

Janet Emig's 1971 study, The Composing Processes of Twelfth Graders, spurred an interest in the writing process: how writers compose rather than simply what they compose. However, a survey of current literature indicates that little has been published on the composing processes of technical writers. Perhaps we have assumed that technical writers compose as other writers do. In order to test this assumption, we conducted the research on which we base this study.

Assessing the Literature

Our first step was to review the literature on the composing process. This literature examines writers from a diversity of disciplines and does not focus upon students or professionals in the pure or applied sciences. From this review, we delineated three areas of general agreement:

1. The composing process is made up of several stages.

For the purposes of discussion, the composing process may be segmented, although researchers differ on the number and names of these stages. Emig delineated seven: pre-writing (from the awareness of stimuli in the environment to the first words put on paper); planning (a setting of parameters); starting; composing; reformulation (correcting, revising, or rewriting); stopping; contemplating the product.(1) However, a simpler model designed by Gordon Rohman is more commonly used: pre-writing, writing, and re-writing.(2)

2. The composing process is reflexive.

Though the writing process may be segmented for discussion purposes, it is in fact reflexive and non-linear. That is, the stages overlap, and may occur and recur at any point. Both Sondra Perl (3) and Sharon Pianko (4) have documented these facts in their studies of writers at the college level. Perl (5) has termed this reflexivity "shuttling," where the writer works backward as well as forward, returning to "substrands" of the writing process in order to compose additional material. Nancy Sommers (6) has also stressed the non-linearity of the composing process in her studies of revision: rewriting can and does occur at any point in the writing process.

DR. RUPNATHJI (DR. RUPNATHJI)

3. The composing process may be mastered by means of strategies.

Experienced writers have a range of techniques, or strategies, to assist them in planning, writing and revising their rough drafts. Therefore, their composing processes are well-developed and effective. Sharon Crowley (7) has stressed this latter fact in her comparison of inexperienced and experienced writers. Inexperienced writers do not pre-plan; they also tend to write their products straight through and revise little beyond changes in mechanics. Experienced writers, on the other hand, have well-defined composing processes.

In their studies of problem-solving, Linda Flower and John Hayes (8) have concentrated specifically on writers' strategies, which provide alternative discovery procedures to the trial-and-error methods inexperienced writers frequently use. Flower and Hayes have discovered that good writers constantly redefine their audience and assignment while composing. They also consider their goals, how they wish to affect this audience. Flower (9) has then delineated techniques which these successful writers use to "solve" the problem of composing.

Collecting the Data

Our second step was to collect data on the way technical writers compose, and relate our findings to these three areas of agreement. We used questionnaires and interviews to gather information from a broad sample, surveying seventy writers in all: technical writing students, students working part-time in industry, university professors, and engineers and researchers working full-time in industry. The disciplines represented by these seventy writers included civil, chemical, agricultural, geological, mechanical, electrical and petroleum engineering, chemistry, hydrology, geology and biology. The writers working full or part-time in industry were employed by firms producing hardware, firms performing consulting services and firms performing research. No technical editors or professional writers were surveyed, only technicians, engineers, and researchers whose jobs involved composing reports.

Interpreting the Results

Our third step was to interpret the results of our survey in terms of the areas of agreement delineated above.

1. The Composing Process is Made Up of Several Stages.

Our study shows that the technical writer does have a composing process of several stages, similar to that of other writers.

We have used Rohman's model to discuss these stages: pre-writing, writing, re-writing. Of the technical writers surveyed, all seventy indicated that they engaged in some form of distinctly pre-writing and re-writing activity, in addition to their writing stages. The amount of time spent in all three stages and their distinct separation varied greatly, however, and depended on two factors: the projected length of the document being written and the form of that document.

If the writer knew that the final product would be long, ten pages or more, he or she spent more time on pre-writing and re-writing activities and separated

the stages of the composing process more distinctly. On the other hand, if the writer knew that the final product would be short, he or she spent less time on the stages and also distinguished among them less sharply.

