.

Comparison and Contrast -- The purpose of comparison and contrast is to explain and evaluate a subject in terms of something else in the same general class similar or dissimilar to it. After this has been done, a decision favoring one of them is reached. Or an argument preferring one thing to another can be offered. In any case, the writer is persuading the reader either that the similarities have meaning or that the differences will prove one idea or object in a class is better than some other idea or object in the same class.

There are two principal methods for organizing a contrast and comparison exposition. The first is to take one object or idea and enumerate all its features in the order of importance. Then take the other object and list the same features in the same order. A more complex approach is to list the features of each object or idea, and in a paragraph or section devoted to each, discuss each item on the list.

The contrast and comparison writing is the most mechanical in organization of the expository types and the most inflexible in terms of development. But it has a strong built-in structure that can always be depended on to support the topic with very little inventiveness on the part of the writer. Despite its rigid practice of swinging back and forth like a pendulum from one object or idea to the other, it comes alive because the writer has firsthand information about his topic and eagerly wants to persuade the reader.

Definition -- Definition points to what a thing is so the reader knows exactly what the writer is talking about. The construction of a definition involves two steps: placing the term to be defined in a class or genus to which it belongs and then stating the characteristics which set it apart from other objects in the same class. Definition literally means to set limits to.

There are many methods of definition. The most frequent are defining by a synonym, by analysis, by negatives (telling what a thing is not), by likeness (comparison, simile, analogy), by example (citing an example of the thing to be defined), by function, and by content (explaining a thing by talking about it in a paragraph). The selection of the appropriate technique depends on the term itself and the writer's purpose. For instance, if an abstract concept is to be defined, employ a familiar illustration or example. If two closely allied terms are involved, choose comparison and contrast. The writer may also have to analyze each and give examples. Methods are often combined. To distinguish the real meaning of a term from an erroneous one, a definition by negation would seem to be a first choice. But comparison and contrast could also be used. One of the most useful kinds of definition is tracing a term or concept back to its origin. This is particularly valuable when the history helps to clarify the present meaning.

The great weaknesses of most definitions are two: ambiguity that results from imprecise language and repetition of the original term in the definition, commonly referred to as circular definition. Two other weaknesses of definition are over-extension and over-restriction. An over-extended definition is one in which the class can apply to more things than the word defined. The definition of gasoline as an inflammable liquid can be applied to many more liquids than just gasoline. Over-restriction is the opposite. The class is more comprehensive than the term. Defining "murder" as the act of killing someone with a knife describes only one form of murder.

Analysis -- Analysis is the most common form of exposition. It stems from definition. First, it is necessary to know what a thing is, and then the writer can inquire into its operation and the reasons behind it. The how and the why are what analysis is all about. Much depends on asking questions of a topic, breaking it down into parts and subparts, and then evaluating it.

There are three things essential to any analysis -- examining the parts of a structure or stages of a process, relating these parts or stages, and evaluating the relation of them to each other. The method is a simple one in outline form but often complex in carrying out.

Argumentation

The third type of writing is argumentation, the presentation of reasoned opinion in a clear, convincing, and logical manner. This form of discourse is very common. Argument, heated and devious as it may seem on the surface, is the true test of a writer, for he has to employ rhetoric, logic, and psychology with all the skill at his command. The writer must know how to organize his ideas so they communicate easily, how to refute the opposition with facts, and most important of all how to reason with someone instead of arbitrarily forcing the writer's opinion on him.

The two basic elements of argumentation are objectivity and persuasion, or more simply, reason and emotion. First, the writer expresses his views, passionate though they may be, in as rational a way as possible. Certain non-logical devices such as personal appeal or direct or indirect references to people's likes and dislikes may be used to put over ideas. Everyone, no matter how sensible and detached he thinks he is, is vulnerable to all sorts of internal pressures that influence him. An awareness of this fact will help the writer determine just how to present his case.

Objectivity -- Argument may be carried on by proceeding from a series of facts to a generalization based on those facts (the inductive approach) or from a generalization to a specific conclusion based on that generalization (the deductive approach). The weakness most people have in developing an argument is the tendency to commit a fallacy by either a false statement, an untruth, or faulty reasoning. Since the burden of proof rests upon the writer, he should be certain of the points he makes and eliminate as many fallacies as he can, recognizing the complete elimination of them is impossible and, in some instances, can be used positively to help persuade an audience to agree with his way of thinking. Most errors that involve reasoning can be termed non sequiturs (i.e., conclusions that "do not follow" from the statement presented). Some common fallacies to avoid in arguments include:

1. The half-truth. A misrepresentation of the complete argument by stating part of the truth as the entire truth.
2. Either/or. A point based on the fact that either this is true or that is true. Such an argument can be valid only if the alternatives are exhaustively pursued.
3. Faulty generalization. A conclusion is reached from insufficient evidence.

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4. Faulty analogy. An argument based on the similarity between two situations without taking into consideration the many dissimilarities.
5. Begging the question. This occurs when it is assumed in the premise the conclusion to be proved.
6. Argumentum ad hominem (argument "to the man"). A form of emotional argument in which a discussion of the issues is turned to a discussion of personalities.
7. Argumentum ad populum (argument "to the people"). Similar to the above. This is the tactic of appealing to the irrational emotions and prejudices of the audience to avoid the issue.
8. The "red herring." This fallacy involves avoiding the issue by changing the subject.
9. Complex question. This is a loaded question with two parts used to trap the unsuspecting. It is impossible to answer without affirming part of the question, hence agreeing to do something that is self-incriminating.

Persuasion -- Argument is not only a matter of objectivity or rational appeal; it is also a matter of persuasion or emotional and ethical appeal. No one is convinced solely by facts or logic alone. Powerful as these can be, they do not finally convince a person of the truth of a proposition. What truly persuades him to accept or reject an idea is the earnestness with which it is presented (emotional appeal) and the character of the writer (ethical appeal) who offers it for consideration. The author can make a direct emotional appeal or an indirect one. In any case, the emotional and ethical appeal is used with a particular audience in mind. No argument takes place in a vacuum. The author must know his reader; he must think of the kind of person whose mind he is trying to change.

THE SENTENCE

A sentence is a group of related words representing an independent unit that presents one or more major thoughts and often one or more minor ones. A sentence must convey a thought to the reader so he can comprehend easily. At the same time, it must convey this thought in such a way that the writing is neither misleading nor monotonous.

A simple English sentence is composed of a subject and a verb and sometimes an object. If it is asked who or what is performing the action, the answer is the subject. If it is asked what the action is, the answer is the verb. If it is asked who or what is being acted upon, the answer is the object. In most simple English sentences, the subject precedes the verb, and the object follows the verb. This arrangement of sentence elements underlies English grammar and sentence structure.

There is one special kind of object, the indirect object. The indirect object is identified by asking whether a sentence contains a secondary sentence element that is related to the object of the verb but does not describe it. Whenever a sentence element receives a direct object, that element is the indirect object. The indirect object occurs in two forms: when it precedes the object, the word *to* is omitted; when it follows the object, a word such as *to* or *for* is needed.

Complicated thoughts may be expressed in simple sentences. To avoid monotony and lack of emphasis, more complicated sentence structures must be used. These sentences provide an opportunity to show relationships and relative importance of the ideas to be expressed. The more complicated sentences include three main categories: compound, complex, and compound-complex.

A compound sentence is composed of two or more independent clauses. An independent clause is a group of words that must contain a subject and a verb and may contain an object. It is called independent because it can stand as a separate sentence. There are three ways to set up a compound sentence:

1. The most frequently used method of joining two independent clauses employs a comma and one of the common connecting words - and, but, or, nor, for, so, yet.

2. Another method is to use a semicolon. When a semicolon is used, no connecting word is necessary.

3. Style is frequently improved by the use of a connecting word -- however, therefore, thus.

A complex sentence is composed of one independent clause and one or more dependent clauses. A dependent clause contains a subject and verb and may contain an object, but a dependent clause cannot stand as a sentence. The dependent clause may be used as a modifier and thus is an important tool to subordinate ideas. The dependent clause may also be used as the subject or object of a sentence.

Compound-complex sentences are a combination of the two forms already discussed. One of the two or more independent clauses contains one or more dependent clauses.

