WRITING METHOD AND PRODUCTIVITY OF SCIENCE AND ENGINEERING FACULTY

Ronald T. Kellogg

The present study aimed to describe the methods of writing used by university faculty and to explore relationships between method and productivity in writing. The survey reported here examined the cognitive strategies, tools, work scheduling, environment, and rituals used by 121 science and engineering faculty members in writing technical documents such as journal articles. The most commonly reported methods (e.g., the cognitive strategy of mentally planning large units of text structure and selecting a pen or pencil for a tool) were uncorrelated with reported productivity. Selecting a quiet work environment was the only typical habit that was associated with high productivity. Three other aspects of writing method were also related to high productivity, but they were not widely employed. These were using a dictation machine, preparing detailed written outlines before beginning a first draft, and the ritual of exercising vigorously before or during a writing session.

The methods employed by a writer refer to the cognitive strategies, tools, work scheduling, environment, and rituals used in producing text. Because of the emphasis placed on publication in hiring and promoting faculty, the subject of writing methods is of interest to academicians. Curiosity about how others tackle the job of writing is one source of interest. Another is the possibility of identifying successful writing methods and training faculty to adopt them. Most programs for faculty development focus on the improvement of teaching and overlook other vital activities such as scholarly writing (Boice and Johnson, 1984). Unhappily, little is known about writing methods, and the few studies that have addressed the issue have not systematically attempted to identify a set of successful methods that are associated with high levels of writing productivity (Boice and Johnson, 1984; Hartley and Knapper, 1984; Lowenthal and Wason, 1977).

Ronald T. Kellogg, Department of Psychology, University of Missouri-Rolla, Rolla, MO 65401.

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RATIONALE

The first purpose of the present survey was to describe the various methods used by a sample of science and engineering faculty. How often do faculty members use written outlines? How often do they use a word processor? How long is a typical writing session? Do they select a quiet environment? How often do they enter a state of intense concentration while writing, and do they use a ritual to enter such a state of consciousness? The survey addressed these and other unanswered questions about writing method. Because faculty members invest large amounts of time and effort in writing, it is intriguing to examine how others cope with the chore.

The second purpose was to explore the relationships between aspects of writing method and writing productivity. It is of interest to know whether highly productive writers use a method not employed by those who are less productive. Such information would be of value in programs that aim to enhance writing productivity.

DESCRIBING A WRITER'S METHOD

The method of a writer—how he or she goes about creating text—can be divided into five general areas: work scheduling, work environment, work tools, cognitive strategies, and rituals used to achieve the right frame of mind. The first area covers when writing is done, the duration of writing sessions, and how regularly writing sessions are scheduled. The environment for writing concerns where the work is done and how distracting that environment is to the writer. Tools refer to the devices used to record one's thoughts, ranging from pens to word processors. Cognitive strategies is a broad category covering many items about mental processing. To illustrate, the level of text structure that the writer plans mentally before actually recording the ideas and the use of outlines are included in this category. Lastly, the state of consciousness or frame of mind associated with writing and the rituals or habits used to achieve this state are also aspects of method.

It seems likely that a writer's method is not constant for all occasions. Therefore, in surveying authors I asked them to estimate how often they used some particular approach. For example, they were asked how often they wrote with a word processor and were provided with a seven point scale ranging from "never" to "always." This survey design allowed for the possibility that a given writer might use a word processor on some occasions and a pen on others. A frequency rating is more informative than a checklist approach in which the participant is forced to choose the one or several options that apply without indicating how often they apply.

