PLANNING YOUR RESEARCH PAPER

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ABSTRACT

This manual, which is divided into two main sections, presents suggestions on how to plan your research paper. The first section deals with preliminary steps in planning--such as outlining, choosing headings, and making tables. The second sections deals with the various parts of the research paper: title, abstract, table of contents, introduction, acknowledgment, procedure, results and discussion, conclusions, summary, and literature cited.

Stress is laid on the importance of keeping the paper in mind from the moment the research is conceived, of making adequate use of easily understood tables and illustrations, and of using outlines and headings. Particular attention is focused on the need for stating the specific problem and for orienting the reader to it. Suggestions are given on how to deal with problems in writing the procedure, the results and discussion, and the conclusion. The difference between the conclusion and the summary is made clear, and the relationship between the title and the specific objectives listed in the introduction is pointed out. Finally, a way of avoiding repetition in writing the summary and the abstract is suggested, the question is answered as to whom acknowledgment should be made, and necessary information is given on some of the more clerical aspects of the paper, such as the table of contents and the literature cited.

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INTRODUCTION

(1) Few occupations are more challenging, more engrossing, or more satisfying than research work. If you are like most research workers, you probably are more concerned about the experimental or observational part of your work than about the writing part of it. In fact, you probably view the task of writing with some distaste because it takes you away from the laboratory or the field.

(2) Research, however, is a cooperative effort in which progress is made on a world-wide front. If you are to contribute effectively to the advancement of knowledge in your field, you will have to report your results in a paper that is easy to understand. If you have been interested primarily in the operational end of your research, you may not have given much thought to the techniques used in attaining clarity in scientific papers. Since good planning is a basic requirement for clear writing, you may find the techniques suggested in the present manual helpful.

Definition of Research Paper

(3) For the purpose of this manual, a research paper is considered to be a report in which you--

1. State what specific problem--or set of closely related specific problems--you were trying to solve.
2. Explain the significance of your problem, if you think that your intended audience may need this explanation for a full understanding of your work.
3. Tell what method you used to solve the problem.
4. Give the results you obtained.
5. List the conclusions or the recommendations you arrived at after considering these results.

Note 1: This manual is not a research paper; hence it does not follow the style of such papers, particularly in the use of personal pronouns. At first you may not like this style, since you are accustomed to the impersonal presentation of scientific papers. A long manual such as this one, however, can be quite dull, and the use of personal pronouns helps to liven it a bit.

Note 2: The purpose of the numbers on the left-hand margin of the manual is to make the various paragraphs readily available for reference.

Importance of Planning

(4) Giving careful thought to the plan of your paper is important in three ways:

1. Your research will be aided.
2. Your paper will be less difficult to write.
3. Your paper will be easier to understand.

(5) Aid to research.--Carefully considering the organization of your paper will aid you in planning the research itself and will catalyze your flow of ideas. Furthermore, it will help to ensure that your research will be carried out soundly and that your findings will be published.

(6) Aid to writing.--If your paper is poorly written, it may be subject to revision--which means, in addition to spending time writing the original paper, you must spend further time in revising it. The time spent in revising actually can be longer than that spent in the original writing. If your paper has been criticized and revised greatly, you hardly will recognize the final publication as being your own, and it still may not be good. After a few of your manuscripts have been subjected to this treatment, you are likely to lose your enthusiasm for research.

(7) Experience indicates that a principal cause of poor writing in scientific

FIGURE 1.--SCIENTIST SUBMITS FOUR-PAGE MANUSCRIPT FOR PUBLICATION. GETS BACK BUNDLE OF CRITICISM. VIEWS SITUATION WITH ALARM.

papers is poor planning. Experience also has shown that the poorly planned papers require the greatest amount of revision. Errors in grammar, for example, can be corrected with relatively little difficulty; whereas those in planning often require you to rewrite your entire paper.

(8) Aid to comprehension.--The number of research papers now being published is so large you are faced with the choice of trying to keep abreast of the advancements in your field or of doing research of your own. Your fellow scientists have the same problem. They therefore read your papers in the same way you read theirs--hastily. Thus, if your paper is poorly written, it is not likely to be given sufficient attention for full comprehension and appreciation. To the extent then, in which you fail to write your paper clearly, the time spent on the research is likely to have been ineffectual and the funds spent to have been wasted.

(9) The seriousness of this problem is not generally realized; at least there seems to be no great awareness that anything can be done about it. The impression prevalent among laymen that scientific papers are of necessity more-or-less incomprehensible is believed to some extent by scientists themselves. Can you visualize what the effect would be, however, if all scientific papers were clear and easy to read--if you could read rapidly through a paper and comprehend it completely on the first reading? You can see that such an improvement in the clarity of scientific papers would effect almost a revolution in scientific progress.

(10) Can scientific papers be written in this manner? Experience in writing, in abstracting, and in editing indicates that usually they can be. Experience also indicates that poor planning is one of the basic causes of obscurity in scientific papers. The purpose, therefore, of this manual is to enliven your interest in planning.

Acknowledgment

The aid of Maurice E. Stansby, William F. Harrington, Mrs. Patricia S. Terao, and Galen H.MMaxfield is gratefully acknowledged.

GENERAL SUGGESTIONS ON PLANNING

This section contains a number of suggestions that will facilitate the writing of your paper.

FIGURE 2.--SCIENTIST KEEPING UP WITH LITERATURE

FIGURE 3.--SCIENTIST TRYING TO DECIPHER POORLY PLANNED PAPER.

Plan from Inception of Research

(11) Your writing can be made easier if you will plan the paper from the moment your research is conceived. Think back to any papers you already have published, and undoubtedly you will remember some that would have been less difficult to write if you had carried out the research differently.

(12) A sound paper is based on sound research. By keeping your paper in mind while planning and conducting the research, you can make modifications that will enable you not only to do your research in the best way, but also to resport it in a logically developed paper.

(13) Keeping your paper constantly in mind is particularly helpful in the following seven ways:

1. You save yourself from doing useless work by deciding before you start the research whether the findings will be publishable.

2. You keep yourself from attempting too much. Owing to the somewhat nebulous nature of research during the period of conception, you may lay out a program that is more ambitious than the available personnel, equipment, and funds will allow. By thinking about your paper while you are planning your program, you form a more concrete idea of what you are trying to do. You thus are more likely to keep your project within practical limits.

3. You prevent yourself from wandering aimlessly. In your paper, you should make a specific statement of the problem under investigation. If your research had no clearly defined objective, you cannot state it. By keeping your paper in mind, you recognize the need for specifically defining the objective of your research.

4. You protect yourself from being sidetracked. One of the pleasures of research is that of making an unexpected discovery (Thompson 1957). After such a finding, you are tempted to learn more about it unless you realize that the data you obtain in this new investigation will not fit into the paper on the original problem. The correct procedure is to re-evaluate your program in the light of the new discovery. Only if this discovery is unquestionably of overriding importance, should the initial objective be altered. You normally will find that the best procedure

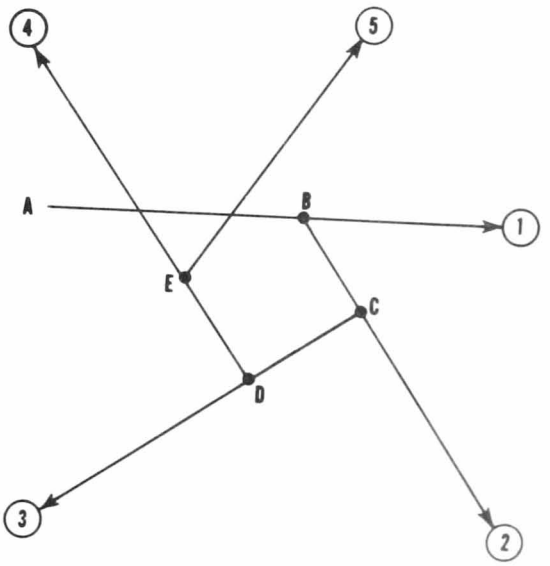

FIGURE 4.--SCIENTIST WHO CHANGED OBJECTIVES AND FOUND HIMSELF GOING AROUND IN A CIRCLE.

FIGURE 5.--SCIENTIST WHO FORGOT TO OBTAIN NEEDED DATA UNTIL AFTER PROJECT WAS TERMINATED

is to keep on with your original objective and to set up the new discovery as a project for later investigation.

Often the only immediately tangible result of your research is the paper. If you have not held to your original problem, you may not have enough data on a single subject to write a good report. You then may have to throw into one paper all of the data obtained on a series of more-or-less unrelated experiments. Since the subject matter of the resulting paper will have no obvious unity, you will be faced with the gruelling experience of trying to supply verbally, the unity that was not inherent in the investigation. This effort may terminate with no worthwhile accomplishment because often such papers are rejected.

5. You help to ensure yourself against overlooking or neglecting some factor on which data must be given when you publish. Ordinarily, if you fail to make some of the required observations, you will not discover this fact until you start to write your paper--which may not be until after your project has been terminated and the additional data are impossible to obtain. On the other hand, by keeping your paper constantly in mind, you are not likely to overlook anything you will require when the paper is being written.

6. You help to ensure yourself against carrying out the work in an unscientific manner; that is, the more thought that you give to the research, the more likely it is to be sound. Also, by keeping your paper in mind, you are more likely to watch for those points on which you might be criticized when you submit it for publication.

7. You help to ensure yourself against loss of your work through obsolescence. The tempo of modern research is such that if you see a problem that needs to be solved, undoubtedly some research worker elsewhere will hit upon the same one. If he obtains prior publication, your work becomes obsolete, and the effort you put into it more or less wasted. With this possibility in mind, you are not likely to allow your work to be delayed by minor difficulties or to procrastinate in writing your paper and in getting it published after the observational part of your work is completed.

Make Early Decision as to Who Will Write

(14) Since most research projects are cooperative ventures involving several workers, there may be a question of who will write the paper; that is, the senior author is not necessarily the one who does the actual writing. A decision should be made as to which worker is to have the primary responsibility for writing the paper and for seeing it through to publication. This decision should be made early so that the paper can be kept in mind from the very start of the research.[1/]

Allow Sufficient Time for Writing and Publishing

(15) A common error in scientific writing is the failure of research workers, in planning their project, to allow sufficient time for writing and publishing the paper. The process of writing and publishing is time-consuming, particularly if several workers are involved. As a result, estimates of the time needed are usually too

1/ Other aspects of authorship have been discussed by Young and Crowell (1956).

short. The writing and the related tasks required in the publishing of the paper then must be sandwiched in between other projects or must be done outside of working hours.