Everything in a sentence that is not a subject, verb, object, or indirect object is a modifier. A modifier clarifies, limits, or describes the subject, verb, object, or indirect object in a sentence. Modifiers may consist of single words or groups of words. Some modifiers are groups of words which are irreducible -- taking any word from the modifier either distorts the meaning or wrecks it completely.

Hallmarks of a good sentence are unity, emphasis, and coherence. Unity demands that a sentence have a central idea. Secondary concepts must be subordinated to this central theme. Emphasis demands that important concepts occupy important grammatical positions -- subject, verb, and object. Coherence requires that the logical relationship of the parts of the statement be clearly discernible to any reader. Thus a good sentence communicates a central concept, places the important parts of that concept in important positions in the sentence, and effectively relates each part of the sentence to every other part.

Clarity

Sentence clarity is difficult to define. How does one know sentences are clear? Not by meaning alone; many very awkward sentences make sense. Nor is it by correct grammar, accurate mechanics, and exact diction. Basically what the reader responds to is coherence. The right words joined together in the right order so he knows what they express in relationship to each other, and he is not disturbed by mistakes in syntax or punctuation. Basic errors of sentence construction include sentence fragments, fused sentences, comma splices, dangling modifiers, and faulty coordination.

Sentence Fragments -- There are two kinds of fragments, the unacceptable and the acceptable. The unacceptable is a group of words without a main subject and verb which cannot stand alone. It is dependent upon another group of words for clear meaning and grammatical completeness. Most unacceptable fragments tend to be appositives, participial phrases, and subordinate clauses. There are three ways to correct them: attach them to a sentence that precedes or follows, absorb them in a sentence that precedes or follows, or add a main subject and verb.

Acceptable fragments, sometimes called minor sentences, are those that can stand alone and do complete an utterance despite the absence of a main subject and verb. Most of them, however, appear in conversation, not in technical reports.

Fused Sentences -- A fused sentence, unlike a fragment, is more the result of carelessness than ignorance of sentence structure. Such an error occurs when two main clauses are ignored without inserting a semicolon, a period, or a comma and a coordinating conjunction between them. The mistake is occasionally one of misunderstanding rather than one of carelessness. The writer may not know that when the conjunctive adverb "then" comes between two main clauses a semicolon must precede it. Among other words that function like "then" in such a situation are "therefore," "however," "consequently," "furthermore," "nevertheless," and "moreover". A fused sentence can also be revised by two other means: making two sentences or inserting a comma and a coordinating conjunction between the two main clauses.

Comma Splices -- The comma splice is the use of a comma without a coordinating conjunction between the two main clauses. The error is more prevalent than the fragment or the fused sentence but may be less serious as far as comprehension is concerned. A semicolon in place of the comma would not change the sense, but it clarifies the meaning by separating the two clauses. This type of faulty sentence construction can also be improved by subordination. Another place where a comma splice often appears is before a conjunctive adverb, such as "then," "therefore," "however," "moreover." A semicolon should be used before such conjunctives. Two other methods for correcting the comma splice are the creation of two sentences and the use of a comma and a coordinating conjunction.

Dangling Modifiers -- A dangling modifier is a phrase or clause, usually at the beginning or end of a sentence, that does not clearly modify anything. Most dangling modifiers are participial phrases. A related mistake concerns the phrase that is not so much dangling as misplaced. It is too far removed from the word it modifies.

Faulty Coordination -- Faulty coordination is the most difficult of the basic errors to correct because it deals more with thought processes than with mechanics. Some writers have a tendency to give equal importance to each point and thus to link all clauses with a coordinating conjunction. Lack of sophisticated thinking is responsible for the practice as well as the habit of using "and" repeatedly in conversation. The author must decide when he writes a sentence which idea, if there are two, is the primary one or whether they both are equal. Then subordinate or coordinate accordingly. A sign of maturity as a writer is the ability to use the subordinate clause when the subject matter calls for it. A series of simple or compound sentences in paragraph after paragraph produces a regularity that is not only monotonous but also childish. On the other hand, do not avoid coordinating conjunctions such as for, and, but, or, and nor when they are appropriate.

This coverage of the five basic sentence errors is by no means exhaustive. It is just a beginning to the problem of clarity that faces the writer. The mind is capable of turning out an infinite number of quirky combinations that deviate from expected patterns. Lack of clarity is ultimately a mental, not a grammatical or a syntactical, problem.

Effectiveness

To achieve clarity in sentences is not enough. They must also be effective. There are three ways of doing this: through emphasis, variety, and length. A writer should become conscious of these techniques so that, when composing a paragraph, he realizes the need for stating ideas in the most persuasive as well as the most fitting manner possible in order to interest the reader and express the ideas with force.

Emphasis -- The most common means of effecting emphasis are the changing of word order, repetition, proper subordination and coordination, and parallelism.

Word Order -- There are two methods of making word order reflect the main idea. One is altering the arrangement of the sentence to stress the key point. The normal pattern of subject, verb, and complement can be changed to complement, verb, and subject, or phrases and clauses can be reordered. Sometimes a sentence is weak because the beginning is too intricate or too cumbersome. Reordering the words may improve the effectiveness. The second method of making a point emphatic is by inserting the dominant word of the sentence at the end.

Repetition -- The most obvious way to gain emphasis and the most dangerous is through repetition. Only words that are central to the thesis should be repeated and not those that are colorless or insignificant, such as concept, thing, and idea. Also the writer must be careful not to overdo the device. Often a writer repeats a word not because it is important but because he is unable to think of a synonym or phrase that conveys the same point. Repetition should be not an escape from word choice but a conscious means of achieving a more vivid and exact meaning.

Subordination -- Subordination is a natural way of gaining emphasis. When part of a sentence is placed in a dependent or minor clause beginning with such words as although, when, if, since, and before, it is an indication to the reader where the writer is putting his stress. The danger is that the wrong clause will be subordinated. Subordination is particularly helpful in combining a series of short sentences for the purpose of eliminating jerkiness and wordiness and gaining smoothness and compactness. However, too much subordination can cause a sentence to be cluttered with clauses and thus become unwieldy.

Coordination -- Coordination is a means of indicating that two ideas in a sentence are of equal importance. Coordinate clauses must be joined by a comma and a coordinating conjunction if they are short. In the absence of a conjunction between coordinate clauses, use a semicolon to avoid either the fused sentence or the comma splice. But coordination should not be used excessively.

Parallelism -- An important form of coordination is parallelism -- the balancing of words, phrases, and clauses in a sentence. It is a good device for achieving emphasis. First, it gains attention; second, it binds the parts of the sentence in a clear, sharp manner; and third, it indicates maturity of thought and expression since the writer must balance ideas as well as grammatical structure. Special techniques for effective parallelism are numerous; examples are use of first, second, and third at the beginning of a sequence of sentences in a paragraph; use of either/or, neither/nor, not only/but also, both/and, not/but; repetition of the same phrase or the same construction at the beginning of a sequence of sentences. It is important the items of a series be parallel in thought as well as in structure.

Variety

Sentence variety often comes naturally as there is a tendency to avoid monotonous patterns in thinking, and this is reflected in expression. Yet authors also may, at times, write a series of sentences that follow a similar pattern, thus weakening their effectiveness. This is especially true when the writer is unsure of what he is trying to say and plays it safe by composing short simple sentences without any clauses or variations from the subject, verb, complement order. Happily, there are methods for overcoming this deadening regularity. The two most productive concern sentence development and arrangement.

Sentence Development: Types and Kernels -- A simple sentence has one main subject and one main verb, a compound sentence two main clauses, a complex sentence one or more subordinate clauses and one main clause, and a complex-compound sentence two main clauses and one or more subordinate clauses. Rereading paragraphs to see that they contain a mixture of such sentences will guarantee variety. Helpful as such an approach appears to be, it is an abstract way of viewing the sentence and its possibilities. Few people write with

these types fixed in their minds. Actually, the way sentences are constructed is through additions -- starting with a kernel, an irreducible pattern such as subject, verb, and complement, and adding modifiers to it. In this way, the kernel grows as the central thought is expanded and elaborated. Hence the sentence contains a variety of levels:

    (1) I relaxed
        (2) in the driver's seat
            (3) for a few minutes,
                (4) staring at
                    (5) the oblong steering wheel,
                    (5) the three pedals
                        (6) on the floor,
                    (5) and the gauges
                        (6) on the dashboard.