Although method is complex, it certainly does not describe everything of

interest about a writer. The personality of the writer is a good example of a nonmethod factor. Personal characteristics such as anxiety, motivation, creativity, intelligence, social adjustment, and so on are logically independent of method. Even more obvious is the writer's knowledge. What the writer knows about language, the domain about which he or she is writing, and the intended audience does not necessarily correlate with method. Both personality and knowledge factors influence a writer's productivity. Pelz and Andrews (1976), for instance, reported that the greater the degree to which scientists and engineers felt committed to or involved with their work, the higher their publication rate. Boice and Johnson (1984) found that faculty members who are least anxious about writing are most productive. Lastly, Glynn et al. (1982) showed that student writers with low verbal knowledge commit more errors in mechanics than do those with high verbal knowledge.

It would be useful to control for the influence of nonmethod factors on productivity. But assessing either knowledge or personality calls for extensive psychological testing and is not easily accomplished through a survey. Asking writers how they go about their work should yield reasonably valid responses, whereas asking them how much they know or what their personalities are like seems of dubious value. Moreover, the need to keep the survey to a reasonable length precluded examining other factors, even nonmethod factors (e.g., writing anxiety) that could be validly assessed in a survey. I preferred to explore the various aspects of method in detail.

EXPECTATIONS

No theory of writing offers detailed predictions about the way most writers go about their work or about the relation of their method to their productivity. This survey was exploratory. Still, some hypotheses can be gleaned from previous theoretical and empirical work. I review this earlier work here because it guided my selection of items for the survey.

The availability of cognitive effort and the capacity of working memory are widely viewed as important limitations of human information processing. Writing theorists reasonably invoke these limitations to explain in part why writing is so difficult (Daiute, 1984; Flower & Hayes, 1980). Cognitive strategies that reduce the writer's workload may boost productivity. One such strategy is to create a mental or written outline of the document before beginning. This could decrease the need for planning while writing a draft and, if the outline is written, it could provide an external memory representation for guiding the writer through the draft. Another strategy is to compose a rough first draft rather than a polished first draft. Composing a polished first draft requires the writer to devote cognitive effort to planning ideas, translating ideas into text, and reviewing the text all at once. This may overload the writer and lower productivity.

Writing instructors recommend the outline (Ewing, 1974) and rough draft (Elbow, 1981) strategies. Yet, clear empirical evidence for their use is hard to find. Two studies examined whether students receive better grades on papers that they prepared a written outline for and found at best only a marginally significant advantage for outlining (Emig, 1971; Hartley, 1980). In interviews with well-known and prolific fiction writers, one finds examples of all possible combinations of these two strategies (Cowley, 1959). Such writers do not necessarily outline or compose rough drafts. Finally, two experiments comparing rough with polished draft strategies yielded conflicting results. Gould, Conti, and Hovanyecz (1983) found that a rough draft strategy was more efficient than a polished draft strategy in terms of the time needed to produce a final version. Still, the final version communicated most effectively when a polished draft strategy was used to compose it. In contrast, Glynn et al. (1982), using different procedures from Gould et al. (op. cit.), reported clear disadvantages for the polished draft strategy in terms of the number of effective arguments included in the text, a measure of quality. Thus, despite a reasonable theoretical rationale for expecting a relation between productivity and cognitive strategies, the empirical literature is limited and inconsistent.

The issue of how tools should affect productivity is complex. For example, the editing functions of a word processor encourage writers to revise frequently, often while they are composing a first draft (Bridwell, Nancarrow, and Cross, 1984). Assuming that more revisions enhance quality but decrease speed, it is not clear how overall productivity would be affected. Aficionados contend that word processors revolutionize writing, improving both quality and efficiency (Moran, 1983; Zinsser, 1983). However, the only systematic experiments on the issue indicate that experienced executives compose one page letters faster in longhand than on a word processor, with no differences in judged quality (Gould, 1980). In Gould's work writers composed fastest with dictation machines, with no decrement in quality as judged by other readers. Interestingly, the writers themselves believed their dictated material was inferior.

Whether Gould's findings extend to composing documents other than one page business letters is an interesting and open question. On the one hand, dictation may best allow the writer to concentrate on composing, because the motor movements involved in speaking into the microphone are automatic and because speaking is fast enough to keep up with the speed of mental translation of ideas into language. On the other hand, lengthy technical documents are more complex than one page business letters; the lack of immediate visual feedback with dictation may be debilitating with highly complex composition tasks.