For example, one experienced writer said that, when composing a short letter, he often thought for a minute or two, mentally noting the main points to be covered and perhaps "came up" with a full sentence to be used in the draft. His pre-writing stage, then, was very brief and tended to merge with the writing itself. After composing the letter, his re-writing activity consisted only of reading through the secretary's typed draft. When preparing a lengthy proposal, however, this same writer had pre-writing and re-writing stages which were divided into several sub-stages and were clearly separated from composing the first draft of the document.

The second factor, form, particularly affected the length of the pre-writing and re-writing stages. If the form were flexible (e.g., the journal article or the proposal), more activity took place in these stages. If the form were highly structured (e.g., the progress report), less activity took place.

2. The Composing Process is Reflexive.

The composing process of technical writers is reflexive and non-linear, as is that of other writers. We found several indications of this reflexivity.

First, as Emig (10) has discussed for others, the writing stage itself is a time of generation for technical writers too. Virtually all writers surveyed indicated that they frequently discovered and added information while composing--content which they had not intended to use and perhaps had not fully articulated. In fact, one chemical engineering professor said he always wrote the conclusion section of a paper or journal article last because he was never sure until he had composed other sections precisely what he wished to conclude, despite finishing his technical work and constructing extensive pre-writing plans. This generative aspect of the writing stage, which involved selecting content and setting parameters for the product--traditionally two pre-writing activities--illustrates the reflexive nature of the composing process: pre-writing acts recur in the writing stage.

Second, pre-writing plans reappear as criteria guiding the re-writing stage. The seventy writers surveyed all performed traditional revisionary activities of adding, rearranging, substituting and deleting material, both during and after composing. Their criteria in terms of content were completeness and proper emphasis of the data, and their procedure was most often a testing process where the writer compared the information included in the draft with the needs of the audience and the purpose of the document. Audience and purpose, as we will discuss, are two primary considerations in the pre-writing stage, which reappear as aids in re-writing.

In addition, all seventy writers said they examined their drafts for logical progression. When checking for logical progression, only a few writers said they referred directly to ordering techniques, another primary component of the pre-writing stage. However, this examining activity itself indicates the internalization of those ordering techniques and another recurrence of pre-writing aids as criteria for re-writing. Thus these writers engage in the process Perl has called "shuttling," again an indication of reflexivity in composing.

Third, writing and re-writing merge with editing, which also ends the writing process. For most writers surveyed, the re-writing of long documents in particular had several sub-stages: the document was examined as a whole and revised; it was examined section by section or paragraph by paragraph and revised; it was examined sentence by sentence and revised. These actions, however, could occur at any point in the composing process. For example, one writer said he frequently reread a previous paragraph or even the entire piece he had composed to date before continuing to write. He then added, reordered, substituted and deleted material and performed editorial operations while composing; his first draft was frequently his last. This merging of writing, re-writing and editing again reveals the reflexive nature of the composing process.

However, editing also ends that process. Although the writers surveyed did not clearly delineate the content or the succession of the sub-stages involved in re-writing, most indicated that they corrected grammar and usage in the sentence-by-sentence reading.

3. The Composing Process May be Mastered by Means of Strategies.

Our survey indicates that the most experienced technical writers have a range of strategies which they use at each stage in the composing process, to help them master writing.

Pre-Writing. We have classified strategies used in the pre-writing stage into two groups: first-order and second-order. First-order strategies apply to composing in general, regardless of the specific communication situation giving rise to the document. These first-order strategies include analyzing the audience, analyzing the purpose of the document, and consulting the "classic" forms of technical writing. Second-order strategies apply to the "classic" form once it has been chosen, and include the use of an ordering device to structure the material.

Only the least experienced writers did not reflect on who would read the document and what its purpose was before beginning to compose. The most experienced writers considered these questions, as well as the form they would select. This first-order strategy, however, was frequently implied rather than consciously articulated. For example, writers would discuss the major and minor emphases of a document or refer to the "parts" they intended to include in a specific report, indicating in this way a consideration of form.