The advantages of this approach to sentence building are several. It shows the infinite variations from the normal pattern that are possible. It provides the writer with a means of combining short sentences. Even more significantly, it aids in analyzing awkward sentences. By reducing a long sentence to its kernel and trying to diagram it in the manner demonstrated above, one can see why it fails to communicate, why the parts are not properly connected. Revising, thus, is simplified. The weakness of the approach is that it works best with descriptive sentences, which lend themselves to such multiple levels.

Sentence Arrangement: Loose and Periodic -- Another way of looking at a sentence is to consider it as either loose or periodic. A loose sentence is one that develops an idea in a natural order, starting with the main point and then going on to the next one, which could be either an amplification or explanation of it. The pattern follows the flow of conversation, first one thing and then another in a kind of chain arrangement. A periodic sentence is more artful and more suspenseful. It deliberately withholds the main point until the very end. This creates an effective climax and places the emphasis in the key position.

Sentence Arrangement: Word Order -- Varying sentences by changing the word order is still another method for bringing about variety. For instance, every sentence should not start in the same way. Instead of beginning with a noun or pronoun, once in a while begin with a prepositional phrase, adverb, participial phrase, or subordinate clause.

Excessive Variety -- Do not seek variety for its own sake. It is not a virtue in itself and, if carried to an extreme, can make a report sound forced and unnatural. To write as one speaks facilitates variety. For example, an author performing before an audience must raise and lower his voice, gesture, turn his head, and use different expressions that will gain the desired response. However, he does not grimace or emit queer noises simply to attract attention because such antics detract. Simarily, sentences should not be twisted into pretzels to avoid a straightforward pattern.

Length
    The length of a sentence depends on the subject, the context of the sentence, the length of sentences preceding and following -- in short, on its position in the paragraph. Some occasions such as dramatic action call for a series of terse, choppy sentences that understate the emotion. Longer sentences are appropriate when the writer wants to concentrate not on the action but on the thought that accompanies the action. As a general rule, though, the happy medium is desirable, avoiding the terse and the choppy as well as the long and the intricate. In this way, the writer prevents monotony on the one hand and unnecessary complexity on the other.

Sentences are the basic units of communication. However, they cannot be writen in isolation. They have to be written in association with each other in a paragraph. Sentences are only effective when they are related and when they express the writer's thoughts in a context and for a purpose.

Effective Sentence Form
    While the writer should strive for excellent sentence form as he makes a first draft, he will find that editing improves every draft. As that editing is done, it will be helpful if eight rules for effective sentence form are considered.

Logical and Grammatical Subjects Must Coincide -- When sentences are edited, the first question to ask is, "What is being discussed?" The answer is the logical subject; it should be put in the grammatical subject position. If it is not there, the reader will have to struggle to find out what is being discussed. The most common faults in regard to subject position result from using the words it and there as subjects. They usually have no meaning.

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Logical and Grammatical Verbs Must Coincide -- When the logical subject is the grammatical subject, ask "What is said about the subject?" The answer to that question is the verb. That verb must be as forceful as possible. Whenever possible, verbs must state something, not merely link. Avoid excessive use of the verb to be in any of its forms. Continual use of this linking verb is a characteristic of poor writers.

Unimportant Concepts Must Be Subordinated -- Logically important concepts always occupy grammatically important positions in good sentences. If a logical object exists, it must normally occupy the grammatical object position. Unimportant information must be subordinated; it must be made to modify the important concepts.

Modifiers Must Be Placed as Closely as Possible to the Words Modified -- Modifiers give precise shadings of meaning to other elements in a sentence. To do their job effectively, they must be placed as closely as possible to the words they modify. Failure to observe this simple grammatical rule obscures or distorts meaning.

Modifier Length Must Reflect Modifier Importance -- A modifier can be a single word, a phrase, or a clause. As the number of words in a modifier is increased, the grammatical importance of that modifier is increased. In editing ask whether the length of each of the modifiers is justifiable. If it is not, reduce it. If a modifier is a clause, perhaps a phrase will do; if a phrase, perhaps a word. De-emphasizing the importance of a modifier further emphasizes the importance of the central statement.

Every Modifier Must Be Logically Necessary -- Unnecessary modifiers kill the words they modify or indicate that the wrong sentence elements were chosen in the first place.

Every Word Must Be from the Same Usage Level – In writing, two things must be considered: the nature of the material and the audience for which it is intended. These two requirements dictate the usage level of the words employed -- formal, informal, or colloquial. Once the level of discourse has been established, it must be sustained throughout. Nothing is more incongruous than a mixture of usage levels.

Every Sentence Must Convey Meaning – Successful editing requires that every sentence add meaning to what has gone before. The most fruitful use of the red pencil comes when whole sentences are eliminated. The inevitable result is stronger paragraphs, stronger writing.

THE PARAGRAPH

A paragraph is a group of related sentences that develop a single idea. The first sentence of the group usually acts as a sign that points to a central thesis. The reader looks for such a sign to see what road the writer wants him to take. The number of these signs and the distance between them depend on the subject matter. The more signs or divisions there are, the more topic sentences and paragraphs there should be. Paragraph length varies with the amount of discussion or the number of illustrations required to cover the material in the topic sentence.

In the final analysis, sentences are themselves no more than elements within larger units. Just as the grammar of the sentence affects the arrangement of elements within a sentence, there is a grammar of the paragraph that affects the arrangement of sentences that are its elements.

Where a sentence stands within a paragraph, what its function is and how it relates to the sentences preceding and following largely dictate its construction. Within a paragraph, individual sentences perform different functions, and these functions place certain constraints upon the sentences. A topic sentence introduces the subject of a paragraph; other continuity sentences develop the subject; transitional sentences connect major elements of the development; summary sentences restate and emphasize the subject of the paragraph.

The paragraph is a convenient unit. As long as it holds together, a paragraph may be of any length.

If the subject is of slight extent, or if it is to be treated briefly, there may be no need of dividing it into topics. Thus, a brief description, a brief book review, a brief account of a single incident, a narrative merely outlining an action, the setting forth of a single idea is best written in a single paragraph. After the paragraph has been written, examine it to see whether division will improve it.

Ordinarily, however, a subject requires division into topics, each of which should be dealt with in a paragraph. The object of treating each topic in a paragraph by itself is to aid the reader. The beginning of each paragraph is a signal to him that a new step in the development of the subject has been reached.

As a rule, single sentences should not be written or printed as paragraphs. An exception may be made of sentences of transition, indicating the relation between the parts of an exposition or argument.

As a rule, begin each paragraph either with a sentence that suggests the topic or with a sentence that helps the transition. If a paragraph forms part of a larger

composition, its relation to what precedes, or its function as a part of the whole, may need to be expressed. This can sometimes be done by a mere word or phrase (again, therefore, for the same reason) in the first sentence. Sometimes it is expedient to get into the topic slowly, by way of a sentence or two of introduction or transition.

In general, paragraphing calls for a good eye as well as a logical mind. Enormous blocks of print look formidable to a reader. He has a certain reluctance to tackle them; he can lose his way in them. Therefore, breaking long paragraphs in two, even if it is not necessary to do so for sense, meaning, or logical development, is often a visual help. But many short paragraphs in quick succession can be distracting.

Sentences

The most important part of any paragraph is the topic sentence. What the thesis sentence is to the whole paper the topic sentence is to the paragraph. It should state the main idea of the paragraph and indicate its development. Place it at or near the beginning and not in the middle or at the end. A topic sentence tells what the paragraph is about. It normally is composed of two elements, a transitional statement that relates the paragraph to the one that preceded it, and the statement of the hypothesis (point of view) of the paragraph it introduces. The rest of the paragraph supports the hypothesis. The paragraph usually ends when the hypothesis has been adequately supported. However, when a hypothesis requires lengthy proof, it may extend over more than one paragraph. In this case, each paragraph must be clearly structured to show its relationship to the other paragraphs in the line of development. The transitional statement in the topic sentence carries this responsibility. A good check on the organization of a report is to list these key topic sentences in the order they appear. They should indicate whether or not the report has a firm structure.