With regard to work scheduling, some interesting findings have been

recently reported. Boice and Johnson (1984) found that 56% of the faculty whom they surveyed wrote on a sporadic basis; only 13% wrote daily. Those who wrote more than once a week were the most productive. Moreover, individuals suffering from writer's block benefit from a behavior modification program that rewards regular writing (Boice, 1982). Besides seeking to corroborate the evidence on regular writing, the present survey examined the duration of writing sessions. Conceivably, the writer needs time to warm up, making brief sessions undesirable, and is subject to fatigue and diminished concentration, making long sessions undesirable.

Boice and Johnson (1984) also examined two aspects of the environment selected by faculty for writing. Their results for writing location showed that 40% wrote in the same place whereas 60% selected different places. For amount of distraction, they found that 56% of the sample chose a quiet environment while the remainder wrote under varying degrees of distraction. Their report made no mention of whether these factors influenced productivity. One might expect that a quiet environment would aid productivity, given the heavy cognitive demands imposed by writing tasks. Indeed, Proust supposedly wrote in a cork lined room and Carlyle in a noise-proof chamber to insure silence (Stein, 1974). Even so, the relationship between cognitive performance and levels of environmental noise is too complex to make a strong prediction that silence is necessary for most productive writers (Bell, Fisher, and Loomis, 1978).

Lastly, expectations about rituals and states of consciousness are especially difficult to formulate because they are likely to be highly idiosyncratic. Thornton Wilder revealed some of the idiosyncracies of well-known writers in the following passage:

> Many writers have told me that they have built up mnemonic devices to start them off on each day's writing task. Hemingway once told me that he sharpened twenty pencils; Willa Cather that she read a passage from the Bible—not from piety, she was quick to add, but to get in touch with fine prose. . . . My springboard has always been long walks (Cowley, 1959, p. 15).

Schiller presumably felt compelled to stock his desk drawer with rotten apples to achieve the right frame of mind; Balzac wore a monkish working garb and drank much strong black coffee; Mozart composed following exercise (Stein, 1974). The survey inquired about some rituals that I suspected might be generally used, but I hoped that the participants would list their own items in the place for "other" responses.

The only existing evidence about the value of rituals and states of consciousness is anecdotal. Aldous Huxley reportedly aided his writing by entering a trance induced through a meditation procedure that he called Deep Reflection. Erickson (1972, p. 50) said in describing Huxley, "it was quite

common for him to initiate a day's work by entering a state of Deep Reflection as a preliminary process of marshalling his thoughts and putting into order the thinking that would enter into his writing later that day." Probably not many academic writers enter a trance for writing, but states of intense concentration may be common and may enable productive writing. Drinking coffee or exercising may be typical means for achieving a high degree of concentration.

METHOD

Participants were science and engineering faculty from the St. Louis, Columbia, and Rolla campuses of the University of Missouri. The science departments sampled were geology, biology, chemistry, physics, computer science, mathematics, psychology, and economics. The engineering departments were agricultural, chemical, civil, electrical, mechanical, mining, geological, aerospace, nuclear, and management engineering. From the total pool of faculty from these departments, I randomly selected 415 individuals and sent them a questionnaire and an explanatory letter. The letter asked for their assistance, explained how to complete and return the questionnaire, and guaranteed their anonymity. Returned questionnaires received a participant number—no names were employed. The method questions concerned only technical writing; the method used in writing other types of material, such as personal correspondence or poetry, was to be ignored.