All seventy writers except one used some type of written technique to order the material they had gathered for their communication tasks. For most, this written technique was an outline though the degree of formality and complexity varied. For example, the most experienced writers began by listing ideas for inclusion in the draft, after which they sought logical relationships among items in the lists and shaped them into more formal outlines. Virtually all the writers said they then used these outlines as guides in the writing stage. In fact, one interviewee's outline was often so complete he would simply write it out in continuous sentences as his rough draft.

Writers did not, however, limit themselves to one organizational pattern in this pre-writing stage. Instead they often considered several patterns before

deciding on a final form. Two such writers mentioned making three or four different outlines in a given reporting situation, then choosing the most effective among them.

Although the list, expanded to an outline, was the most common ordering device used, writers also mentioned utilizing diagrams when describing systems, or a combination of diagrams and flow charts when describing processes, indicating the form-specific nature of this second-order strategy.

The pre-writing stage we have delineated resembles that described in the literature. However, the technical writer's pre-writing stage does differ from the pre-writing stages of other writers in one significant way: generation of material. Researchers on the composing process frequently emphasize searching for new knowledge (11), "inventing" content (12), or choosing a topic (13) as the writer's first pre-writing step. Thus strategies for invention are important pre-writing aids.

None of our interviewees considered searching for or inventing knowledge or choosing a topic in pre-writing or anywhere else in the composing process. Instead, most viewed pre-writing as a time to select and organize material collected prior to the communication task in their technical inquiry. This difference is probably due to what James Souther has called the "situational" (14) nature of most technical writing, where the writer is assigned a topic or one is dictated by an organizational problem he or she has explored, an exploration which also provides the content for composing.

Because the technical writers interviewed generally do not face the problems of generating content or delineating a specific topic and intent from a broader subject area, their pre-writing stages were more deliberate than that described in the literature. Again, the technical writer's pre-writing steps involve setting parameters for a specific communication task: selecting and ordering content rather than generating it. These activities give the stage its deliberate cast, which is also reflected in the specific strategies used to order: the list and the outline. Technical writers find these strategies useful because of the nature of technical forms, which tend to be more prescriptive than forms used in other writing situations and structured on logical rather than associative or emotional principles.

Re-Writing. Strategies used in the re-writing stage are all first-order because they apply regardless of the specific communication situation. This re-writing can and does occur throughout the composing process and proceeds on three levels: content, form and style.

In terms of content, technical writers return to their audience and purpose analyses as checks when revising for inclusiveness and proper emphasis of content.

In terms of form, technical writers tend to revise from larger units to smaller, solving major structural problems before proceeding to the paragraph or sentence level. Logical progression of the draft is the major criterion guiding this revision, which proceeds by checking the actual pre-writing outline or more frequently an internalization of that outline.

In terms of style, technical writers make stylistic changes during composing, often after considering audience needs, but they also edit when the draft is complete.

The re-writing stage we have delineated also tends to be more deliberate than that of other writers described in the literature. The technical writer's audience, purpose and form are set by his or her technical task. The parameters guiding the technical writer's revision are thus more clearly defined than is the case with other writers. The technical writer's major criteria for revision--inclusiveness and proper emphasis of the contents of the draft, and logical progression--can be met because the revisionary task itself is clearer.

Defining the Implications

The seventy technical writers we surveyed all engage in a composing process similar to that of other writers, with strategies to master it at each point. The differences we found do not concern the process itself, but the deliberate cast or character of the stages and the well-defined nature of the strategies used.

We feel that this information has several important pedagogical implications:

1. Composing as process ought to be taught.

In addition to the data we have presented, we have found that most experienced technical writers understand the nature of composing: the process involved and the steps used. Our students must also understand composing as process if they are to write well.

2. Strategies to master writing ought to be delineated.

The successful technical writers we surveyed have a range of writing strategies at their disposal. Our students must also be given these tools, in order to master composing.

3. The distinctive nature of the technical writer's composing process and writing strategies ought to be presented.

Technical composition does differ from composing in other fields, as our study indicates. The composing process is more deliberate and strategies more clearly defined: audience, purpose and form guide planning, writing and revising. The situational nature of writing also influences composing. These distinctions help define the nature of technical writing, and thus they too ought to be taught.