(16) Any delay in the publication of the paper can add greatly to the complications. Other rush projects may take every moment of available time, or key workers may become ill or transfer to other jobs. Your paper may never be published if sufficient time is not budgeted for the work that will be required for getting it into print.

Allow Sufficient Time for Search of Literature

(17) Every experiment in science is a pebble resting upon a vast pyramid of earlier findings. As Piskur (1956) has pointed out, the scientific literature represents a tremendous number of man-years of work that is available to research, development, and production. In a search of the literature, you obtain "experimental results, history of experiences, and data at a cost in effort and supplies comparable to as little as a p.p.m. or even a millimicron of the supplies and labors expended to produce this information." Failure to allow sufficient time for a proper search of the literature is a serious mistake.

Consider Statistical Requirements

(18) In many lines of research, changing one variable at a time is inefficient. When planning your research, consider your statistical requirements, or even consult a statistician. At the termination of the project do not expect a statistician to wave the magic wand of mathematics over a hatful of your data and pull out a sound research rabbit for you. If you need the help of a statistician, the time to consult him is while you are planning the work. Keep in mind that mere statistical calculations can never be a substitute for careful planning, sound experimental techniques, and old-fashioned common sense.

Tailor Paper to Audience

(19) Write your paper in such a way that your intended audience will understand it completely after reading it through once. To accomplish this, you will have to visualize your audience. In particular,

FIGURE 6.--STATISTICIAN WITH HATFUL OF UNRELIABLE DATA FROM WHICH HE IS EXPECTED TO PRODUCE A NICE RESEARCH BUNNY.

visualize your least-informed reader and write the paper at a level he will understand. Otherwise, in effect, you will have eliminated him from your audience and will have narrowed your circle of readers accordingly.

(20) Unless you have good reason for doing otherwise, visualize your least-informed reader as being a recent graduate with a bachelor's degree in the field in which you are writing. This practice will give the widest audience possible without making the paper into a popular one or involving vast amounts of explanation.

(21) Whatever audience you choose, keep your presentation consistent, for any shift in your point of view will alienate readers. If you start the discussion on a simple plane and later make it more complex, you will lose the readers who are less informed. On the other hand, if you simplify your discussion after introducing it on a more difficult level, you will give your readers the impression you are talking down to them.

Limit Scope

To make your paper effective, limit its scope. This practice will require that

you evaluate the complexity of your ideas and limit the number of subjects presented.

(22) Complexity of ideas.--To express an idea, you must use a certain number of words. If you use fewer than the required number, you are doomed to failure, regardless of your skill in writing succinctly. Owing to space limitations in scientific journals, you therefore are restricted in the types of subject you can present to certain audiences, for you cannot use enough words to make the subject clear. Accordingly, you should consider carefully whether the limitations of space in your contemplated journal will preclude a successful presentation of your idea.

(23) The foregoing statement should not be construed to mean that clear articles are necessarily long-winded. Often only a few additional words of explanation will contribute greatly to clarity. To see how this works in practice, consider the following paragraph taken from a paper by Brown, Venolia, Tappel, Olcott, and Stansby (1956) --with the last sentence of the original paragraph omitted:

> "The effect of the hematin compounds of fish flesh on the catalysis of oil oxidation next was determined. This work was carried out by measuring the oxygen uptake of a salt of an unsaturated fatty acid, ammonium linoleate, when shaken in a Warburg respirometer. With the reaction being carried out at 20° C. and at a pH of 9.0 aqueous extracts of fish were added to the ammonium linoleate substrate, and their effect on the rate of oxidation was determined. The fact that the catalysis was due primarily to hematin compounds and not to some other biocatalysis in the fish was confirmed by repeating the experiment in the presence of cyanide, in which case no catalytic effect from hematin compounds was observed."

Now read the omitted last sentence of the original paragraph: "Cyanid inhibits hematin catalysis of unsaturated fatty acids." This explanatory sentence greatly illuminates the experiment, yet contains only eight words.

FIGURE 7.--SCIENTIST HAPPILY WEIGHING MANUSCRIPT, CONCLUDES HE HAS A DANDY.

(24) Number of subjects.--The greater the number of subjects you present at one time, the greater the difficulty your readers will have in understanding you. In planning your paper, make certain you are dealing with only one problem or with only one set of closely related problems (unless you are writing a comprehensive paper or monograph, which is a type of scientific paper not treated in this manual). Do not report two or more separate research projects in the same paper, even though you may have studied them at the same time.

(25) Length of paper.--Try to keep your paper short. Writing short papers has several advantages:

1. Ordinarily, you present only a few ideas in a short paper and you therefore can discuss each one adequately.

2. You can report your research as soon as each unit is complete, which helps to ensure your work against obsolescence. Further, you then will have published all your completed work if some contingency should make it impossible for you to finish your entire program.

3. Since the shorter papers are easier to write and to revise, you are less likely to procrastinate in writing them and more likely to see them through to publication.

4. Your audience will find your papers

easier to read and to understand. The papers therefore are not likely to be laid aside until the reader can find a more opportune time. If you keep your papers short, they will be read not only more understandingly but more widely and will gain correspondingly in effectiveness.

(26) Since many scientific papers are lengthy, you may feel that you also should write a long paper. If, however, you are reporting a completed unit of research and not a fragment of it,[2/] the shortness of your paper need not disturb you. The value of your paper lies not in its length but in its content.

Consider the Tables

(27) Many subjects can be presented better in tables than by words alone. Those subjects, for example, that are difficult to write because of their repetitive nature can be given better in tabular form. Use of tables is not limited necessarily to the presentation of numerical data, as can be seen from table 1.

(28) Names of the various parts of the formal table are shown in table 2 (Jenkinson 1949). Table 3 gives a specific example corresponding to table 2. As Jenkinson has pointed out, formal tables may be classified into two groups: (1) general purpose (reference tables) and (2) special purpose (analytical tables). Reference tables merely record the results of a census, a survey, or an experiment. Arrangement of the data is simply to permit their ready use. The function of such a table is not to bring out any particular point but merely to serve as a repository of information. Analytical tables, in contrast, illustrate or demonstrate a specific point or answer a specific question. Only material bearing on the problem at hand appears in the table. The data are arranged to emphasize relationships pertinent to the problem and to subordinate those that are not.

(29) Owing to limitations on space, some journals are more restrictive of tables than are others. Further, most journals have a format that must be followed more or less closely. You will have to adhere to the policy of the journal in which you intend to publish. The following suggestions on the preparation of tables therefore are offered simply as a guide:

1. Present all tabular material in formal tables. There are two reasons for this suggestion: (a)

2/ This topic is treated by Young and Crowell (1956).

Table 1.--Scale of organoleptic ratings

Description of flavor and odor of fish sticks		Organoleptic rating
Whole fish stick	Component parts 1/	
Normal, characteristic of fresh product; no off-flavor or off-odor	Normal, characteristic of fresh product; none to trace off-flavor or off-odor; barely noticeable	Good (Grade A)
Lacking normal flavor or odor of fresh product; none to slight off-flavor or off-odor; barely noticeable	Lacking normal flavor or odor; slight to moderate off-flavor or off-odor; definitely noticeable but not objectionable	Reasonably good (Grade B)

1/ Breading, dark meat (including the layer of skin fat), and light meat.

Table 2.--The formal table and its major parts
(Headnote)

Panel

Stubhead	Spanner head			Spanner head 1/		
	Column head	Column head	Column head	Column head	Column head	Column head
CENTER HEAD						
Total line caption				Cell		
Line caption				Cell		
Line caption				Cell		
Block - Line caption				Cell		
Line caption				Cell		
Line caption				Cell		
Line caption				Cell		
Line - Line caption	Cell	Cell	Cell	Cell	Cell	Cell
CENTER HEAD						
Total line caption						
Line caption				Cell		
Line caption				Cell		
Line caption				Cell		
Line caption				Cell		
Line caption				Cell		
Line caption				Cell		
Line caption				Cell		

1/ Footnote

Note: Compare this table with table 3.

Heading - - - - -

Table 3.--Age of all persons and of citizens by sex, for the United States, urban and rural: 1940
(Age classification based on completed years)

Tope rule - - -

Area and age	All persons			Citizens 1/		
	Total	Male	Female	Total	Male	Female
UNITED STATES						
All ages				769		
Under 5 years				26		
5 to 14 years				115		
15 to 24 years				139		
25 to 34 years				178		
35 to 44 years				205		
45 and over				106		
21 and over	988	475	513	567	302	265
URBAN						
All ages				453		
Under 5 years				15		
5 to 14 years				73		
15 to 24 years				86		
25 to 34 years				104		
35 to 44 years				116		
45 and over				59		
21 and over				328		

Boxhead - -

Stub - - -

Field - -

1/ Include both native and naturalized.

Note: Compare this table with table 2.

Table 4.--Composition of press cake and meal showing effects of type of drier on vitamin content

Drier and materials	Moisture	Oil	Riboflavin[1/]	Nicotinic acid[1/]	Vitamin B_{12}[1/]
	Persent	Persent	Micrograms per gram	Micrograms per gram	Micrograms per gram
Direct flame drier:					
Press cake A....	56.5	5.55	4.7	90	0.33
Meal A.....	8.4	8.57	4.5	66	0.29
Indirect flame drier:					
Press cake B....	53.6	4.80	3.8	82	0.23
Meal B.....	7.5	7.85	3.8	80	0.24

1/ Moisture- and oil-free basis.

Note: This table illustrates format used in many government publications.

Table 5.--Type of Drier, Material and Composition of Sample.[1/]

	Type Drier			
	Direct Flame Drier		Indirect Flame Drier	
	Press Cake A	Meal A	Press Cake B	Meal B
Moisture, %	56.5	8.4	53.6	7.5
Oil, %	5.55	8.57	4.80	7.85
Riboflavin, γ/g.	4.7	4.5	3.8	3.8
Nicotinic Acid, γ/g.	90	66	82	80
Vitamin B_{12}, γ/g.	.33	.29	.23	.24

1/ This table shows how not to present the data in table 4.

Formal tables, being able to stand independent of the text, are the clearest of all tables. (b) The printer can place the table on the page wherever it will fit best.

2. Type each table on a separate sheet of paper. If you follow this practice, you will not have to retype your table every time you revise the text, or vice versa. (When, however, the table is published, it should be placed conveniently close to where it is discussed.)