The questionnaire consisted of 44 items concerned with writing method, four items regarding productivity, and three concerning demographic information. For demographics the survey asked their department, their title, and the year in which they received their Ph.D. Respondents provided numerical estimates of the number of journal articles, technical reports, technical books, and grant proposals (or grant progress reports) completed during the past three years. Writing method covered five categories as will be detailed below. Each method question assessed how often the respondent used a particular method on a seven point scale ranging from "Never" (1) to "Always" (7). Every method question included a blank "other" line for respondents to provide additional information not covered clearly in the survey.

Three questions comprised the section on cognitive strategies; the first two contained multiple items that related to the same question. The question "How often do you mentally plan what you are going to write at each of the following levels of text structure on a first draft?" included these items: single words, phrases, single clauses (simple sentences), multiple clauses (compound and complex sentences), paragraphs, sections, and the entire document. The question "How often do you prepare a detailed outline before beginning a first draft?" included a rating for two items—one for

mental and one for written outlines. The third single-item question asked, "How often do you try to write a polished first draft as opposed to a rough first draft?"

The next section asked, "How often do you use the following tools?" The four items listed were pen (or pencil), typewriter, dictation machine, and word processor.

The next section was on work scheduling and included three questions, the first two with multiple items. Regarding hour of the day, the survey asked, "How often do you write during the following periods?" Starting with midnight to four a.m., the survey listed the full day as six periods of four hours each. For duration of work periods, it asked, "How often is the duration of your writing periods equal to the following times?" and listed the following five items: 0–1 hour, 1–2 hours, 2–3 hours, 3–4 hours, and more than 4 hours. Lastly, the survey asked, "How often do you schedule some time for writing each working day?"

Two questions on the environment selected for writing came next, each with multiple items. The question "How often do you write in each of the following locations?" listed university office, home office, and library as items. The question "How often do you write in an environment with the following noise conditions?" included five items: quiet, office personnel and equipment noise, radio, television, and stereo music system.

The last section of method questions concerned rituals and states of consciousness. The question "How often do you engage in the following types of activities before or during a writing session?" listed as items prayer (or meditation), vigorous exercise, walking, drinking coffee, and smoking tobacco. For states of consciousness, the survey explained that "Some writers experience unique states of consciousness or attention while they are writing; how often do each of the following states apply to you?" and went on to list daydreaming, mild concentration, moderate concentration, intense concentration, and trance.

RESULTS AND DISCUSSION

Demographics

A total of 121 individuals returned the questionnaires, representing a 29% rate of return. The low rate of return suggests that faculty members share at least one thing in common with Ernest Hemingway, who said that it is "bad for a writer to talk about how he writes" (Plimpton, 1963, p. 3). Lowenthal and Wason (1977) also reported a reluctance of academic writers to comment in their survey on writing attitudes, which yielded a 17% return rate. Similarly, Boice and Johnson (1984) reported that their survey elicited a

record number of complaints to the institutional review board about invasions of privacy. The present sample seems representative of science and engineering faculty; the range and variance of responses on all questions gave no indication that the sample was limited to people who wrote using a common method or to people with high productivity.

All sampled departments participated though not in equal numbers. The largest group was chemists ($n = 17$) and the smallest was geologists ($n = 2$). In sum there were 75 respondents from science departments and 46 from engineering departments; the rate of return was identical from these classes of departments. The average participant had held his or her Ph.D. for 14.73 years (the data were collected in 1982); the range was from 3 to 47 years. The most frequent title was full professor. For the most part, then, the sample represented highly experienced scientists and engineers.

Respondents reported completing over a three year period a mean of 7.08 journal articles (S.D. = 5.54), 3.29 technical reports (S.D. = 4.21), .29 books (S.D. = .86), and 5.64 grant proposals and reports (S.D. = 4.86). The mean overall productivity was 16.30 (S.D. = 9.54). The range of overall productivity was zero to 53. Hence, the sample represented both the highly unproductive and the highly productive—the latter group considered by Boice and Johnson (1984) to be individuals producing a minimum of 50 documents.