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12. Many researchers stress invention. In particular, Rohman feels the pre-writing stage is a time for discovery, and Stallard and deBeaugrande discuss invention as well. Heuristic systems such as Pike's tagmemics, Burke's pentad or the classical topoi are strategies for mastering invention.
13. Robert deBeaugrande, "The Process of Invention: Association and Recombination," College Composition and Communication, 30, (1979), 160-7.
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HOW EXAMINING PEDAGOGY IN TECHNICAL DISCIPLINES
CAN ENHANCE TECHNICAL WRITING INSTRUCTION

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SUMMARY

Because technical writing courses generally reside in English departments, technical writing teachers often lack perspective concerning students' writing outside English courses. Because teaching methods used by professors in technical disciplines often determine the extent of students' writing development, understanding these methods is a prime need of writing teachers. Working closely with these professors provides the writing instructor with knowledge of their teaching methods while providing opportunities to modify these methods to enhance writing development. Moreover, such interaction enhances the writing teacher's knowledge of technical subject matter. The teacher thus gains credibility in the eyes of both students and faculty with whom he/she works.

Rising demand for technical writing courses calls upon English departments to offer additional sections, a situation for which most departments are unprepared, being heavy laden with literature specialists. At North Carolina State University, and I suspect elsewhere, continual outside recruitment of experienced technical writing teachers to staff these classes is infeasible, which means teachers having mostly humanities backgrounds and inclinations find themselves preparing to teach technical writing. At North Carolina State, we held a week long workshop to train recruits, offering them a rather intensive overview of methods and materials used by our existing technical writing staff. We now have, as a result, a larger pool of instructors to share ever increasing class loads. Nationwide, in some fashion this process is repeated, either formally or informally; thus the ranks of new technical writing teachers swell.

But in this solution to one problem lies another: faculty with primarily humanities backgrounds often don't know very much about what technical students do in their disciplines. Coming from literary study, from teaching freshman composition or literature survey courses, and from a writing tradition mainly humanities based, these new technical writing teachers usually have limited experience with technical subjects and even less experience with technical and scientific report writing. To teach technical writing courses, they have the guidance provided by excellent literature on the subject. (I refer especially to Cunningham and Estrin's The Teaching of Technical Writing, published by NCTE in 1975.) And they can peruse an array of technical writing textbooks to learn what to require of students. But discovering the types of work science and

technical students do and the types of writing that professors require in technical courses demands exploration outside the normal range of an English instructor's experience.

Indications are that such exploration is needed and that when occurring it is highly beneficial. Writing across the curriculum programs evidence the need for two-way information exchange about writing instruction and the setting of clear rhetorical objectives uniformly applied. Terri Paul and Mary Rosner, studying style in agriculture journals, concluded that "we have to learn more about the writing of the professions our students will enter if we want to teach them technical writing." I heartily agree, based on my experiences with forestry and engineering students in programs designed to insert technical writing instruction into their technical courses. Further, I cannot think of a more convenient or necessary place to examine the contexts and particulars of technical writing as it occurs than in the technical courses students take. Between the ideals we and the textbooks teach and the actualities of technical situations, critical differences exist. Some of these differences are never more evident than in the assignments required by technical subject professors and prepared by their students. Biases color professors' expectations, traditions govern their reactions to right and wrong in report writing. Various limitations constrain how writing gets evaluated and what kind of information students receive about their communication--its success or failure and reasons for either. Discovering these characteristics of technical pedagogy, I think, becomes essential if we want to understand how what we teach integrates with writing practice elsewhere in the university and, ultimately, in professional contexts. Obviously such discovery can especially benefit those new recruits lacking the breadth of technical experience to find comfort in their new roles as technical writing teachers.