3. Give special thought to the table heading. Keep it short, if you can, but make it adequate and make it logical. The heading preferably should point to the relationships you were trying to investigate rather than merely catalogue the contents of the table, which the reader can discover for himself by reading the various box heads. The heading of table 4, for example, might have been "Type of drier, material, and composition of sample." Such a heading, however, would not show the relationships that the author had in mind. "Composition of press cake and meal showing effects of type of drier on vitamin content" reveals more the intent of the author because the information wanted was the following: (a) Is there a loss of vitamins when press cake is dried to meal? (b) If the vitamins are decomposed, which type of drier contributes to greater loss? You can see that the title in table 5 does not even hint at these relationships.

4. Try to place the unit of measurement at the head of a column (table 4), if at all possible, rather than to bury it in a line caption (table 5). (Note: This suggestion is the key to the design of easily understood tables.)

5. Draw vertical guide line between all columns.

6. Make the table stand independent of the text.

7. Test the table by asking someone who is not familiar with it to explain it to you.

Consider the Graphs

(30) If the same information can be given in either table or graph form, the graphical presentation is likely to be comprehended more readily. Tables, however, have certain advantages that should not be overlooked. Exact values can be read directly from the table, whereas they are somewhat more difficult to determine from a graph. If the policy of your journal permits, it may be desirable to present both table and graph.

(31) In constructing your graph, keep in mind that it probably will be photographically reduced in size for publication. Make all of the lettering and the figures large enough to be read easily in the published paper. Do not forget to label the ordinate and abscissa and to state the units of measurement, if any (figure 8). Do not put these labels inside the field. You will find it a good rule not to put anything in the field that logically can be placed outside it or in the legend. There are two

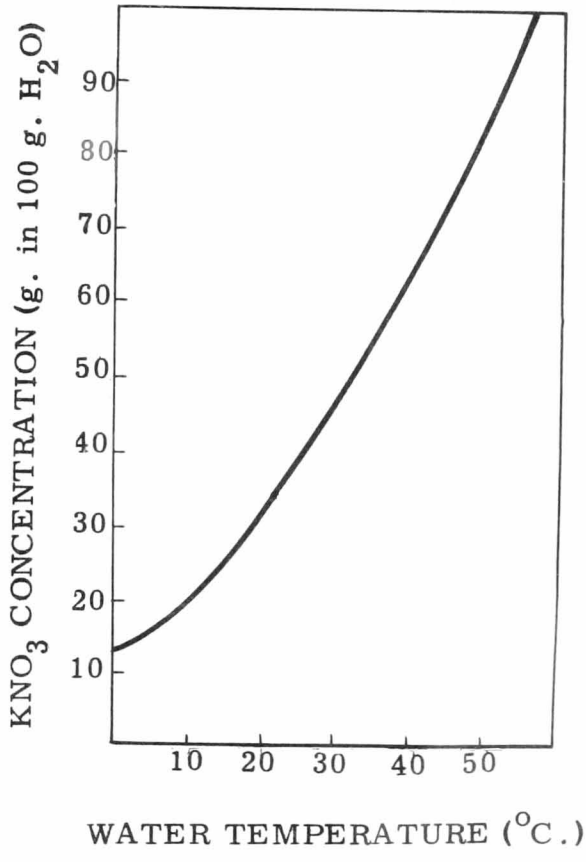

FIGURE 8.--INFLUENCE OF TEMPERATURE ON THE SOLUBILITY OF POTASSIUM IN WATER.

reasons for this rule: (1) The less extraneous material inside the field, the more quickly the reader will grasp the relationships you are trying to illustrate. (2) You save yourself work in drawing the graph or in redrawing it.

(32) The legend should point to the relationships you were trying to discover when you obtained your data rather than merely repeat the variables that can be read from your labeled ordinate and abscissa. Figure 8, for example, might have been given the legend "Concentration of potassium nitrate versus water temperature," which lists the variables but is not helpful in revealing the intent of the author. Note how much more informative is the legend "Influence of temperature on the solubility of potassium nitrate in water."

(33) Follow the format of the journal in which you intend to publish. You will save yourself much effort if you will check on the format before you make the graphs.

Consider the Illustrations

(34) It is impossible adequately to present certain subjects by words alone, and all other subjects can be made clearer and more interesting if they are illustrated. If your journal permits the use of drawings or photographs, you miss an opportunity if you do not employ them. Including such illustrations requires forethought. If photographs are to be used, you may not be able to take them after your project is completed. Try to schedule your photographs ahead of time.

Make an Outline

(35) One of the great labor-saving devices in writing is the use of an outline. Unfortunately, many beginning writers are not convinced of this fact. The result is much unnecessary work not only for the authors, but also for typists, critics, and editors.

(36) A word of warning: the use of an outline is not foolproof. It enables you to organize your thoughts; it does not guarantee that you will do so. Perfunctory use of an outline will get you nowhere. Only by careful thinking can you be sure that your outline will enable you to present your research to best advantage.

(37) General method.--Many authors have trouble in getting started on their outlines. If you have this difficulty, you might try making your outline by the "general" method, which takes advantage of the fact that the mind prefers to think in general terms rather than in specific ones. To use the method, first divide your subject into its principal divisions, as illustrated in outline 1.

Outline 1 3/

I. Introduction
II. Changes in texture of stored fish
III. Changes in color and flavor of stored fish
IV. Etc.

Next start a new outline and divide each principal division into its principal subdivision, as in outline 2.

Outline 2

I. Introduction
II. Changes in texture of stored fish
    A. Desiccation
    B. Etc.
III. Changes in color and flavor of stored fish
    A. Color changes
    B. Flavor changes
    C. Etc.
IV. Etc.

Continue this approach until you have completed your outline down to the paragraph level, as in outline 3.

Outline 3

I. Introduction
II. Changes in texture of stored fish
    A. Desiccation
        1. Adverse effects of moisture
        2. Etc.
    B. Etc.
III. Changes in color and flavor of stored fish
    A. Color changes

3/ From Section 2. Changes taking place during cold storage of fish by Maurice E. Stansby. Part 3, Refrigeration of Fish, U. S. Department of the Interior, Fish and Wildlife Service, Washington, D. C., Fishery Leaflet 429 (January 1956).

B. Flavor changes
1. Flavor in fresh and frozen fish
2. Etc.
C. Etc.
IV. Etc.

(38) If you use this method, you will find that for each paper you will make several outlines, with each succeeding one increasing in specificity. By the time your thinking has become quite specific and detailed, you will have done enough on your outline to encourage you to complete it. This method has another advantage in that you reconsider your subject, as a whole, several times. You thus are aided in critical reexamination of the logical structure of your paper.

(39) In practice, you probably will find it easier to develop the outline for certain divisions of the paper than for others. Once your ideas start to flow readily on a given division, finish it without worrying about the rest of the outline. The point is not how you make the outline, but that you make a good one.

(40) Subject method.--While you are reflecting on how best to write your paper, you may think of a good idea concerning some subsection before you have thought the paper through completely. A practice you may find useful is to write down your ideas on the subject, taking care to use a separate sheet of paper every time your thoughts take a new direction (Prince 1955). When you write your final article, you can shuffle these papers until the various subjects fit into your outline. As long as you do not write more than one subject on a single piece of paper, you will have no trouble in fitting these subjects into whatever outline you finally devise.

(41) Check outline.--Do not be satisfied too easily with your outline. Check it and then discuss it with your colleagues. If you have a supervisor, give it to him for a final check. Only if your outline is logical and complete, will your problem of writing be relatively easy.

(42) Often you can think of several different ways to write the paper. If so, make an outline to correspond to each of them before arriving at your final decision. Making the additional outlines will require less labor than will the work of revision if you decide later that your first way was not the best. Further, the additional consideration given to the various outlines will help to crystallize your ideas and facilitate the process of getting them on paper.

FIGURE 9.--SCIENTIST WHO FAILED TO MAKE AN OUTLINE.

(43) Mental writing.--After you have completed your outline, but before you start to write, give careful thought to the modes of expression to be used. Read your outline through, and mentally note possible alternative topic sentences for each paragraph. By trying out such approaches, you mentally can "write" your paper several different ways in a much shorter time and with far less effort than if you actually were to write out the paper each way. Do not try to complete the mental writing all in one sitting. Rather, think about the various sections a little at a time, and intersperse this work with other activities. Often you can allow several days to elapse profitably between the time you complete your outline and the time you start to write your paper, providing you spend this time in intermittent pondering on ways of writing the various sections. Then, when you are ready, you often can write without hesitation and possibly even dictate.

Use Headings

(44) A monumental discovery in the history of writing was the invention of headings, for they serve two important functions:

1. They point out to the reader changes in your direction of thought.

2. They show him where certain information is given.

By the aid of headings, the reader is able to follow without confusion intricate changes in your line of thinking, since the headings serve as signposts to guide him. The headings also enable him (1) to skip large sections of the paper, if he is so inclined, and to read only those parts in which he has a particular interest or (2) to go back to certain parts, time and again if need be, for data or other information.

(45) Important though headings are as filing guides, their use as indicators of changes in direction of thought is vastly the more important function. The mind of the reader has inertia. It will continue to follow along the same line of thought, unless you supply a force sufficient to start it to thinking in whatever new direction you desire. Headings are forceful enough to enable you to accomplish these shifts in thought.

(46) Relationship between outline and headings.--Your outline and the headings of your paper are closely related in two ways:

1. The headings reveal the various divisions in your outline.

2. If you employ care in wording the outline, the wording of the headings can be taken directly from it.

In the paper by Brown and coworkers, cited earlier, the original outline of the paper was, for example, as follows:

OXIDATIVE DETERIORATION IN FISH AND FISHERY PRODUCTS. II - PROGRESS ON STUDIES CONCERNING MECHANISM OF OXIDATION OF OIL IN FISH TISSUE

I. Introduction
II. Hematin catalysis
    A. Hematin-compound content of fish
    B. Catalytic effect of hematin compounds
    C. Catalytic effect of porteins
    D. Hematin-compound changes during oxidation
    E. Rate of oxidation in fish flesh
III. Role of antioxidants
    A. Naturally occurring antioxidants
    B. Commercial antioxidants
IV. Oxidation of oil in fish meals
    A. Rate of oxidation of meals
    B. Effect of commercial antioxidants
V. Summary

* * *

The corresponding headings in the paper were:

OXIDATIVE DETERIORATION IN FISH AND FISHERY PRODUCTS. II - PROGRESS ON STUDIES CONCERNING MECHANISM OF OXIDATION OF OIL IN FISH TISSUE

INTRODUCTION

HEMATIN CATALYSIS

Hematin-Compound Content of Fish

Catalytic Effect of Hematin Compounds

Catalytic Effect of Proteins

Hematin-Compound Changes During Oxidation

ROLE OF ANTIOXIDANTS

Naturally Occurring Antioxidants

Commercial Antioxidants

OXIDATION OF OIL IN FISH MEALS

Rate of Oxidation of Meals

Effect of Commercial Antioxidants

SUMMARY

* * *

You can see that the headings in the paper were the same as those in the outline.