Because books are longer than the other three types of documents, I tried various weighting schemes in deriving the measure of overall productivity. The correlational analyses reported below led to the same conclusions regardless of whether books were weighted twice as much or even 10 times as much as the other types of documents. The reason is that participants reported books too infrequently for them to have much of an influence on the outcome of these analyses.

Productivity was uncorrelated with experience, defined as years since receiving the Ph.D. ($r = .05$). The correlations reported below between productivity and particular methods, therefore, cannot simply be attributed to the experience of the writer.

Across all items and participants, only 16 items were left unanswered. The respondents rarely volunteered additional information under the "other" category, however. Depending on the question, they wrote in an "other" response between 1% and 5% of the time.

Categories of Writing Method

Table 1 provides descriptive statistics for all items concerned with cognitive strategies. The productivity correlation is the value of Pearson's r and total productivity. Looking first at mental planning, the mean and modal responses increased as the level of text structure became increasingly comprehensive. For planning single words, the modal response was "never,"

TABLE 1. Analysis of Cognitive Strategies[a]

Survey Item	Mean	Mode	Std. Dev.	Productivity Correlation (r)
		Mental Planning		
Single words	3.09	1.00	2.07	−.03
Phrases	3.69	1.00	2.00	.08
Single clauses	3.75	4.00	1.89	.08
Multiple clauses	3.65	4.00	1.77	.07
Paragraph	4.66	6.00	1.70	.06
Sections	5.52	6.00	1.42	.04
Entire document	5.13	7.00	1.95	.03
		Prewriting Outlines		
Mental outline	3.82	4.00	1.77	.17
Written outline	3.58	4.00	1.86	.27**
		First Draft Strategy		
Polished draft	2.49	1.00	1.92	−.01

[a]The response scale ranged from "Never" (1) to "Always" (7).
**$p < .01$.

whereas for planning the entire document the modal response was "always." These results suggest that low level or small units of text structure are often generated at the moment of translation without prior forethought, whereas high level units require planning prior to translation. Although planning tended to focus on high level or comprehensive units of text structure for most writers surveyed, the reported strategy had no effect on productivity. As shown in the final column of Table 1, all correlations for these items were close to zero.

The use of mental and written outlines was only moderately frequent, but was positively correlated with productivity. The correlation for written outlines was statistically significant. Thus, the standard recommendation to prepare a written outline finds support in these data. The use of outlines may reduce the writer's workload during composition of a draft. Lastly, few participants adopted a polished first draft strategy; those who did failed to suffer in productivity. The recommendation to avoid trying to polish a first draft was not vindicated, therefore. As might be expected from the inconsistent literature on rough versus polished draft strategies, no relationship with productivity was observed.

Table 2 presents the data for tools. The most widely used tool was the pen or pencil. In this sample few reported the use of typewriters, dictation

TABLE 2. Analysis of Tools[a]

Survey Item	Mean	Mode	Std. Dev.	Productivity Correlation (r)
Pen or pencil	6.61	7.00	0.96	−.02
Typewriter	2.18	1.00	1.95	.05
Dictation machine	1.44	1.00	1.30	.39***
Word processor	1.15	1.00	0.63	.13

[a]The response scale ranged from "Never" (1) to "Always" (7).
***$p < .001$.

machines, or word processors. I assume that the popularity of word processors is increasing rapidly as they become more widely available; one respondent cited availability as the only reason he or she was not composing on a word processor. Evidence to recommend the widespread use of word processors was not obtained, however. Although the productivity correlation for word processors was positive, it was nonsignificant.

Interestingly, the use of dictation machines was strongly correlated with productivity. These results dovetail with the literature cited in the introduction. Laboratory experiments employing business executives as writers suggest that dictation machines are the most efficient tool. Of course, one needs secretarial assistance to transcribe dictation if this method is to save time. But the same could be said of the pen, and to a lesser degree, the typewriter and word processor. At any rate, all the university respondents studied here had secretarial assistance available to them.