Initially, and practically, we have to acknowledge the significance of the writing or lack of writing done in technical curricula. Undeniably, the way professors in technical disciplines treat student writing can have greater effect on how students write than do writing courses. Students, after all, spend far more time in technical studies. Usually professorial indifference or concern toward writing induces student indifference or concern. Professors' attitudes can either underline communication's importance to the subject or ignore its role. The more we in English departments know about what occurs in technical courses, how professors treat writing in Forestry 405-406, Electrical Engineering 202, Civil Engineering 342, etc., the better able we will be to enhance students' writing development. In fact, we can begin cooperating with technical faculty in a better unified effort to produce competent professional communicators.

We have to look, I think, at some general practices, examining misconceptions they can engender that we have to counteract as best we can. We should look at the variety of ways professors make assignments and what kinds of skills students must bring to their report writing. We can then examine what concepts and practices students should transfer or modify when they enter writing situations. In addition, we can see several important benefits to us as technical writing teachers in our own classes.

Perhaps the most problematic characteristic of how technical faculty treat student writing has to be inconsistency. Some professors are niggers harping on what amount to fairly insignificant details of usage, while failing to address the larger issues of organization and coherence. Some professors seem blind to any student writing problems. Some professors labor over students' papers, giving comprehensive comments and spending more time on the paper than the student did. Such inconsistency leads to confusion, with students trying to guess at how much the professor cares rather than working at some consistent level of competence.

Niggers have pet peeves and place undue emphasis on their own preferences for word choices or subtle points of grammar drilled into them by some past writing teacher. Niggers, for instance, might know that splitting infinitives is wrong and be able to distinguish between who and whom, but they may be so caught up with such matters that they miss the larger problem of disorganization that plagues the student. Professors blind to student writing problems allow everything to get by, treating the poorly written paper the same or better than the well written paper depending on technical correctness. Such blindness can lead to reliance on formulaic lab report formats that provide technical answers in what amount to fill-in-the-blank exercises, for which students provide numbers, equations, and the like but never have to articulate substantive ideas. Confronted with niggers on the one hand and the blind professors on the other, students begin to discredit professors' concerns altogether. The conscientious professor who makes accurate and directive comments is perceived as an oddity, someone to be appeased but not really taken seriously.

Inconsistency also extends to who does the paper grading--the professor or graduate assistants. In large classes with multiple lab sections, assistants perform the grading tasks, with or without close professorial supervision. Like professors, graduate students have varied abilities with the language. Because of their second-class status, graduate students may not have or may not assume the authority to make needed rhetorical and grammatical comments, but this is hardly consistent. In fact in my experience, I know of several graduate students, good writers themselves, who provide thorough coverage to writing problems. Unfortunately, however, their authority gets questioned by students who balk at being evaluated for more than technical correctness. At North Carolina State, moreover, where nearly half the engineering graduate assistants are foreign nationals, whose English competence in many cases remains minimal, the problems of grading students' writing quality are extensive, and the arguments that ensue between graders and students can be quite destructive.

Inconsistency can also affect the very styles students are required to present in their writing. Academic styles, the full-blown discourse so often evident in journals and texts might be appealing to one professor and totally wrong for another. How is the student to know except by trial and error? Overall, professors seem to prefer a plain style that says what it has to say without adornment, that supplies the most information with the least fuss. But the degree of simplicity remains hazy, especially when students sense that the simple statement lacks prestige and proper force. In some part, the problem here stems from the types of writing often examined and taught in English

composition and literature classes. Significantly, though, students required to read and use technical literature will begin to emulate what they read and, without being told to do otherwise, begin to write, though less successfully, like the published authors. While such a result could be good, more often than not it is bad. I think we have to sound out the technical professors whose students we teach and establish a concensus about what expectations are going to exist.