(47) Grades of headings available.--In the paper just cited, the degree of subdivision of the outline was revealed by the grades of headings used in the paper. There were, for example, only two degrees of subdivision. The first degree was shown by capitalizing all words in the heading and by putting it in the center of the page:

HEMATIN CATALYSIS

The second degree of subdivision was shown by (1) capitalizing only principal words in the heading, (2) putting it at the left-hand side of the page, and (3) underlining it:

Hematin-Compound Content of Fish

(48) With only two degrees of subdivision, you have no difficulty in devising suitable types of headings, even with the limited facilities of a typewriter. You may require as many as six different types of headings, however, with an outline of the following degree of subdivision:

I. _____

A. _____

1. _____

a. _____

(1) _____

(a) _____

(49) After you have considered this problem, you may wish to adopt the system of headings used by those writing for the Federal Government. In this sytem, for convenience of reference, each grade of heading is given a number as follows:

THIS IS AN EXAMPLE OF GRADE O HEADING

THIS IS AN EXAMPLE OF GRADE 1 HEADING

This Is An Example of Grade 2 Heading

This is an example of grade 3 heading

This Is An Example of Grade 4 Heading

This is an example of grade 5 heading.--The grade 5 heading is run in and made a part of a paragraph as is shown here.

1. This is an example of a grade 6 heading: Grade 6 heading is similar to grade 5 heading in that it is indented and made a part of the paragraph, but it differs (a) in being numbered, (b) in not being underlined, and (c) in having a colon rather than a period and two hyphens following the last word.

(50) In the paper by Brown and coworkers, the title was a grade O heading, the principal subdivisions of the paper were grade 1 headings, and the other subdivisions were grade 4 headings. The reason the last headings were not grade 2, as would seem more logical, is discussed later.

(51) The grade O heading (in capitals, underlined) is used only for title to papers. It is proper usage, however, only

for papers to be published by photolith or offset reproduction of typewritten copy. For papers to be printed by letter press or similar method, the grade 1 heading is used.

(52) Capitalization of grade 2 and grade 4 headings.--In the grade 2 and grade 4 he headings, the articles a, an, and the; the prepositions at, by, for, in, of, on, to, and up; the conjunctions and, but, if, or, and nor; and the second element of a compound numeral are not capitalized as is shown by following examples, which are taken from the United States Government Printing Office Style Manual (1953):

Built-up Stockpiles Are Necessary

Man Hit With 2-Inch Pipe

Price-Cutting War

No Ex-Senator Admitted

Notice of Filing and Order on Exemption From Requirements

but Building on Twenty-first Street (if spelled)

One Hundred and Twenty-three Years (if spelled)

Only One-tenth of Shipping Was Idle

Many 35-mm. Films in Production

(53) Recommended headings.--If you compare the preceding seven grades of headings (grades 0, 1, 2, 3, 4, 5, and 6), you will see that, unfortunately, many of them are similar in appearance and that your readers may have difficuly in distinguishing one grade from another. The ideal arrangement is to use only those grades that are as dissimilar as possible. If your outline is complex, however, you may have no choice, since all of the grades will be needed to distinguish between the various subdivisions. Because most papers fortunately do not require such a high degree of subdivision, you ordinarily have a choice among the grades of headings.

(54) The problem now becomes: Which grades are the most dissimilar appearing and how should they be chosen? The following combinations have been found to work well:

1. For papers with only one grade of subheading, use grade 1 headings.

2. For papers with two grades, use grade 1 for principal headings and grade 4 for second-grade subheadings.

3. For papers with three grades, use grade 1, grade 4, and grade 5 subheadings, in that order.

4. For papers with four grades, use grade 1, grade 2, grade 4, and grade 5 subheadings.

5. For papers with still more elaborate subdivisions, use in proper order the other headings given above.

(55) Use of headings with individual paragraphs.--Ordinarily, you will not set off each paragraph by a heading. The factor determining whether you should use a heading for an individual paragraph, however, is how abruptly you shift your line of thought. The principal purpose of headings is to indicate that the direction of your thought has changed. Where the subject matter of your paper varies markedly from one paragraph to another, give headings to the individual paragraphs in order to alert your reader to the fact that the direction of thinking has changed and that you now are discussing a different topic.

(56) Introduction of subsection.--Each subsection of your paper should be given an introduction. None of the introductions to the subsections should be given a subheading called "Introduction", however, since this subheading should be reserved for the first main section of your paper. Otherwise, the repetition of the heading "Introduction" will become intolerably monotonous. Furthermore, labelling a subheading "Introduction" serves no good purpose, since tne reader ordinarily expects some introductory remarks whenever he reads a new section.

Give Thought to the Paragraphing

(57) The use of paragraphs has much the same function as the use of headings; that is, the paragraph break tells the reader you have finished discussing one topic and now are ready to discuss another. There

also is a further parallel between headings and paragraphs: the heading signals to the reader that the group of paragraphs being considered are related; the paragraph signals that the groups of sentences are related.

(58) You neither should have long sections without trying to organize them into shorter subsections, nor long paragraphs without trying to break them into shorter ones. Long paragraphs, like long sections, are mentally tiring. View with suspicion any paragraph that is longer than a typewritten page. Usually, it can be separated logically into smaller divisions. Pay particular attention to the opening paragraphs. A long one looks formidable, promises much dull reading, and tends to repel prospective readers.

(59) Your paragraphs must be logical units of thought. An example of a type of paragraphing that gives scientific authors much difficulty, is the following:

> The analysis was carried out in two steps.
>
> In the first step, so and so, so and so, and so and so was done....
>
> In the second step, such and such, and such and such was done....

This is logical paragraphing, and it is clear. You know how many steps there are and where each one starts.

(60) You tend to confuse your readers if you combine the first sentence with the second paragraph:

> The analysis was carried out in two steps. In the first step, so and so, was done....
>
> In the second step, such and such, such and such, and such and such, was done....

The introductory sentence, in this example, belongs just as much to the second step as it does to the first one. It is true that combining the introductory sentence with the paragraph explaining the first step is only slightly illogical, but this practice is more serious than you might think because in scientific writing you need to be only slightly confusing to tire your readers greatly.

(61) Matters are further complicated if you forget about parallel construction and start your description of the second step with different wording from that used with the first one:

> The analysis was carried out in two steps. In the first step, so and so, was done....
>
> The second step consisted in such and such, such and such, and such and such and such....

Since your attention has been focused on these slight changes, you know what they are, so they may not strike you forcefully; but you will be surprised how fast you can lose an inattentive reader by this confused method of breaking up paragraphs.

(62) These faults are minor in comparison to leaving out the introductory statement:

> In the first step, so and so was done....
>
> The second step consisted in doing such and such....

(63) Now visualize the confusion, if you also neglect to mention that you are describing the first step:

> So and so, so and so, and so and so was done....
>
> The second step consisted in doing such and such....

If your reader has been half asleep, the statement about the second step may wake him up, and he will go back to discover what your first step was. If your discussion is short, he may have no difficulty; but if your discussion is long, he may waste much time before he discovers where your discussion of the first step begins.

(64) The last example is not the worst. You also might omit mentioning that you are describing the second step:

> So and so, so and so, and so and so was done....
>
> Such and such, such and such, and such and such was done....

FIGURE 10.--READER FORCED TO TURN DETECTIVE WHEN AUTHOR FAILED TO STATE, IN THE INTRODUCTION, THE OBJECTIVES OF THE RESEARCH. DOG'S NAME IS DR. WATSON.

(65) In addition, you might run the paragraphs together:

> So and so, so and so, and so and so was done....Such and such was done....

Do all these things, and you leave your reader with a nice puzzle to solve--if he ever gets around ot it.

Obtain Reader's Viewpoint

(66) The burden of communication lies with you. If your intended reader fails to comprehend your message, it is a sign that something is wrong with your writing, and not that the reader lacks intelligence. A practice you may find helpful in gaining insight into the reader's problem of comprehension is to have someone who is technically competent, but not familiar with your work, read your paper to you. By noting the ease--or lack of ease--with which he reads, you can tell where your paper needs revision.

PARTS OF THE SCIENTIFIC PAPER

(67) In general, the scientific paper can be considered as being made up of the following parts: title, abstract, table of contents, introduction, acknowledgment, experimental procedure, results and discussion, conclusions, summary, and literature cited.

(68) The parts called introduction, experimental procedure, results and discussion, and conclusions have resulted from the desire of readers to obtain answers to the following five questions:

1. What were you trying to accomplish?
2. Why were you trying to do it?
3. How did you carry out the work?
4. What did you find out?
5. What did you conclude from these findings?

Questions 1 and 2 are answered in the introduction; question 3, in the experimental procedure; question 4, in the results and discussion; and question 5, in the conclusions.

The Introduction

(69) As just was stated, the primary function of the introduction is to answer two questions: (1) What were you trying to do? (2) Why were you trying to do it? Your failure adequately to answer these questions may reduce greatly the effectiveness of your research. If you fail to answer the first one, you force your readers to turn detective in that they must infer your objectives from the data and the discussion in the latter part of your paper.

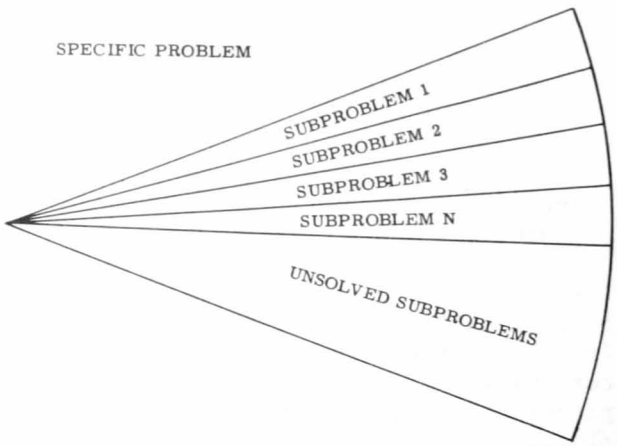

FIGURE 11.--ILLUSTRATION SHOWING THAT A RESEARCH PAPER ORDINARILY REPORTS ON THE SOLUTION OF A NUMBER OF CLOSELY RELATED SUB-PROBLEMS.