A continuity sentence provides the details that prove the hypothesis stated in the topic sentence. The form of the continuity sentence is determined by the nature of the material and the complexity of the ideas. The major problem in writing continuity sentences is making sure that they all relate to the hypothesis presented in the topic sentence. Failure to do so results in loss of unity, emphasis, and coherence. The reader cannot follow the course of the argument.

A summary sentence is sometimes needed at the end of a paragraph to supply emphasis. Generally, the summary statement is an entire paragraph that comes at the close of a paper. Less frequently, it is a sentence or a paragraph coming at the end of one part of a paper. A summary sentence is needed at the close of a paragraph only when the paragraph has presented a particularly important or difficult statement.

Transition

The second most important part of a paragraph is transition, the means by which sentences are linked. A transitional sentence supplies the reader with direction either between paragraphs or within a single paragraph when the development of the argument demands an abrupt change in direction. In most writing, a transitional word -- relating one thought to another by repetition of a word used in the previous statement -- is all that is needed. Common connectors are words like also, next, however, and therefore; pronouns; repeated words; expressions such as first of all; and reference to a previously stated idea.

Types of Paragraphs

The third and largest aspect to consider is the type of paragraph. There are four main types: introductory, developing, transitional, and concluding. The first attracts the reader and informs him of the subject. The second develops the major points of the report in detail. The third type, the shortest and most infrequently used, is necessary to bridge the gap between paragraphs when no word or phrase is sufficient. The fourth summarizes the central idea and extends it to provoke the reader to consider its broader applications.

Introductory and Concluding Paragraphs -- Beginning a report is time-consuming. Do not wait for inspiration or try to find some exotic phrase or clever point. Plunge right into the topic. Avoid superfluous and ornate language that seeks to impress. Often it will be found after the report is finished that the first sentence was unnecessary. Keep in mind that the initial sentence should be clear, compact, and directely related to the topic. A first impression is all important. If the wording is vague or the syntax awkward, the reader loses confidence in the writer from the start, and this colors his evaluation of the rest of the paper. Three basic elements of a concluding paragraph are transition, reference to the introduction, and an extension of the main point of the report.

Developing Paragraph -- The developing paragraph represents the heart of the report and is a microcosm of the report itself. The topic sentence is the introduction. The expansion of the central idea in the following sentences is the body, the center of interest and information. The last sentence is the one which either summarizes or prepares for the next paragraph. There are three fundamental steps in writing a developing paragraph.

First, analyze the topic sentence to determine the kind of development necessary for the paragraph. To do this, consider the two parts of a sentence, subject and verb. The subject announces what is to be discussed and the verb what is planned. After this has been done, the writer knows what has to be done to expand, clarify, or illustrate the topic sentence.

Once the author settles on which ideas in the topic sentence need to be developed, the next step is to decide on a pattern of development. Below are examples of frequently used patterns appropriate to the expansion of the first or topic sentence:

ENUMERATION – Details are arranged in order of importance with the most significant last.

COMPARISON AND CONTRAST – Each sentence contains two different aspects.

ANALOGY – Recognize the similarities between two things and ignore their differences.

SPATIAL – Usually in descriptive paragraphs, the objects are presented in a particular order from the most distant to the nearest or vice versa, from the top to the bottom or the bottom to the top, left to right, right to left, etc. Sometimes shift the point of view from one object to another to create a dominant impression.

There are many other patterns for paragraph development, such as definition, cause and effect, and climactic order. However, no one begins a paragraph with a particular pattern in mind. He begins with an idea, and this idea suggests a type of natural development. Consequently, one needs to keep in mind the topic sentence, what it says, and where it points. Out of it evolves the method for expanding the paragraph. Most of the time, this method will be the enumeration of facts, examples, or illustrations.

Transitional Paragraph – The least common type of paragraph is the transitional one. Its sole purpose is to get the reader smoothly and logically from one subject to another. Hence, it is short.

COMMON ERRORS

1. Avoid a succession of loose sentences

This rule refers especially to loose sentences of a particular type: those consisting of two clauses, the second introduced by a conjunction or relative. Although single sentences of this type may be unobjectionable, a series soon becomes monotonous and tedious.

If the writer finds he has written a series of loose sentences, he should recast enough of them to remove the monotony, replacing them by simple sentences, by sentences of two clauses joined by a semicolon, by periodic sentences of two clauses joined by a semicolon, by periodic sentences of two clauses, by sentences (loose or periodic) of three clauses -- whichever best represent the real relations of the thought.

2. Express coordinate ideas in similar form

Parallel construction requires that expressions similar in content and function be outwardly similar. The likeness of form enables the reader to recognize more readily the likeness of content and function. Correlative expressions *(both, and; not but; not only, but also; either, or; first, second, third)* should be followed by the same grammatical construction. Many violations of this rule can be corrected by rearranging the sentence. An article or a preposition applying to all the members of a series must either be used only before the first term or else be repeated before each term.

3. Keep related words together

The position of words in a sentence is the principal means of showing their relationship. Confusion and ambiguity result when words are badly placed. The writer must, therefore, bring together words and groups of words that are related in thought and keep apart those that are not so related.

The subject of a sentence and the principal verb should not, as a rule, be separated by a phrase or clause that can be transferred to the beginning. The relative pronoun should come, in most instances, immediately after its antecedent. If the antecedent consists of a group of words, the relative comes at the end of the group, unless this would cause ambiguity. *The Superintendent of the Chicago Division, who* results in no ambiguity. But *A proposal to amend the Sherman Act, which has been variously judged* leaves doubt as to what has been judged -- the proposal or the Sherman Act.

4. Tense

Verbs not only state an action or condition of the subject, but they also indicate when that action or condition occurred. The time may be present, past, or future. The aspect of a verb that indicates when the action occurred is called tense. As a general rule, technical reports should be written in the past tenses.

5. **Agreement**

Agreement is the relationship between a verb and its subject. Singular verbs must have singular subjects; plural verbs must have plural subjects.

Each student does his own homework.
Men find work necessary.

In these simple sentences, agreement between subject and verb is obvious. In complicated sentences, faulty agreement may occur because the writer fails to identify the correct subject and verb or to recognize that such words as *one, each, either, another, none, neither, someone, somebody,* and *everyone* are singular.

6. **A/An/And**

Use *a* before words beginning with consonants and *an* before words beginning with vowels. Be careful not to write *an* when *and* is required.

7. **Affect/Effect**

The verb *affect* means to influence. The noun *effect* means a result.

8. **The "Am-Was-Been" Equation**

The verb *to be* is one of the most useful in the language. But the writer should try not to overuse it since it lacks verve, force, emphasis, punch; it does nothing really except connect. But it connects in a very specific fashion. The verb *to be* is almost the same as the equals sign in mathematics.

9. **Among/Between**

Both are prepositions meaning about the same thing, except for one difference. When *among* is used, the writer is concerned with more than two things or individuals. With *between,* only two or sometimes three entities are involved.

10. **Cite/Site/Sight**

Cite means to refer to, as when the writer cites an authority. *Site* means a place, as when the site (loaction) for something is selected. *Sight* means seeing or something seen.

11. **Compare**

To *compare to* is to point out or imply resemblances between objects regarded as essentially of a different order; to *compare with* is mainly to point out differences between objects regarded as essentially of the same order.

12. **Comprise**

Literally, "embrace": a zoo comprises mammals, reptiles, and birds (because it "embraces," or "includes," them). But animals do not comprise ("embrace") a zoo -- they consititute a zoo.

13. **Consider**

Not followed by *as* when it means "believe to be." When considered means "examined" or "discussed," it is followed by *as.*

14. **Data**

Like *strata,* phenomena, and media, data is a plural and is best used with a plural verb.

15. **Divided into/Composed of**

Not to be misused for *composed of.* The line is sometimes difficult to draw. An apple, halved, is divided into sections, but an apple is composed of seeds, flesh, and shin.

16. **Fact**

Use this word only of matter capable of direct verification, not of matters of judgment.

17. **Farther/Further**

The two words are commonly interchanged, but there is a distinction worth observing: *farther* serves best as a distance word, *further* as a time or quantity word.