We should also know more than we do about the types of reports students write for other courses and the types of problems they have to solve to write those reports. Just as inconsistencies among professors can affect students' perceptions of what writing is, the types of reports they prepare will affect their perceptions of how to approach the writing process. They are going to write laboratory reports quite differently from how they write term papers. Without any knowledge or without correct knowledge, we are doomed to act with a set of assumptions based on our own limited experience with scientific and technological processes. I grant that we can provide a valuable service as uninformed readers outside the technical context and thus serve as an audience for whom students must prepare to write. But I think we can serve this function just as well after looking into the nature of the technical problems and more closely than we have at reports that will derive from them. As teachers shaping students' writing experience, I think we have some responsibility for sensing when the material is right technically. More importantly, though, we can better guide students toward correct report procedures when we have a modicum of experience with the technical subject matter. We can ask the significant questions that have to be asked as the student explores the writing process. Further, we can better understand the stages of report compilation that precede the actual drafting. Insights into the land management planning process, for instance, will help us teach forestry students why certain information goes in appendices rather than the body of a management plan, or why transitions in these reports are so essential.

On a more specific level, if we have the practical experience, we can draw attention to the pitfalls that prove most irksome to technical professors. We can highlight the small points that proofreading and careful revision will monitor, so that students will give credence to the impact such errors can have. Understanding some of the terminology and recognizing the symbols used by electrical engineers can help us emphasize the need for accuracy in design project papers. The capital K and lower case k, for example, denote quite different things (Kelvin and kilo respectively) and are not interchangeable. Though we can argue that such details are not the writing teacher's responsibility, being able to note such distinctions makes us decidedly better report evaluators. In this regard, we can reinforce or counteract some of the evaluation practices that we know exist outside the rigors of a writing course, making students aware of the consistent and idiosyncratic concerns report readers will have. In general, though we have to make the effort to identify such characteristics by making more frequent contact with technical professors than has generally been the practice. The question, of course, is how.

Writing across the curriculum programs are providing some opportunity, a much needed chance for mutual discussion and learning. At North Carolina State

we have established, at the invitation of the Schools of Forestry and Engineering, programs specifically designed to bring writing instruction into technical classrooms as part of normal course activity. A variety of approaches allow us to work closely with faculty members who require written reports. Sitting down with them, we are able to establish mutual expectations and identify the most crucial areas for instruction. In a course I team teach with a forestry professor, we have substantially revised the scope of the land management planning paper students must prepare their last semester. Over the three years we have worked together, our shared experience has led to changes in the way we make the assignment and evaluate the reports. Once submitted as a whole at the end of the semester, the plans are now submitted in parts, to be evaluated and sent back for revisions. Bill and I have learned from each other and have modified our approaches accordingly.

With engineering faculty, workshops and consultations have led to changes in assignment types, our emphasis being on giving students realistic situations, wherein they might be required to submit a construction site evaluation or act as consultants to contractors requiring specific lab analyses of soil samples. Classroom presentations allow us, as writing consultants, to enter the classroom and supplement what the professor has said about a paper assignment with specific information concerning the preferred style in which it should be written. Simultaneously, working with students individually allows us to see the results of our efforts and diagnose the types of problems that need further attention in future presentations. At every turn we are able to examine faculty expectations and make suggestions as to how these expectations might be altered or made clearer.

In our present situation at North Carolina State, we have a fairly formal structure for doing what I am advocating, but I think that any technical writing teacher with the gumption can learn the ropes and explore writing done in the technical disciplines. Paying attention to what students are interested in and asking them what types of writing they have to do elsewhere indicate where to begin an exploration. Following up these probes by informal contacts with technical faculty will fill in the gaps.

The benefits of such explorations are easily discernible when the technical writing teacher puts this newfound knowledge to work. For one thing, credibility in the classroom increases. Students who lose interest in the abstractions of technical writing instruction pay attention if the person up front cites examples that strike close to experience or quotes a particularly well known professor's desires. Students begin to identify the relevance of the message. Then, too, they respond to the teacher who exhibits a real interest in their subject area and who can speak accurately about its intricacies, who at least recognizes the technical terminology and can distinguish it from the jargon. Students greatly appreciate the outsider who can see their problem and can provide a sounding board that helps them find a workable approach to solve it. The teacher who can help them identify the audiences they will need to address does them a real service and can act credibly as that audience when the time for report evaluation comes. In fact, the whole range of teaching activities we engage in the technical writing course will be enhanced by informed teachers who examine methods and problems that exist in the real contexts outside their own courses.