If you fail to answer the second one, your paper may join the many others that have lain long in disuse because their authors did not make clear the significance of their findings. A thought you might keep in mind is that numerous examples exist of worthwhile research projects which have been terminated because those who have had to pay the bills for the research were not shown it was worth the cost.

(70) In answering the foregoing two questions, you may find it helpful to consider the general nature of research, which is illustrated in figures 11 and 12. These figures are intended to show two points:

1. Your paper ordinarily reports on the solution to some set of related problems of relatively narrow scope, which for convenience can be grouped together and called the specific problem.

2. Your specific problem is never an isolated one, for your findings always help to solve some problem of greater scope, which may be called the broad problem. The solution of the broad problem, in turn, helps to solve a problem of even greater scope, which may be called the general problem. This process may be continued to the widest field of knowledge. It seldom is profitable, however, to consider relationships beyond the general problem. The figure implies that as scientific knowledge advances, the special problem in your paper eventually may become a general problem, or one of even wider scope, since there are few limitations to the inquiries of science.

(71) The subjects treated in scientific papers are so widely different that no one outline will suffice for all introductions. The following is offered, however, to suggest the general approach:

I. Introduction

A. Orientation of readers to the specific problem

1. Transitional sentence or paragraph to relate the title of your paper to your general problem.

2. General problem

a. What it is?

b. Why it is important? 4/

c. What has been done to solve it?

d. What still needs to be done on it? (This introduces your broad problem.)

3. Broad problem

a. What has been done to solve it?

b. What still needs to be done on it? (This introduces your specific problem.)

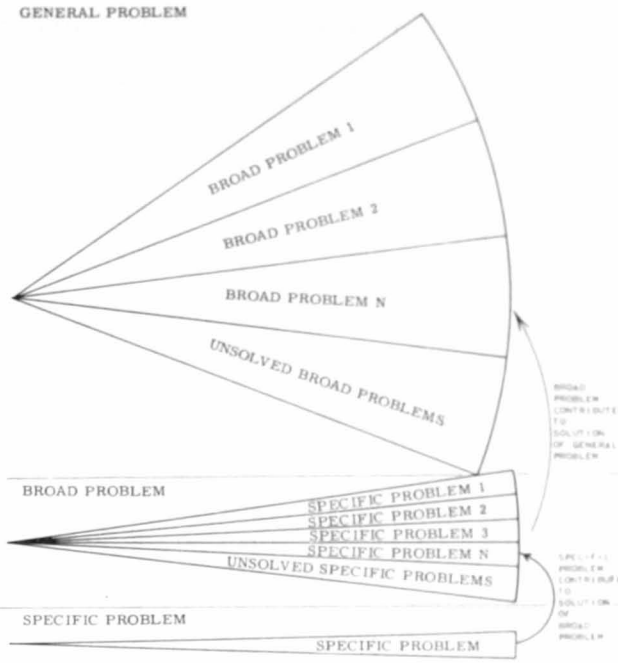

FIGURE 12.--RELATION BETWEEN GENERAL, BROAD, AND SPECIFIC PROBLEMS.

4/ Once you establish the importance of your general problem, you automatically establish the importance of anything that contributes significantly to its solution.

B. Objectives of specific problems

1. Objective of subproblem 1.

2. Objective of subproblem 2, and so on.

(72) Orientation of readers to specific problem--From the outline, you will see that orienting your readers to your specific problem (telling them why you were trying to solve it) may be somewhat involved, depending upon their background of knowledge. With a poorly informed audience, you may have to tell them something of the general problem--what it is, why it is important, what has been done to solve it, and what still needs to be done on it--and then go on to discuss the broad and the specific problems. With a better informed audience, no mention need be made of the general problem. Only with the most specialized audiences, however, can you omit mention of the broad problem; and even then, some of your readers may not see the significance of your work.

(73) Your title should reveal your specific problem. If you start your paper directly with a discussion of your general problem, your readers may get the impression that you have strayed from your subject. The opening transitional sentence or paragraph is to assure them that your discussion of the general problem is pertinent to the subject indicated in your title. Take, for example, the paper entitled "Photographic Device for Accurately Measuring Fish" by Long and Arzylowicz (1957). The opening paragraph begins as follows:

> "The photographic measuring device described in this paper was developed to aid the work of the International North Pacific Fisheries Commission. One of the objectives of the Commission is to devise a suitable method of identifying the various races of salmon so that North American stocks can be differentiated from Asian stocks..."

You can see that if the paper had not included an opening transitional sentence, the readers would have wondered what the objective of the Commission had to do with a photographic device. Some papers do not require this transitional statement; others definitely do. Give thought to whether such a statement will be helpful in your paper.

(74) You may feel that you can eliminate the need for this transitional statement by starting with the specific problem and then discussing the broad and general problems. This technique leaves your reader thinking about your general problem. You then will need a transitional statement to bring him back to the problem at hand. Ordinarly, you will find the better technique is to start with the general problem and end with the specific problem, rather than with the reverse.

(75) In telling what has been done on the broad and general problems, you will be citing the literature. Keep in mind that often a citation of only one or two papers with good bibliographies will give references to all the important papers in your field. Because of this fact, you may wish to call special attention to these bibliographies.

(76) If a thorough review of the literature has not been made in your field for some time, you might consider including one with your paper. The great problem in science is how to bring order out of the numerous separate research reports that are being published in a continuous stream. A review gives the various workers a clearer insight into the problems of their field and helps them to continue making significant contributions to it.

(77) In citing the literature, keep in mind that your readers always should be able to distinguish between your work and that of others. Owing to the custom in scientific writing of omitting personal pronouns, the reader often is left in doubt as to whether the author or someone whom he cited did the work being discussed. Be sure that your differentiate what you and your co-workers did from what other workers did.

(78) You can see from the outline that most of the introduction is devoted to orienting your readers to your specific problem. In summary, a technique for doing this is to (1) show the importance of your general problem, (2) show that the solution of your broad problem is necessary to the solution of the general one, and (3) show that the solution of your specific problem is necessary to the solution of the broad problem. How detailed you make these explanations will depend upon the background of information of your intended audience.

(79) Statement of the objectives of specific problem.--As is indicated in figure 11, your specific problem ordinarily is composed of a number of closely related subproblems. The objectives of your work on the specific problem are to solve these subproblems.

(80) In stating your specific problem, you should list these objectives by number and mention them explicitly so that your reader will know exactly what you were trying to accomplish. Numbering your objectives and stating them in this explicit manner are two of the most important things you can do to help your reader comprehend your paper completely on one rapid reading.

(81) In the paper "Comparative Keeping Quality, Cooling Rates, and Storage Temperatures of Haddock Held in Fresh-Water Ice and in Salt-Water Ice" by Peters and Slavin [5/]; these authors might have stated their objectives as follows:

> The specific objectives of the experiment were to determine the keeping quality of haddock iced and stored aboard a fishing vessel (employing the manner traditionally used in the haddock fishery) in crushed fresh-water ice and crushed salt-water ice (3 percent salt by weight) and to determine the cooling rates and storage temperature of haddock stored in these ices.

Instead, they listed them by number:

> The specific objectives of the experiment were--
>
> 1. To determine the keeping quality of haddock iced and stored aboard a fishing vessel (employing the manner traditionally used in the haddock fishery) in (a) crushed ice and (b) crushed salt-water ice (3 percent by weight).
>
> 2. To determine the cooling rates and storage temperature of haddock stored in these ices.

You can see that numbering the objectives helped to clarify them. You also can see that if the authors had left out this statement of objectives altogether, a reader would have great difficulty in inferring what they are from any discussion in the remaining part of the paper. The omission of such a statement of objectives is the primary reason why so many scientific papers are hard to understand.

(82) Before stating your specific problem, be sure that you clearly distinguish in your own mind between your general, broad, and specific problems. The statement of your general or of your broad problem is not a satisfactory substitute for the statement of your specific problem. Your reader needs to know exactly what you were trying to do and not merely your general field of studies.

(83) A minor difficulty you will encounter if you state your problem specifically, as was done by Peters and Slavin in their work on salt-water ice, is that your readers will wonder why you took the particular experimental approach that you adopted. Many readers, for example, would wonder why Peters and Slavin decided to conduct their tests on a fishing vessel instead of in a laboratory as would have been more convenient, why they decided to use haddock instead of cod or some other species, and why they decided to use crushed ice instead of flake ice.

(84) In your introduction, be sure that you answer all such questions. If you adequately orient your readers to your research, you then can include the word "therefore" in your statement of objectives, as in the following example: "The objectives of the research reported in the present paper therefore were as follows: (1) to determine the keeping quality of haddock...and so on." Use of the word "therefore" helps you to determine whether you have given an adequate introduction to your specific problem.

(85) You will find that listing your objectives usually will determine the logical structure of your paper. This fact does not seem to be well known, for many authors use only the following outline 1 for all of their papers:

5/ John A. Peters, Chemist, and Joseph W. Slavin, Refrigeration Engineer, Fishery Technological Laboratory, East Boston, Massachusetts. Manuscript in preparation (1957).

OUTLINE 1

I. Introduction
II. Procedure
III. Results and discussion
IV. Conclusions

Outline 2, however, generally will be more appropriate:

OUTLINE 2

I. Introduction
  A. Orientation of readers to specific problem
  B. Objectives of specific problem
    1. Objective of subproblem 1
    2. Objective of subproblem 2, and so on
II. Subproblem 1
  A. Introduction
  B. Procedure
  C. Results and discussion
III. Subproblem 2
  A. Introduction
  B. Procedure
  C. Results and discussion
  D. Conclusions
IV. Subproblem 3, and so on
V. General discussion
VI. General conclusions

(86) From an examination of outline 2, you see that outline 1 normally will be suitable only if your specific problem has but one objective. You thus can see another reason why many scientific papers are hard to understand--the authors use only one outline, regardless of how unsuitable it may be.

(87) Outline 2 is not the ultimate for all papers. It is presented simply to stimulate your thinking. Each of your papers should be considered individually, and you should develop whatever outline will enable you to present your paper to best advantage.

(88) You probably have noticed that in discussing the subproblems of your specific problem, I have been careful to point out that they must be closely related. If this relationship is not close, you will have two or more papers instead of one. With each of your papers, determine whether your specific subproblems are closely enough related to justify reporting them in one paper.