The respondents tended to schedule their work between eight a.m. and eight p.m., with the morning hours being the most common time of day (Table 3). Positive but nonsignificant correlations were obtained for these time intervals. Night owls were rare and not unique in their productivity. In terms of the duration of writing sessions, the data indicate a preference for one to three hours. Working for one to two hours was significantly correlated with productivity. But as will be explained later in describing the multiple regression analyses, this effect is best attributed to other factors correlated with the frequency of working for one to two hours. Highly regular work scheduling was not the rule; the most common response was only a three on the seven point scale. "Write in spurts" and "marathon writing just before a deadline" were comments listed by respondents that match the pattern commonly observed in Boice and Johnson's (op. cit.) survey. As in Boice and Johnson's study, regular writing was positively correlated with productivity, but here the relationship was weak and nonsignificant.

Table 4 presents the data on writing environments. There was a strong

TABLE 3. Analysis of Work Scheduling[a]

Survey Item	Mean	Mode	Std. Dev.	Productivity Correlation (r)
		Hour of Day		
Midnight–4 a.m.	1.76	1.00	1.29	.01
4 a.m.–8 a.m.	1.87	1.00	1.49	.04
8 a.m.–Noon	4.61	6.00	1.44	.17
Noon–4 p.m.	4.34	4.00	1.33	.15
4 p.m.–8 p.m.	3.60	4.00	1.54	.13
8 p.m.–midnight	3.80	2.00	1.80	.05
		Duration		
0–1 hour	3.50	2.0	1.58	.09
1–2 hours	4.46	6.0	1.40	.22*
2–3 hours	4.44	6.0	1.36	.07
3–4 hours	3.49	4.0	1.63	−.04
More than 4 hours	2.76	1.0	1.73	−.12
		Regularity		
Every working day	3.01	3.0	1.50	.11

[a]The response scale ranged from "Never" (1) to "Always" (7).
*$p < .05$.

preference for working in a university office and home office. The location, however, made no difference in productivity. Although a library was not a popular alternative site, a variety of locations other than home and university offices were listed. These included restaurants, airport waiting rooms, and various locations in the home, such as the patio and living room. With regard to background sounds, the most frequent response was five for a quiet environment and one for all sources of distraction. Although all of the productivity correlations were positive, only the frequency of selecting a quiet environment was reliably related to productivity. This outcome supports the notion that an environment should be free of distractions for productive writing.

Lastly, Table 5 shows the results for rituals and states of consciousness. Many respondents often drink coffee before or during writing. Note, however, that this item showed the highest standard deviation of any of the method questions, indicating that a sizeable minority never touch the brew. Walking showed a similar pattern. Enough respondents gave high ratings to yield a moderate mean for the walking measure, even though the most frequent response was one. Prayer-meditation, vigorous exercise, and smok-

TABLE 4. Analysis of Environment[a]

Survey Item	Mean	Mode	Std. Dev.	Productivity Correlation (r)
		Location		
University office	5.28	6.00	1.36	−.06
Home office	4.58	6.00	1.77	−.01
Library	1.74	1.00	1.12	.09
		Noise		
Quiet	4.14	5.00	1.97	.21*
Personnel and equipment	2.88	1.00	1.92	.12
Radio	2.74	1.00	1.87	.08
Television	1.86	1.00	1.46	.14
Stero music	2.35	1.00	1.63	.11

[a]The response scale ranged from "Never" (1) to "Always" (7).
*$p < .05$.

ing were all idiosyncratic rituals judging from the means and modes. Five respondents noted various snacks that they eat while writing. One noted playing pinball to get in the mood. With the exception of drinking coffee, therefore, the reported rituals were as idiosyncratic as expected. What about their relationships to productivity?