18. **Former/Latter**

The terms "former" and "latter" are still much in vogue today, but they should not be. Unless used with extreme care, the words place a burden on the reader to recall the former or the latter *what.* It is better to repeat the word or phrase rather than confuse the reader even for moment with such imprecise terms.

19. **However**

Avoid starting a sentence with *however* when the meaning is "nevertheless." The word usually serves better when not in first position. When *however* comes first, it means "in whatever way" or "to whatever extent."

20. **Imply/Infer**

Not interchangeable. Something implied is something suggested or indicated, though not expressed. Something inferred is something deduced from evidence at hand.

5. Agreement

Agreement is the relationship between a verb and its subject. Singular verbs must have singular subjects; plural verbs must have plural subjects.

Each student does his own homework.
Men find work necessary.

In these simple sentences, agreement between subject and verb is obvious. In complicated sentences, faulty agreement may occur because the writer fails to identify the correct subject and verb or to recognize that such words as *one, each, either, another, none, neither, someone, somebody,* and *everyone* are singular.

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The terms "former" and "latter" are still much in vogue today, but they should not be. Unless used with extreme care, the words place a burden on the reader to recall the former or the latter *what.* It is better to repeat the word or phrase rather than confuse the reader even for moment with such imprecise terms.

19. However

Avoid starting a sentence with *however* when the meaning is "nevertheless." The word usually serves better when not in first position. When *however* comes first, it means "in whatever way" or "to whatever extent."

20. Imply/Infer

Not interchangeable. Something implied is something suggested or indicated, though not expressed. Something inferred is something deduced from evidence at hand.

21. Inside of/Inside

The *of* following *inside* is correct in the adverbial meaning "in less than." In other meanings *of* is unnecessary.

22. Irregardless

Should be *regardless*. The error results from failure to see the negative in *-less*.

23. Less/Fewer

Less refers to quantity, *fewer* to number.

24. Like/As

Like is not to be used for *as. Like* governs nouns and pronouns: before phrases and clauses the equivalent word is as.

25. None

Use the singular verb when *none* means "no one," or "not one." A plural verb is commonly used when *none* suggests more than one thing or person. The rule applies equally to other distributive expressions: each, each one, everybody, everyone, many a man, nobody.

26. Nor

Often used wrongly for *or* after negative expressions.

27. Partially/Partly

Not always interchangeable. Partially is best used in the sense of "to a certain degree" when speaking of a condiiton or state: "I'm partially resigned to it. *Partly* carries the idea of a part as distinct from the whole -- usually a physical object.

28. Principal/Principle

"Principal" as an *adjective* means primary or most important in describing something. "Principle" is a noun meaning a basic code or rule.

29. Relevant/Irrelevant

Use these words to express a precise relationship, not a vague discontent.

30. Respective/Respectively

These words may usually be omitted with advantage.

31. Than

Any sentence with *than* (to express comparison) should be examined to make sure no essential words are missing.

32. That/Which

That is the defining, or restrictive, pronoun; *which* the nondefining, or nonrestrictive.

33. Unique

Means "without like or equal." Hence, there can be no degrees of uniqueness.

### 34. While

Avoid the indiscriminate use of this word for *and, but* and *although.* Many writers use it frequently as a substitute for *and* or *but*, either from a mere desire to vary the connective or from doubt about which of the two connectives is the more appropriate. In this use it is best replaced by a semicolon. Its use as a virtual equivalent of *although* is allowable in sentences where this leands to no ambiguity or absurdity. In general, the writer will do well to use *while* only with strict literalness, in the sense of "during the time that."

✪ ✪

APPENDIX D

PROOFREADERS' MARKS

ℓ or *ℐ* take out or expunge -- used with a line through the material to be deleted

ℐ take out a letter and close up

⌣ less space

⌒ close up entirely; no space

Λ insert at this point

or # space or more space

L or ⌐ or [carry farther to the left

⌐ or ⌐ or] carry farther to the right

⌐⌐ elevate a letter or word

⌐⌐ sink or depress a letter or word

℘ make a new paragraph

◯ (a ring drawn around an abbreviation, figure, etc.) spell out

Ⓘ change to italic type

Ⓜ change to medium type

Ⓑ change to boldface type

⌐⌐ transpose

ℓc lowercase -- used with a slanting line drawn through the letter in the text

= put in small capitals -- the double lines drawn under the letters or word

stet restore words crossed out

APPENDIX E

RULES FOR NUMERALS
(Modified from Reference 3)

1. Most rules for the use of numerals are based on the general principle that the reader comprehends numerals more readily than numerical word expressions, particularly in technical, scientific, or statistical matter. However, for special reasons numbers are spelled out in certain instances.

2. Arabic numerals are generally preferable to Roman numerals.

3. A figure is used for a number more than ten with the exception of the first word of the sentence. Numbers ten and under are to be spelled, except for time, measurement, and money.
> 10 x 15 feet
> 9:45 a.m.
> $75
> 10 miles
> Each of 15 major commodities (nine metal and six nonmetal) was in supply.

4. Numbers ten and under are to be spelled except when in a series with numbers greater than ten.
> That man has 3 suits, 2 pairs of shoes, and 12 pairs of socks.

5. Where two numbers are adjacent, spell the smaller of the two (a series may be an exception).

> There were three 6-room houses, four 5-room houses, and three 2-room cottages and they were built by 20 men.
> There were 3 six-room houses, 5 four-room houses, and 3 two-room cottages, and they were built by nine men.

6. A unit of measurement, time, or money is always expressed in figures.
> A team of four men ran the 1-mile relay in 3 minutes 20 seconds.
> This usually requires from two to five washes and a total time 2 to 4 hours.
> The contractor, one engineer, and one surveyor inspected the 1-mile road.

7. The comma is used in a number containing four or more digits, except in serial numbers, common and decimal fractions, astronomical and military time, and kilocycles and meters of not more than four figures pertaining to radio.

8. Numerals are spelled out at the beginning of a sentence. Rephrase a sentence to avoid beginning with figures.

9. A spelled-out number should not be repeated in figures, except in legal documents. In such instances these forms will be observed:
> five (5) dollars, not five dollars (5)
> ten dollars ($10), not ten ($10) dollars

10. Numbers expressing time, money, or measurement separated from their unit descriptions by more than two words are spelled out if ten or less.
> two and more separate years
> whether five or any number of years
> but 5 successive years
> 4 calendar years

11. Indefinite expressions are spelled out.
   the seventies; the early seventies;
      but the early 1870's or 1870's
   a thousand and one reasons
   between two and three hundred horses
   midthirties
   in the eighties, not the '80's nor 80's
   twelvefold;   fortyfold;   hundredfold,
      twentyfold to thirtyfold
but 1 to 3 million
   mid-1951
   40-odd people; nine-odd people
   40-plus people
   100-odd people
   3 1/2-fold; 250-fold; 2.5-fold; 41-fold

The words *nearly, about, around, approximately*, etc.,
do not constitute indefinite expressions.

12. Except as indicated in Rule 4, a number of
ten or less is spelled out within a sentence.
   six horses
   five wells
   eight times as large
but 3 1/2 cans
   2 1/2 times or 2.5 times

13. For typographic appearance and easy grasp of
large numbers beginning with *million*, the word *million*
or *billion* is used. The following are guides to treatment
of figures as submitted in copy. If copy reads
   $12,000,000, change to $12 million
   2,750,000,000 dollars, change to $2,750
   million
   between 10 and 20 million
   10 or 20 million

14. Round numbers are spelled out.
   a hundred cows
   a thousand dollars
   a million and a half
   less than a million dollars

15. Fractions standing alone, or if followed by *of
a* or *of an*, are generally spelled out.
   three-fourths of an inch; not 3/4 inch nor 3/4
      of an inch
   one-half inch
   one-half of a farm; not 1/2 of a farm
   one-tenth
   two one-hundredths
   thirty-five one-thousandths
but 1/2 to 1 3/4 pages
   1/2-inch-diameter pipe

PREPARATION OF VISUAL AIDS
AND DRAWINGS

VISUAL AIDS

Most everyone seems to know how to make bad slides. Figures F-1, F-2, and F-3 are some examples. If these are viewed from 12 inches (0.3 meter), they will appear as they would on a 10-foot (3-meter) screen viewed at 60 feet (18 meters). Each has too much on it. The fact that it can be read, if given enough time, when projected in a living room or office does not mean that an unfamiliar audience can read it in 30 to 60 seconds in a 300-foot (90-meter) long lecture hall.