(89) Example of an introduction.--To see how these suggestions work in practice, consider the following slightly altered and abridged introduction taken from a paper by Thurston (1957):

DYE-BINDING CHARACTERISTICS OF FISH MEAL PROTEIN. PART I - SOME PRELIMINARY FINDINGS AS TO SUITABLE DYES

INTRODUCTION

General problem

Owing to the time required in making animal tests for determining the quality of proteins in foods, chemists long have been interested in developing quicker methods.

One promising approach has been to correlate the quality of the protein with its dye-binding properties. Such a method has many practical advantages because of the simplicity with which the concentration of dyes can be measured by spectrophotometric techniques.

Several of the investigations reported in the literature indicate that the quality of a vegetable protein can be determined by its dye-binding characteristics. Chapman, Greenberg, and Schmidt (1927) showed by reactions of several acid dyes with various protein solutions that the amount of dye bound was proportional to the number of basic groups in the protein. Fraenkel-Conrat and Cooper (1944) found that dyes could be used to determine the number of acidic and basic groups present.

Udy (1954)--working with vegetable proteins, chiefly wheat--found that the quality of the protein could be determined from its dye-binding characteristics.

Broad problem

If a similar relationship exists between dyes and the proteins in fish meal, the nutritive value of these proteins might be determined by a chemical index, in hours, rather than in 1 to 3 weeks as now is required when a feeding test is used. An investigation of the dye-binding characteristics of the protein in fish meal accordingly has been started at the Seattle Technological Laboratory in order to learn if there is any correlation between the nutritive value of the meal, as determined by chick-feeding tests, and the extent of binding of the dye.

Specific problem

Since no previous research has been reported on the use of dyes with fish meals, one of the preliminary steps necessary in undertaking this investigation was to determine what dyes are suitable and how they best can be employed.

The specific objectives of the study reported in the present paper therefore were to determine--

1. What dyes will be bound by the proteins of fish meal.

2. What are the optimum conditions in the use of these dyes.

* * * *

(90) If you analyze this introduction, you will see that the general, the broad, and the specific problems are as follows:

General problem:	To develop a quick method for determining the quality of proteins.
Broad problem:	To determine the quality of proteins in fish meal by the use of dyes.
Specific problem:	To determine which dyes will be bound by the proteins in fish meal and what are the optimum conditions in the use of these dyes.

The experimental procedure

(91) The expression "experimental procedure" is ambiguous in that it may refer (1) to all the different things you did to solve your problem or (2) to some limited set of operations you followed, as in the analysis of fish meal for nitrogen. For the purpose of this manual, the word "procedure" will be restricted arbitrarily to meaning 1. If meaning 2 applies, the word "method" will be used. This restriction in the meaning of "procedure" not only makes it less ambiguous but also makes it more suitable for use with certain biological, economic, or other studies in which experimental manipulation is not feasible.

(92) Introductory statement describing the overall procedure.--Many practices have developed in the scientific literature that do not contribute to clarity of writing. Sometimes, for example, an author may give a detailed description of the various parts of the procedure without first telling his readers how these parts fit together, as in the following example:

Experimental Procedure

Five ml. of saturated solution of $SbCl_3$ was measured into a cuvet. With the cuvet in place, the spectrophotometer was adjusted for dark current and zero optical density, using a slit width of

0.04 mm. and a wavelength of 620 mμ. To the reagent in the cuvet, 1 ml. of $CHCl_3$ solution was added...and so on, perhaps for several pages.

(93) In presenting your procedure, consider whether or not it needs an introductory statement as to overall scope. Ordinarily, you will find that this added statement will make a vast difference in the ease with which your work is comprehended. The kind of statement needed is shown by the following example taken from the paper by Peters and Slavin cited earlier:

Experimental Procedure

Briefly, the procedure was (1) obtain haddock at sea, (2) eviscerate and washthem, (3) divide them into two groups, (4) ice one group with fresh-water ice and the other with salt-water ice, (5) measure the changes in temperature of the two groups during storage, and (6) organoleptically determine the change in quality of the two groups during storage. Details of the experiment are given in the subsections immediately following.

(94) A short introductory statement of this kind will be particularly helpful to those of your readers who want to find out what you did in a general way, but who do not have the time to read the details or who actually lack the ability to synthesize them into a meaningful picture. You might keep in mind that this group often includes abstracters and that the niche in scientific history which your paper will occupy may depend on how well some abstracter understands it.

(95) Description of a series of similar experiments.--If your work involved a series of experiments all of which were quite similar, you may find it difficult to describe the procedure. The following technique provides a good solution to this problem:

1. Tell the reader how many experiments there were in the series. 6/

2. Describe the first experiment in detail.

3. Tell how each of the remaining experiments differed from the first one.

(96) In using the foregoing technique, you will find the following practice helpful:

1. Set off in separate paragraphs the introductory statement and the description of each experiment. 7/

2. Use parallel construction so that the reader easily can see any similarities and differences.

(97) The following description of a procedure taken from a report by Osterhaug and Andrews (1955) gives an example of these points:

(Statement of number of series)	Two experiments were made: series I, experimentally handled oysters; and series II, commercially handled oysters.
(Detailed description of series I)	In series I, shucked Pacific oysters purchased in 1/2-gallon cans in Seattle and transported to the laboratory were sorted, the undamaged oysters were repacked...and so on.
(Description of series II showing how it differed from series I)	In series II, 10-ounce cans of commercially frozen oysters that had been in storage at 10° F. for approximately 9 months were used. These oysters were divided into similar groups and thawed under the same conditions as were those in series I.

(98) Use of illustrations.--In describing the procedure, keep in mind the importance of

6/ If you give thought to the numbering of the experiments, you may find that you can simplify their description. In short, unless the chronological sequence is significant, the experiments should be numbered in whatever order best will aid in their logical description.

7/ Setting off the introduction to the series and the description of each experiment in a separate paragraph may result in a number of paragraphs that contain only one sentence. Although longer paragraphs usually are to be preferred, the function of paragraphing is to help the reader to a quick comprehension of the article. When clarity is aided, use of one-sentence paragraphs not only is permitted but is recommended.

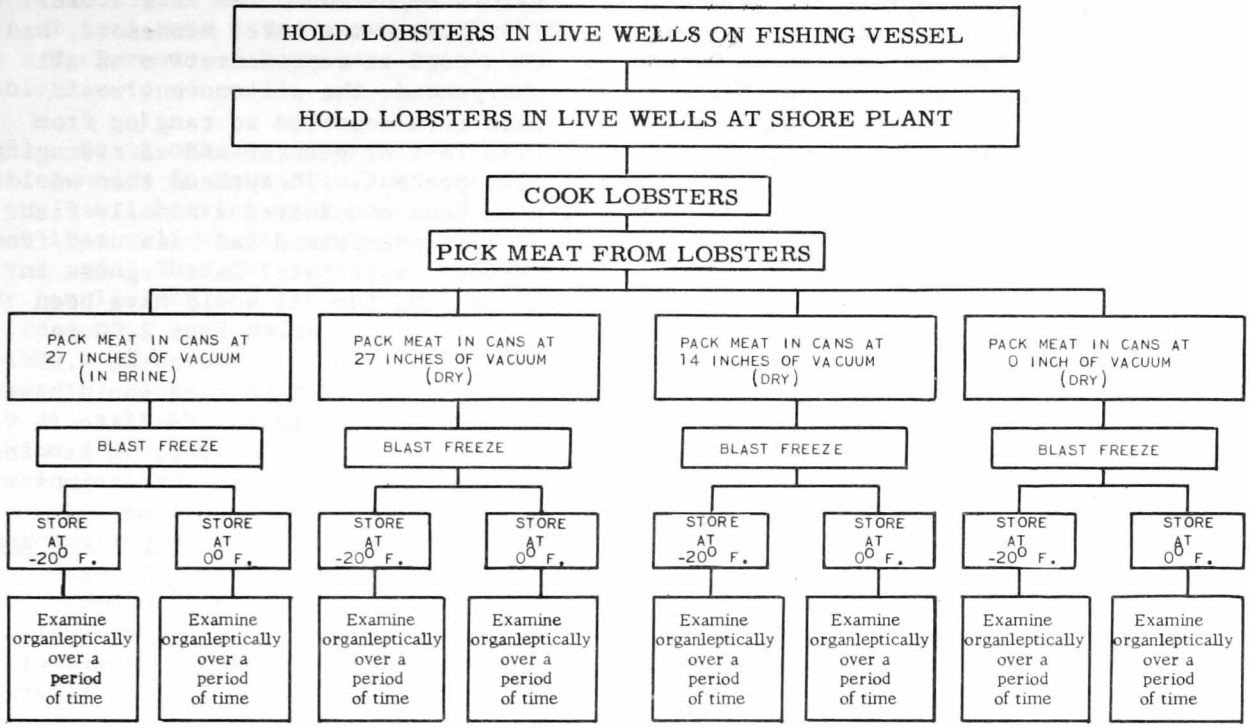

FIGURE 13.- FLOW DIAGRAM ILLUSTRATING PROCEDURE IN AN EXPERIMENT ON THE CANNING AND THE FROZEN STORAGE OF LOBSTER MEAT.

illustrations. There are two possible approaches to their use:

1. The illustrations are used simply to support the text.

2. The text is used to support the illustrations.

The second approach greatly simplifies your problem of description. Thus, if you have something hard to describe, first make whatever illustrations are needed and then build your text around these illustrations. This technique often will save you pages of difficult writing. Furthermore, it will enable your readers to obtain an almost instantaneous comprehension of your subject; whereas a written description, in addition to being tiresome, may leave them with only a foggy notion of what you are trying to convey.

(99) In describing your procedure, keep in mind the possibility of using a flow diagram. Figure 13 shows how this technique could be applied to an experiment on the canning and frozen storage of lobsters. 8/

8/ Personal communication from Joseph W. Slavin, February 1957.

Without the flow diagram, the description of this procedure would be very involved.

(100) Description of method by reference to authors.--If the method you used already has been published, do not describe it in detail in your own paper. Include a brief general description of it, however, for the benefit of those who are not familiar with it and who may not have the time or opportunity to look up the reference to it.

(101) Warning of pitfalls in method.--When describing your method warn your reader of any pitfalls; that is, tell him where it may go wrong if he does not take certain precautions. Otherwise, he uselessly will have to rediscover for himself all your hard-won knowledge of how to avoid these difficulties. The reader who is trying to follow your method is not likely to revere you for leaving out these warnings. In fact, if he has trouble in repeating your experiments, he may regard you as being something of a faker instead of merely an inept author.

(102) Description of a method involving a number of consecutive steps.--A problem frequently encountered is that of describing a

method which involves a number of consecutive steps. In such a description you have two difficulties: (1) your sentences become monotonously the same, and (2) your readers find it difficult to follow you, especially if you intersperse explanations with directives, as you often have to do.