On the one hand, the negative, nonsignificant correlation for prayer or meditation offers no encouragement that, say, Huxley's technique of Deep Reflection would benefit most writers. To be fair, though, the specific technique of meditation may be critical, and the present survey made no attempt to ascertain this. On the other hand, the frequency of engaging in vigorous exercise was positively and significantly correlated with productivity. One can only speculate about why this relationship was observed. My own experience is that repetitive vigorous exercise, such as jogging, sometimes enables me to plan mentally what I wish to write later, and the relaxation that comes after the workout helps me to concentrate. I suspect that any ritual fostering these effects, possibly including Huxley's Deep Reflection, could benefit a writer.

As expected, few academic writers ever enter a trance while writing. However, a state of intense concentration yielded the highest mean and mode for all items concerning states of consciousness (Table 5). The mean responses were systematically lower for moderate concentration, mild concentration, and daydreaming. These findings are consistent with the view that writing generally invokes deep concentration, yet none of the items was significantly correlated with productivity. Although daydreaming was not frequently

TABLE 5. Analysis of Rituals and States of Consciousness[a]

Survey Item	Mean	Mode	Std. Dev.	Productivity Correlation (r)
		Rituals		
Prayer–Meditation	2.16	1.00	1.87	−.14
Vigorous exercise	2.21	1.00	1.65	.25**
Walking	3.49	1.00	1.99	−.01
Drinking coffee	4.15	6.00	2.17	−.03
Smoking tobacco	1.76	1.00	1.76	.01
		States of Consciousness		
Day dreaming	2.85	3.00	1.52	.08
Mild concentration	3.45	4.00	1.48	.01
Moderate concentration	4.77	5.00	1.32	−.10
Intense concentration	5.23	6.00	1.36	.12
Trance	1.28	1.00	0.89	.08

[a]The response scale ranged from "Never" (1) to "Always" (7).
**$p < .01$.

used by most of the sample, one participant noted daydreaming was frequent during the early stages of prewriting, while intense concentration dominated draft writing.

Interrelationships of Items

Table 6 shows the correlations among the five items that yielded significant productivity correlations. Four were significant. Participants who frequently used written outlines were also likely to write for periods of one to two hours and to exercise vigorously. Those who frequently wrote for one to two hours were likely to select quiet environments. Finally, those who often selected quiet environments also regularly exercised vigorously.

To determine whether each of these factors had an independent effect on overall productivity, I conducted a multiple regression analysis, which controls for interrelationships among items. The resulting multiple regression equation was statistically reliable ($p < .001$) and indicated that 22% of the variance in total productivity could be accounted for by the five items shown in Table 6. The beta weight estimates for the five items were as follows: written outline (0.87), dictation machine (2.60), one to two hours (0.41), quiet environment (0.75), and vigorous exercise (0.82). These weights suggest that the strongest independent correlate of productivity was the frequency of using dictation. The weight assigned to each item was signifi-

TABLE 6. Correlations Among Significant Variables

	Written Outline	Dictation Machine	1–2 Hours	Quiet Environment	Vigorous Exercise
Written outline	1.00	.16	.21*	.16	.21*
Dictation machine		1.00	−.01	.13	.01
1–2 hours			1.00	.28**	.16
Quiet environment				1.00	.18*
Vigorous exercise					1.00

*$p < .05$; **$p < .01$.

cantly greater than zero—the item independently contributed to predicting total productivity—for all but the work scheduling item. Phrased differently, the significant correlation between productivity and work scheduling was not meaningful. It arose because the work scheduling item was positively correlated with other items that did independently predict productivity (namely, written outline and quiet environment).