The standards for the review of slides are based on the following rules, and compliance with them will ensure that slides are acceptable. Large transparencies for use in an overhead projector are not satisfactory visuals in large rooms. Therefore, this type of visual aid shall not be used.

Rule 1

Never show more on one slide than can be assimilated in 30 seconds. Captions and details should not be shown. Tell the audience what the slide is about.

Rule 2

Make letters and numbers as big as possible. The minimum letter size based on size of original copy is given in the following tabulation:

Original Copy Size		Absolute Minimum Letter Size	
(in.)	(m)	(in.)	(mm)
8 by 12	0.20 by 0.30	0.25	6.3
10 by 15	0.25 by 0.38	0.30	7.6
20 by 30	0.51 by 0.76	0.60	15.2

The width of the copy is always 1 1/2 times the height, and vertical slides should be avoided. A convenient size for the original copy is 8 by 12 inches (0.2 by 0.3 meters). The letters and figures should not be smaller than 1/50 or two percent of the longer dimension of the original copy. Use larger letters if possible. Use broad strokes for letters and wide lines on graphs.

Rule 3

Use 2- by 2-inch (35-mm) slides. Slides should be standard 35-mm, 2- by 2-inch size. The set of slides prepared must all be the same size.

Rule 4

Prepare separate copy for slides. Good slides are seldom made from drawings or tables that are intended for publication with the paper. Printed illustrations may contain considerably more detail, and letters may be somewhat smaller. Figure 1 in a printed paper is not the same as Slide 1 in a lecture hall.

Rule 5

Use the standard mask size (approximately 7/8 by 15/16 inches (2.2 by 3.3 mm) furnished for 35-mm transparencies. Only by so doing can it be assured that all slides will just fill the screen.

TENSILE STRENGTH		LITHOLOGY		ANISOTROPY	DURABILITY
POINT LOAD INDEX, I_s				STRENGTH ANISOTROPY INDEX, I_a $$I_a = \frac{\text{Maximum Strength}}{\text{Minimum Strength}}$$	SLAKE DURABILITY INDEX, I_d PERCENT SLAKE
CLASS	MPa				
Very Strong (1)	> 10	SS	Sandstone	1.0 - 1.2 (1) Isotropic	< 5 (1) Very Durable
Strong (2)	3 - 10			1.2 - 1.5 (2) Slightly Anisotropic	5 - 10 (2) Durable
Medium (3)	1 - 3	SH	Shale	1.5 - 5 (3) Moderately Anisotropic	10 - 25 (3) Moderately Altered
Weak (4)	0.3 - 1			5 - 20 (4) Anisotropic	25 - 50 (4) Highly Altered
Very Weak (5)	< 0.3	LS	Limestone	> 20 (5) Very Anisotropic	50 - 100 (5) Decomposed

Example: 1 - LS - 2 - 1 indicates a very strong, slightly anisotropic, very durable limestone

Figure F-1.   Typewriter Type Is Too Small; Too Much Detail.
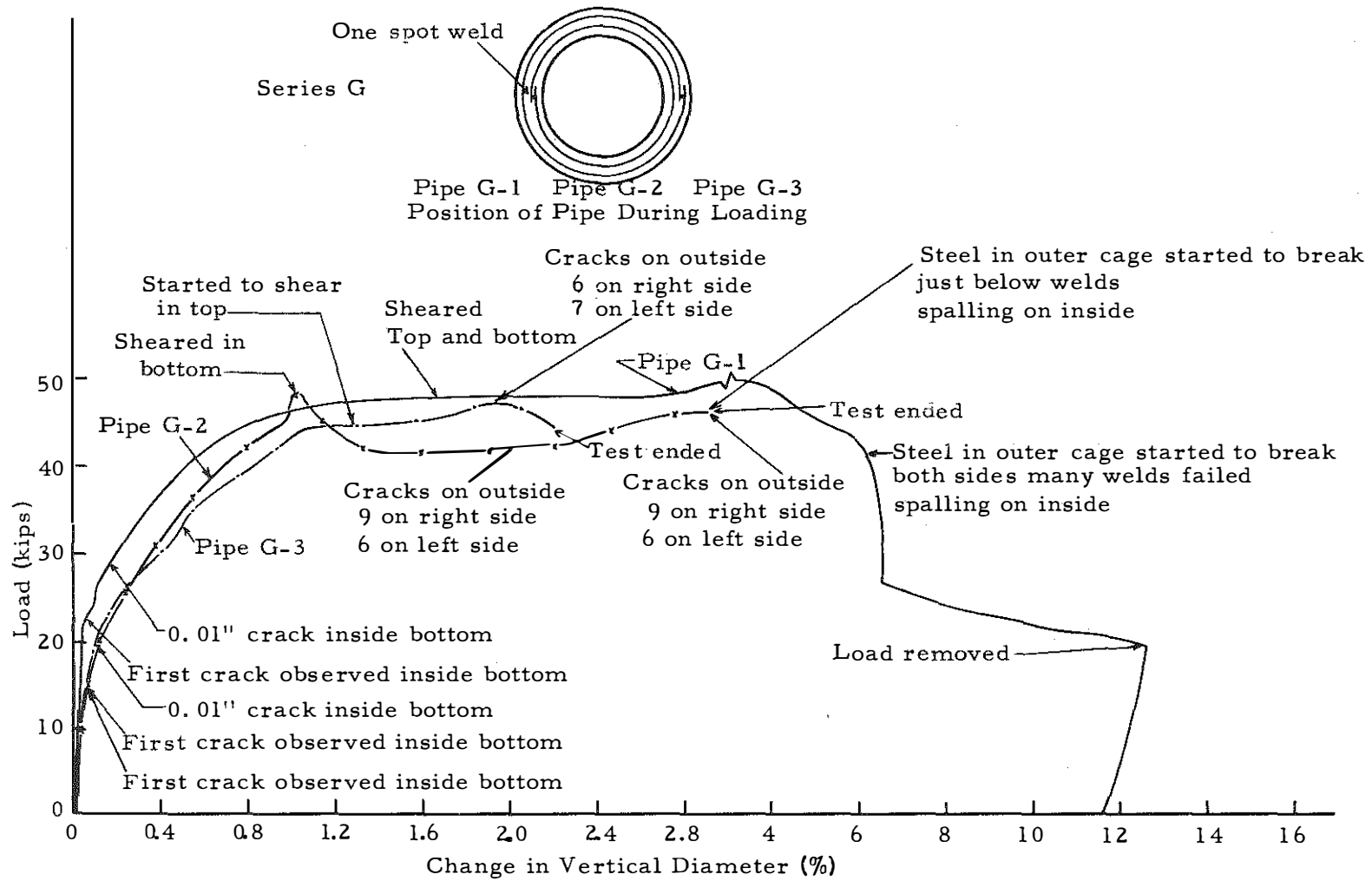
Figure F-2. Lettering Is Too Small; Too Much Distracting Material.
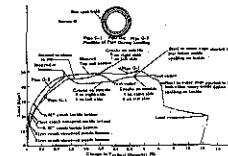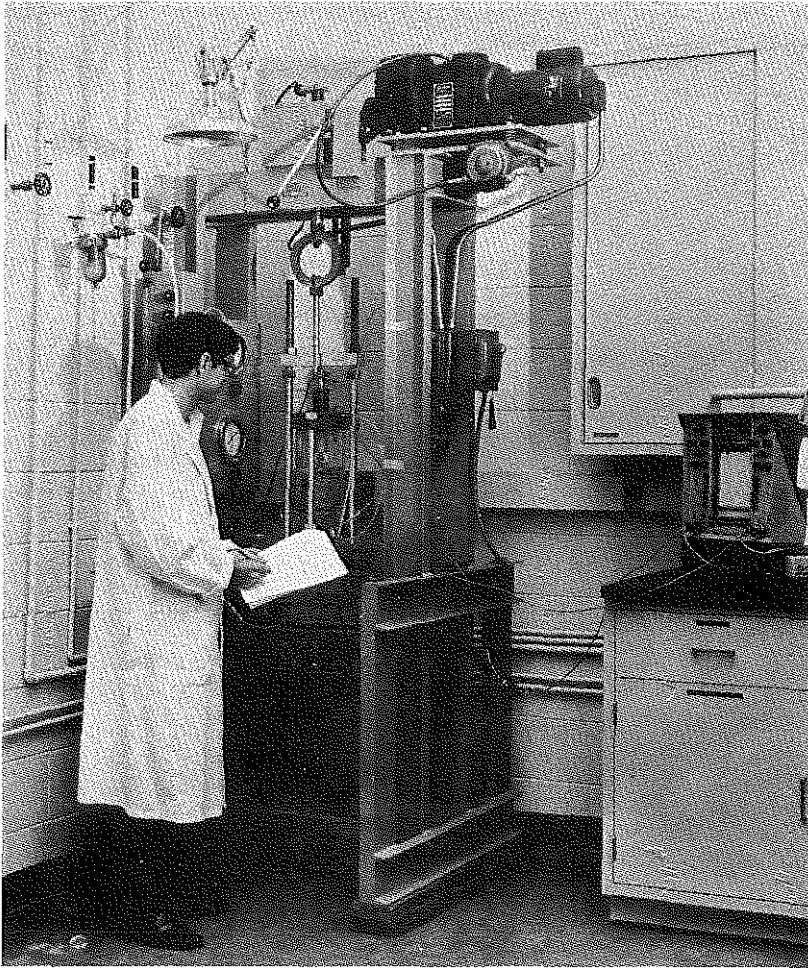
Figure F-3.   Too Much Is Shown; No Contrast.
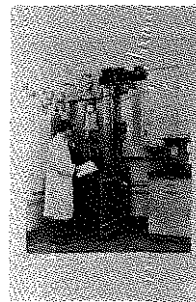
PEDESTRIAN FATALITIES