This problem can be solved by the following technique: (1) Number each step, and (2) give directions in imperative sentences and explanations, if any, in declarative ones. An example of this technique is given on pages 7 and 11 of this manual. A second example is furnished by Thurston (1957) [9/] in the description of the method he used to determine the natural contents of sodium and potassium in fish:

1. Partially thaw a can of frozen sample in lukewarm water for 30 minutes, and then open can.

2. Transfer a 10-gram portion of the sample to a porcelain evaporating fish.

3. Divide sample into fine particles by cutting it with a shears; remove any...and so on.

(103) Adequacy of the sample.--In describing the materials employed in your experiments, give a full description of any samples you may have used. Keep in mind that no work is ever more reliable than is the sample. This fact, unfortunately, is not always recognized. Much of the early analytical work in fishery technology, for example, was useless because in experiment after experiment the samples were not adequate.

(104) A striking example of the great care needed in sampling has been pointed out by Karrick, Clegg, and Stansby (1956) in their work with sheepshead, a common species of fresh-water fish:

> "If only 16 sheepshead (a much larger sample than that for most values reported in the literature) from Clearwater Lake, Minnesota, had been used as representative of all sheepshead, the oil content would have been reported as ranging from 0.72 to 1.67 percent and as averaging 1.04 percent. Sheepshead then would have been considered a nonoily fish. If only sheepshead had been used from another small lake, Lake Kegonsa in Wisconsin, the oil would have been reported as ranging from 2.00 to 8.84 percent and as averaging 4.89 percent. Sheepshead then would have been considered as intermediate in oil content. If, however, 16 samples of sheepshead from the Mississippi River had been taken in June 1954, values from 3.57 to 14.20 percent and averaging 8.78 percent would have been found. Sheepshead then would have been classified as an oily fish. This is an example of the danger of analyzing one fish, or even one large lot of fish from the same source, and reporting that the values obtained are representative for the species."

The Results and Discussion

(105) As was stated earlier, you should present the results of your study in tables and graphs if at all possible, for this is the most efficient and satisfactory way. Important as your tables and graphs are, however, make your discussion stand independently of them so that the reader can follow the main trend of your findings.

(106) When you discuss tabular or graphical material, let your reader know early in the discussion to which table or graph you are referring. Otherwise, he may have to go over your discussion again when he finally discovers about which specific table or graph he has been reading.

(107) Be sure that you point out all of the relationships shown by your data. On the other hand, take care that you are not merely recapitulating the detailed contents of your tables and graphs. Otherwise, you will alienate your reader, because after laboriously going through your verbiage, he will find that you have told him nothing that was not already more clearly seen from the tables and graphs themselves. What he wants to learn from your discussion are the trends, the correlations, and the

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9/ "Content of Sodium and Potassium in the Edible Portions of 34 Species of Fish" by Claude E. Thurston, Chemist, Fishery Technological Laboratory, Bureau of Commercial Fisheres, U. S. Fish and Wildlife Service, Seattle, Washington. Manuscript in preparation.

conclusions that he otherwise would have to extract from your data, presuming that he has a background of knowledge sufficient to enable him to do so.

(108) Point out any apparent or real inconsistencies in your data, and explain them if you can. Leaving your reader to wonder about them will weaken your paper more than if you point them out yourself. Also, if your conclusions are not obvious, explain the reasoning process by which you arrived at them. If certain trends or correlations appear to exist in your data when none actually do, make the situation clear. Also, in your discussion, be sure to distinguish between fact and theory.

The Conclusions

(109) Ordinarily, the conclusions are the most important part of the paper. The rest of it usually is for the purpose of showing the reader their significance and reliability. Most papers would need to present only the conclusions were it not for the reader's lack of information regarding the need for the research and for his healthy skepticism as to the correctness of the results and of the conclusions drawn from them.

(110) Occasionally you see a paper in which the author has neglected to draw conclusions from his data. This practice is poor; for the author, being best acquainted with the work, should be best able to draw the conclusions.

(111) Because the conclusions are so very important, they rate a subsection of the paper entirely to themselves. In writing your conclusions, list each by number (in order of origin in the paper) so that each will be separate, distinct, and easy to read. Do not include any discussion or explanation. If you find yourself tempted to add an explanation, you have not done a good job of writing your "Results and Discussion."

(112) After presenting your conclusions, check back to your statement of objectives in the introduction to make sure that your conclusions are in line with what you started to do. Experiments have a way of straying from the intended path. Make certain that yours have not done this.

(113) Your paper may be one in which you make recommendations rather than draw conclusions. If so, list each recommendation by number just as you would if it were a conclusion. You then should use an appropriate heading such as "Recommendations."

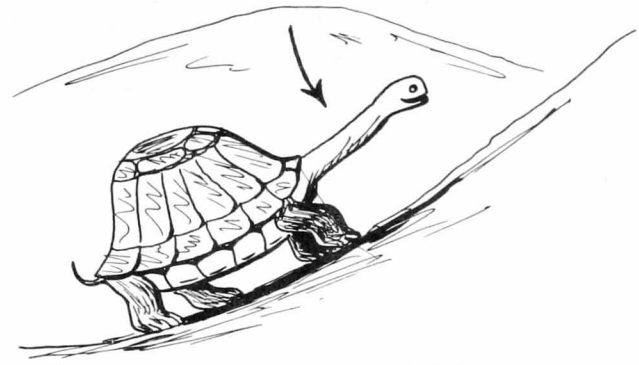

FIGURE 14.--NOTE POSITION OF NECK WHEN TURTLE IS IN FORWARD MOTION.

The Summary

(114) Some authors seem to be confused as to the difference between the summary and the conclusions. The difference, however, is distinct. Your conclusions give only the inferences that you have drawn from your data, whereas your summary recapitulates the paper and gives it to the readers in miniature. Thus in the summary, you ordinarily make some mention of each of the other sections (introduction, procedure, results and discussion, and conclusions) of the paper, mentally digesting it for the reader and presenting it to him in its barest essentials. In restricting the summary to the essentials, however, be informative by giving quantitative rather than merely descriptive data.

(115) Your summary should stand independently. On the other hand, do not mention any topic that was not mentioned in the body of the paper; the summary is not for tucking in facts you forgot to mention earlier.

(116) Inasmuch as the summary helps the reader to separate essentials from details and gives him a final comprehensive grasp of the article, a summary should be included with all but the very shortest papers. Omitting the summary gives your reader the impression that you have left the paper dangling. The summary not only aids those who take the trouble to read your paper, but also those who skim through the journal

in which it is published. Keep in mind that the summary is the only part of your paper that will be given serious attention by most readers of your journal. Keep in mind also that your summary is a tremendous aid to the abstracter of your paper.

The Title

(117) In choosing a title for your paper, you may fall into errors such as making the title incomplete, misleading, or too general, owing to your desire to keep it from becoming overly long. Although the title preferably should be short, it is more important to have one that correctly reveals the contents of your paper. This is why choice of final wording of the title may well be left until the writing of the paper is completed.

(118) With many of your papers, the title will be a compromise between what you think should be mentioned and what space you think can be spared for it. The following examples illustrate how the length of the title increases as it becomes more specific and informative:

Determining Fish Measurements

Device for Determining Fish Measurements

Photographic Device for Determining Fish Measurements

Automatic Photographic Device for Determining Fish Measurements

(119) How to choose a title.--Titles of scientific papers are of two kinds: those used with independent papers and those used with papers that form a series. An example of the first kind is "The Lengths of Albacore in Commercial Catch." An example of the second kind is "Dye-Binding Characteristics of Fish-Meal Protein. Part I - Some Preliminary Findings as to Suitable Dyes."

(120) In independent papers, the title points only to the specific problem. In papers belonging to a series, the first part of the title names the broad problem and the second part names the specific one. Thus, in the example listed earlier, "Dye-Binding Characteristics of Fish-Meal Protein" named the broad problem; "Some Preliminary Findings as to Suitable Dyes" named the specific problem.

(121) Take great care in naming your broad problem, for the title you devise will be used in the entire series. Make certain that the title to the first paper will be adequate for later ones. To name the part of the title pointing to your specific problem, study the objectives listed under the specific problem. Now devise a title that will cover these objectives adequately. (You will find that unless your objectives are closely related, you will not be able to devise a suitable title, because in reality you will have two or more papers instead of one.) An example of how to word the specific portion of the title is shown by Feuge, Gros, and Vicknair (1953) in their paper "Modification of Vegetable Oils XIV - Properties of Aceto-Oleins." The following is a statement of their objectives:

> "The present investigation had the following objectives: (1) to determine the properties of 1, 2-diaceto-3-olein, triolein, and a mixture of aceto-oleins; (2) to determine the properties of acetlated oils prepared by interesterification with triacetin or by glycerolysis followed by acetylation; and (3) to examine the plastic properties of these mixtures with mixtures of highly hydrogeneted cottonseed oil and unacetylated oils and with margarine oil."

Note that all of their objectives are covered by the specific part of the title "Properties of Aceto-Oleins." This is an example of a paper that had several objectives which were closely enough related so that they logically could be reported in a single paper. Accordingly, the title was easy to devise.

(122) Impractical sounding titles.--An unfortunate aspect of titles is that some of them sound impractical. In fact, often the better and more specific the title from the scientific viewpoint, the less sensible it may sound, especially to the layman who might not be acquainted with the project. Take, for example, the title "Automatic Photographic Device for Determining Measurements of Salmon." For it to be ridiculous, all you need to do is make it more specific by adding something like "Caught at the

Mouth of Hunter Creek" or "Caught at the Mouth of Hunter Creek by Frogmen."

(123) You should keep the danger of misjudging or misunderstanding titles in mind because often it is a layman who must approve the bill for your investigation. Do not expect him to be enthusiastic about a project that does not seem to be of value. If your title is unavoidably pedantic sounding, make certain that you show the full significance of your work when you write the introduction to your paper.

The Abstract

(124) This discussion is concerned with the short abstract often found at the beginning of scientific papers but usually written after the paper is completed. Such abstracts are of two kinds: qualitative and quantitative. Qualitative ones tell what you studied; quantitative ones, what you found.

(125) Try to summarize your findings in the opening sentence of the abstract. This practice enables the reader to decide immediately whether or not the paper is of sufficient interest to warrant further attention.