Table 7 shows interrelationships among tools, outlines, and first draft strategies. These are the aspects of method that probably are the easiest to incorporate into a faculty development program on writing skills. Five significant correlations emerged. Participants who often used pens or pencils were unlikely to use typewriters or word processors. Those who often wrote with word processors were likely to often use detailed mental outlines. Next, writers who mentally outlined were likely to use written outlines. Lastly, those who frequently used written outlines were likely to adopt a polished first draft strategy. This could be interpreted in terms of the cognitive over-

TABLE 7. Correlations Among Tools, Outlines, and First Draft Strategies

	Pen or Pencil	Typewriter	Dictation Machine	Word Processor	Mental Outline	Written Outline	First Draft
Pen or pencil	1.00	−.25**	.04	−.40***	.06	−.09	.11
Typewriter		1.00	.01	.13	.05	.10	.02
Dictation machine			1.00	.08	.03	.16	−.07
Word processor				1.00	.20*	.09	−.12
Mental outline					1.00	.38***	.11
Written outline						1.00	.19*
Polished first draft							1.00

*$p < .05$; **$p < .01$; ***$p < .001$.

load view discussed in the introduction. Without the benefits of the memory aid provided by a written outline, a polished draft strategy may be too demanding in terms of cognitive effort. A multiple regression equation for the seven variables shown in Table 7 was significant ($p < .001$) and showed that 23% of the variance in total productivity could be attributed to these aspects of method. The only statistically significant weights in the equation were those associated with dictation and written outlines.

CONCLUSIONS

The present survey aimed to describe the writing method of experienced scientists and engineers and to explore the relationships between aspects of method and productivity. The results show that such writers often (a) mentally plan large units of text structure, including paragraphs and entire documents, (b) write with a pen or pencil, (c) work from eight a.m. to noon, (d) work for periods of one to three hours, (e) work in university and home offices, (f) choose quiet environments, (g) drink coffee, and (h) enter states of moderate and intense concentration. Of these typical methods, only working in a quiet environment proved to have a significant, independent influence on productivity. Recall that working from one to two hours was spuriously correlated with productivity and had no independent effect.

Three other aspects of writing method also influenced productivity, but these were not widely employed. Using a dictation machine showed the strongest relationship with productivity and the lowest mean score in terms of frequency of use. Engaging in vigorous exercise was also unpopular but effective. Preparing a written outline during prewriting was reported with moderate frequency and was useful.

Instructing authors to prepare written outlines is not new. Yet, I know of no other published evidence that clearly documents the benefits of outlining. Tebeaux (1983) presented a convincing theoretical argument in favor of teaching students to dictate as preparation for working in business and industry. The present results strongly support the value of learning dictation skills for working in academics as well. Instructing faculty to select quiet work environments and to exercise as a writing ritual may be more difficult and less practical. To say that it is pointless to attempt to train such work habits, however, underestimates the difficulties that many people have with writing. Using written outlines, dictation, quiet work environments, and exercise are worthy methods that should be taught in a faculty development program focusing on writing skills.

The strength of the correlations between method and productivity was statistically reliable in the cases described above but was still relatively weak. Given the problems involved in assessing the relationships between method

and productivity, this is not surprising. First, the reliability and validity of the respondent's self reporting of methods and productivity are undoubtedly less than perfect. To the extent that it is difficult to judge these consistently and accurately, error would be added to the correlational analyses. Second, organizational factors such as grant money, support from secretarial, clerical, and laboratory workers, and assistance from coauthors probably affect productivity. Because of a desire to protect anonymity of the participants and because the survey was lengthy already, these factors were left uncontrolled. Finally, as noted in the introduction, the personality and knowledge of the writer also probably accounted for some of the variance in productivity. With these difficulties in mind, accounting for 22% of the variance in productivity with the five aspects of method shown in Table 6 is frankly encouraging. If a survey were to measure and statistically control for these other influences, then the method variables would probably account for a larger proportion of the variance than that observed here. At any rate, the effect sizes seem to be large enough to take seriously.

In summary, this survey provided the first systematic description of the writing method of university scientists and engineers. The most commonly used methods were rarely correlated with productivity. Those methods that were related to productivity usually were not often employed by participants. The results may interest faculty in providing a view of how others deal with the difficult task of writing and in suggesting methods that should be incorporated into faculty development programs concerned with writing productivity.

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