	Percent
Two - Lane	75
Four - Lane - Undivided	10
Interstate - Parkway	9

Figure F-4.   No More Than 12 or 15 Words on a
              Table.

PEDESTRIAN FATALITIES

	Percent
Two - Lane	75
Four - Lane - Undivided	10
Interstate - Parkway	9
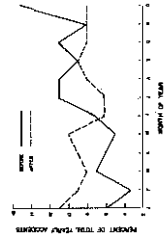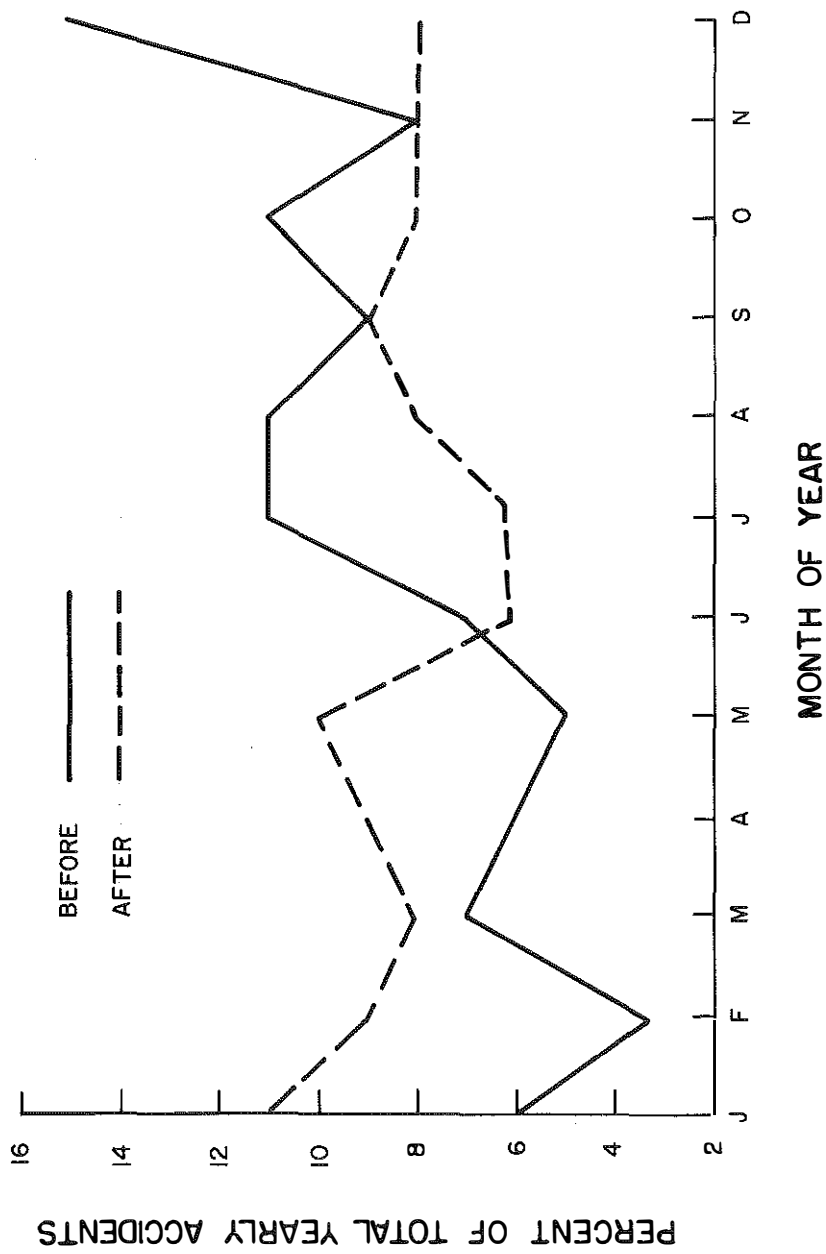
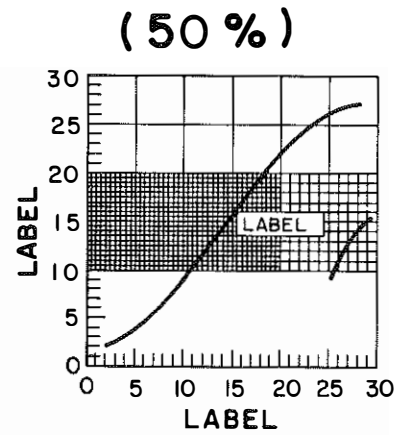Figure F-5.   No More Than One or Two Curves.
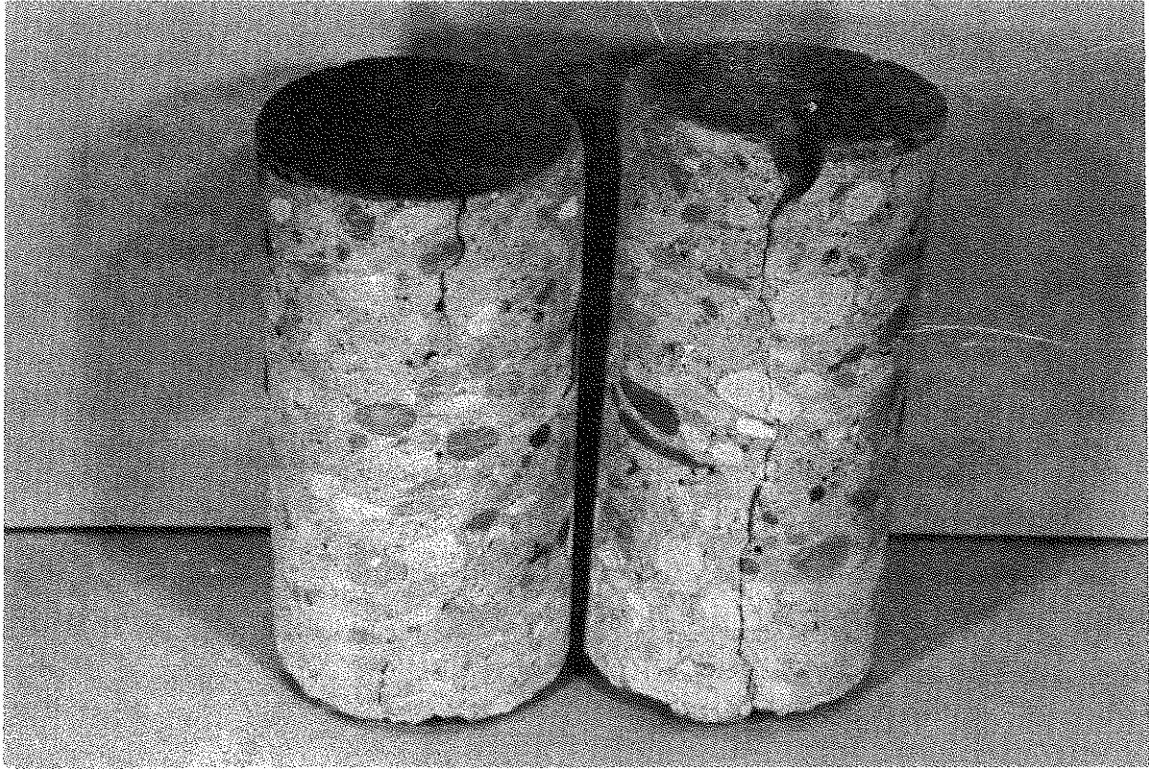
Figure F-6.   Uncluttered, Close-up Photographs.
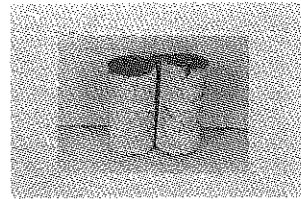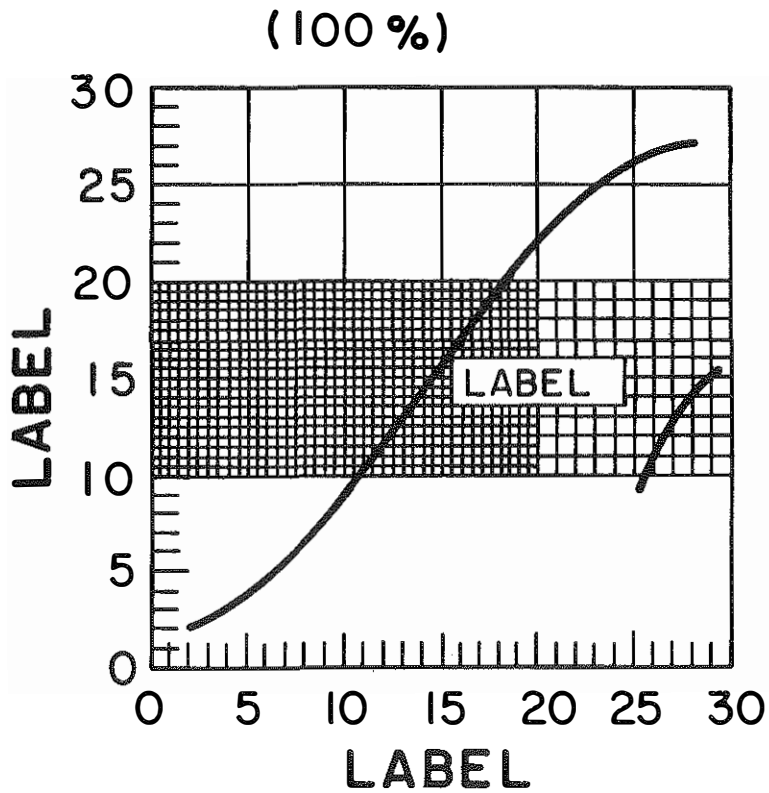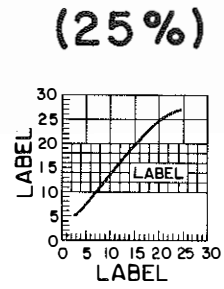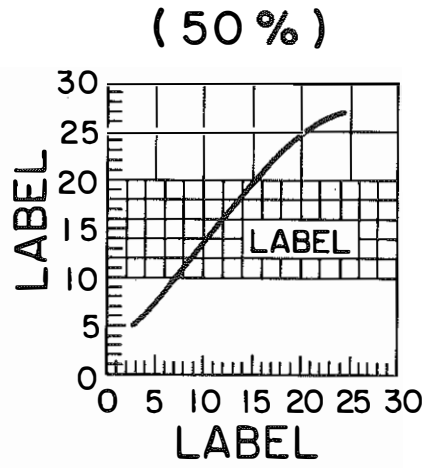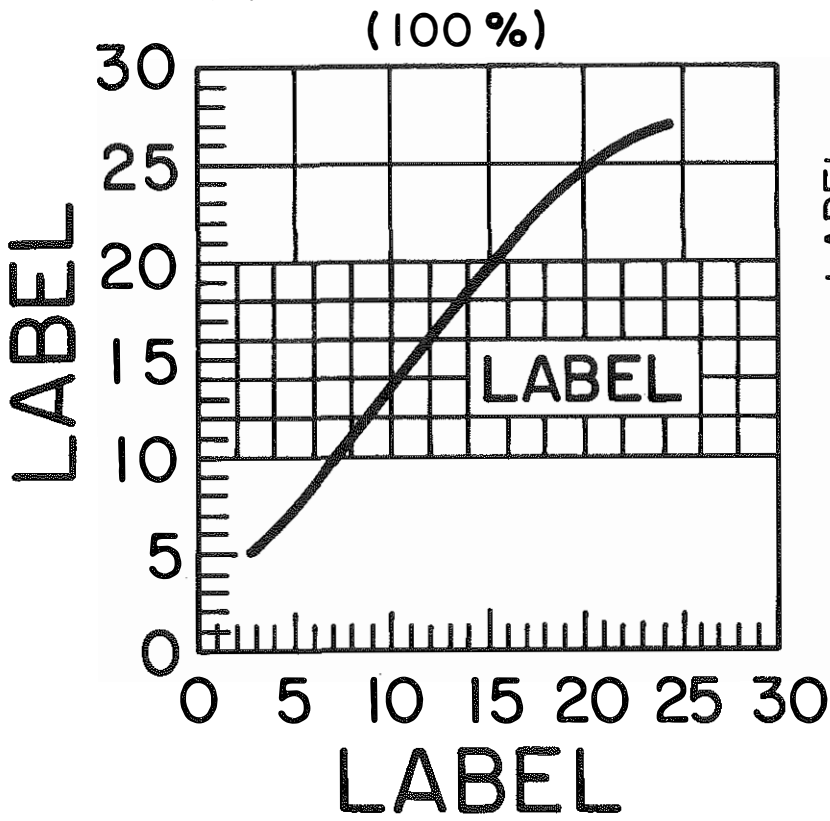
Figure F-7. Illustration of Affect of Various Reductions.

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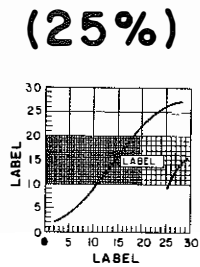
DRAWINGS

All drawings shall be reproduced using one color unless prior approval is obtained. This facilitates reproduction in the one-color (black) process normally used. All labels or notes inside the chart must be contained within the outer boundaries