(126) If you do not include a summary in your paper, you ordinarily should make your abstract quantitative. If you do include a summary, however, as is recommended in this manual, you will find that a quantitative abstract is difficult to write because your abstract and summary will tend to become repetitious. A way to avoid this difficulty is to make the abstract qualitative, and the summary quantitative. This practice helps to keep your abstract short.

(127) Each journal, however, has its own policy. Before writing an abstract, study your journal to determine whether the abstract should be quantitative, qualitative, or omitted altogether.

The Table of Contents

(128) The following are three suggestions for authors submitting articles to journals that require table of contents with long papers:

1. Provide a table of contents if the paper is longer than nine double-spaced typewritten pages.

2. Include not more than the first three subordinate headings, even though your outline and the corresponding headings appearing in the text of the paper have further subdivisions. (The present manual contains only three subordinate headings--grade 1, grade 4, and grade 5. If, however, four subordinate headings had been used--for example, grade 1, grade 2, grade 4, and grade 5--the titles to the grade 5 headings would not have been included in the table of contents, in accordance with this rule.)

3. Follow standard rules of capitalization; that is, capitalize the first word and proper nouns. Use standard punctuation within the heading, but do not put a period at the end. Study recent issues of your journal for accepted style.

The Acknowledgment

(129) In writing your acknowledgment, if any, make it warm, but not "Uriah Heepish." Do not give credit to your fellow workers for doing routinely what they were hired to do. Typing your manuscript, for example, does not ordinarily call for an acknowledgment. Neither do the supervisory and the administrative services of project leader, laboratory director, or other official, regardless of how essential these services were. If an acknowledgment is to have meaning, it should be reserved for aid of an exceptional character.

The Literature Cited

(130) In citing references, follow the format of your journal. Checking the format may seem like an inconsequential detail, but it will save much labor for you, your typist, and all others concerned. Further, if you do not follow the proper format, the editor of your journal will tend to distrust your work for carelessness in format indicates carelessness in other matters, including the technical content of your paper.

(131) The following examples show the format used in most of the publications of the Federal Government in citing authors:

Many investigators have studied various methods of preserving fish and have made recommendations involving

(1) the use of proper icing techniques (Knake 1946; Castell and MacCallum 1953; and Castell, MacCallum, and Power 1956), (2) the freezing of fish at sea (Hartshorne and Puncochar 1952), and (3) the addition of certain substances to the crushed ice in which the fish is stored, in order to inhibit the growth of bacteria and thereby reduce fish spoilage (Tarr 1956).

(132) If you give only the references that actually have been cited in the paper, they are listed at the end in a section called "Literature Cited." If, however, you included in your list references you did not cite, the heading "Bibliography" is used. Do not list unpublished papers or papers "in press" in the Bibliography or Literature Cited. Such papers should be cited in footnotes or in the text. If information in the cited source is required to complete the thought, it should be quoted, paraphrased, or condensed and included in a footnote or in the text itself, since this information ordinarily will not otherwise be available to the reader. Examples showing the format used in most government publications in listing the references is shown at the end of this manual under the heading "Bibliography."

(133) Inaccuracies in your literature cited or bibliography may cause your reader much inconvenience, and accordingly, decrease his regard for you. Assure the accuracy of your list by carefully checking such items as spelling of authors' names, exact titles of articles, place and year of publication, name of publisher, volume number, and page references.

SUMMARY

1. Keep your paper in mind from the moment your research is conceived.

2. Make an early decision as to which one of the coworkers on your research team is to have the primary responsibility of writing the paper and of seeing it through to publication.

3. Budget sufficient time for planning, writing, and publishing.

4. Allow sufficient time for a review of the literature.

5. Consider whether you need the aid of a statistician when planning your project.

6. Tailor your paper to your audience by visualizing the least informed member in it.

7. Limit the scope of your paper; make sure you are dealing with only one problem or with only one set of closely related problems.

8. Where suitable, use tables.

9. In designing your tables, if possible, place the units of measurement at the head of columns rather than in line captions.

10. Where suitable, present your data graphically.

11. Use illustrations wherever possible. Schedule your photographs ahead of time.

12. Make an outline.

13. Check the outline to ensure that it is logical, complete, and properly worded.

14. Use headings.

15. Choose the most dissimilar grades of headings that the complexity of your outline will allow.

16. If the thought changes abruptly from one paragraph to the next, use a heading with the individual paragraph.

17. Introduce each section and subsection of your paper.

18. Make your paragraphs logical units of thought. Examine any overly long paragraphs to see if they can be broken into shorter ones.

19. Have a technically competent individual read the paper to you so you can test it for clarity.

20. Orient your readers to your specific problem. To do so, point out the importance of your general problem and show (a) that your broad problem is necessary to the solution of the general one and (b) that your specific problem is necessary to the solution of the broad problem.

21. State the objectives of your specific problem. In stating them, list each by number and be explicit.

22. If possible, organize your paper according to the statement of your specific objectives.

23. In presenting your procedure, give thought to whether it needs an introductory statement outlining its general scope.

24. If your paper is reporting a series of experiments, (a) tell your readers how many experiments there were in the series, (b) describe the first experiment in detail, and (c) tell how each of the remaining ones differed from the first.

25. If your procedure is hard to describe, use a flow diagram or whatever other illustrations are possible and then build your write-up around these illustrations.

26. If your method already has been described in the literature, do not describe it in detail but do include a brief general statement of it.

27. Warn your readers of any pitfalls in your method.

28. If your method involved a number of consecutive steps, (a) number each step and (b) give directions in imperative sentences and explanations in declarative ones.

29. Give a full description of any samples you may have used.

30. Make your discussion stand independent of your tables and graphs.

31. In your discussion, take particular care not to recapitulate data in your tables and graphs; rather, point out trends, correlations, and conclusions.

32. List each conclusion by number in a section labeled with the proper heading.

33. Make sure your conclusions are in line with the objectives listed in your introduction.

34. In your summary, recapitulate the essentials; include no subjects not discussed in the body of the paper.

35. Make your summary quantitative, not merely descriptive.

36. Choose a title that fully and accurately reveals your specific problem. To do this, carefully study your list of objectives.

37. If your paper belongs to a series, take care that the part of the title naming the broad problem is adequate for later papers in the series.

38. If your title tends to sound impractical, make sure that you show the significance of your work in the introduction to your paper.

39. Determine the policy of your journal as to whether the abstract should be quantitative, qualitative, or omitted altogether.

40. Study your journal to determine whether a table of contents should be provided.

41. Limit acknowledgments to aid of an exceptional character.

42. In citing references, follow the format of the journal to which you intend to submit your paper. Check the list for accuracy.

BIBLIOGRAPHY

BROWN, W. D., A. W. VENOLIA, A. L. TAPPEL, H. S. OLCOTT, AND M. E. STANSBY

1957. Oxidative deterioration in fish and fishery products. Part 2 - Progress on studies concerning mechanism of oxidation of oil in fish tissue. U. S. Department of the Interior, Fish and Wildlife Service, Commercial Fisheries Review, vol. 19, no. 5a (Supplement), May, pp. 27-31, Washington, D. C.

FEUGE, R. O., AUDREY T. GROS, AND E. J. VICKNAIR

1953. Modification of vegetable oils.

XIV - Properties of aceto-oleins. The Journal of the American Oil Chemists' Society, vol. 30, no. 8, August, pp. 320-325.

GUDGER, E. W.
1924. Discussion and correspondence on the proper wording of the titles of scientific papers. Science, vol. 60, (N.S.), no. 1540, pp. 13-15.

JENKINSON, BRUCE L.
1949. Bureau of the Census manual of tabular presentation. U. S. Department of Commerce, Bureau of the Census, 266 pp. (Available from the Government Printing Office, Washington 25, D. C., $1.75)

KARRICK, NEVA, WILLIAM CLEGG, AND MAURICE E. STANSBY
1956. Composition of fresh-water fish No. 1. U. S. Department of the Interior, Fish and Wildlife Service, Commercial Fisheries Review, vol. 18, no. 2, February, pp. 13-16, Washington, D. C. (Separate No. 430)

LONG, CLIFFORD W., AND RAYMOND A. ARZYLOWICZ
1957. Photographic device for accurately measuring fish. U. S. Department of the Interior, Fish and Wildlife Service, Bureau of Commercial Fisheries, Special Scientific Report: Fisheries No. 228, November, 17 pp., Washington, D. C.

NELSON, J. RALEIGH
1952. Writing the technical report. Third Edition, McGraw-Hill Book Company, Inc., New York, 356 pp.

OSTERHAUG, KATHRYN L., AND MURRAY ANDREWS
1955. Cold storage of frozen Pacific oysters (Crassostrea gigas) - No. 1. U. S. Department of the Interior, Fish and Wildlife Service, Commercial Fisheries Review, vol. 17, no. 12, December, pp. 11-14, Washington, D.C. (Separate 423)

PISKUR, M. M.
1956. The importante of a good technical library for research, development, and production. The Journal of the American Oil Chemists' Society, vol. 33, no. 10, October, pp. 4 and 18.

PRINCE, MARTIN,V. H.
1955. News item. Chemical and Engineering News, vol. 33, no. 34, August 22, p. 3513.

RICKARD, T. A.
1931. Technical writing. Third Edition, John Wiley and Sons, Inc., New York, 337 pp. (Note: This book begins where the present manual ends; namely, at the sentence level. Those not familiar with this classic will find the reading of it a pleasant and valuable experience.)

THOMPSON, W. FURNACE
1957. Why don't the scientists admit they're human? The Saturday Review, vol. XL, no. 36, September 7, pp. 44-46.

TRELEASE, SAM FARLOW
1951. The scientific paper: How to prepare it, How to write it. Second Edition, Williams and Wilkins Co., Baltimore, Maryland, 163 pp.

UNITED STATES GOVERNMENT PRINTING OFFICE
1953. Style manual. Revised edition, January 1953, Government Printing Office, Washington 25, D. C. ($2.25), 492 pp.

WEIL, B. H. (Editor)
1954. The technical report. Its preparation, processing, and use in industry and government. Reinhold Publishing Corporation, New York, New York, 485 pp. (Note: This excellent book contains a number of valuable bibliographies covering all aspects of technical writing.)

WOOD, GEORGE McLANE, AND BERNARD H. LANE
1935. Suggestions to authors. Fourth Edition, 1935, Government Printing Office, Washington 25, D. C. ($.25), 126 pp.

YOUNG, FRANK N., AND SEARS CROWELL
1956. The application of gamesmanship in science. The American Institute of Biological Sciences, 2000 P St., N. W., Washington 6, D. C., Bulletin 6, no. 5, November, pp. 13-14.

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