of the chart. Any unusual circumstances requiring deviation from these standards must receive prior approval. Choice of the extent of grid is the author's discretion and depends upon what the author is trying to show. When tick marks are used, major division marks should be 50 percent longer than the unit tick mark lengths specified in the table below. If a full grid is desired, appropriate major grid division lines should be made using the Leroy pen size specified for the axis line.

Table F-1.   RECOMMENDED   GUIDES   FOR DRAWINGS

REPRODUCTION SIZE AS PERCENT OF ORIGINAL DRAWING SIZE *	SIZES							SPACINGS, INCHES					
	LEROY PEN				LEROY SCALE			BETWEEN AXIS LABEL & AXIS SCALE	BETWEEN AXIS & AXIS SCALE	MINIMUM DISTANCE BETWEEN FIGURES ON AXIS SCALE	FULL GRID		AXIS UNIT TICK LENGTH
	CURVE		AXIS	GRID	AXIS "LABEL"	AXIS SCALE	LABELS INSIDE FIGURE – MINIMUM				PREFERRED	MINIMUM	
	PREFERRED	MINIMUM											
100	3	2	0	00	120	100	70	0.08	0.08	0.20	0.05	0.03	0.10
50	4	3	1	0	200	175	140	0.10	0.10	0.20	0.10	0.05	0.15
25	5	4	2	1	350	240	240	0.10	0.10	0.175	0.20	0.10	0.15

*See Figure F-7