

done, get the material flowing in your head, then extend it forward. As you do this, you will probably find things to change before you get to your stopping point. Most people do revise every time they write. Something, somewhere, begs to be changed. This might well result in the earlier portions of your document being more polished than the later ones: try to be aware of this and to note if any important discrepancies in style exist.

To revise properly, you must be able to see your own work from a distance. This is where your models can come in again. Before going through your document to make changes, choose an article from your collection of good writing, preferably on a topic related to your own, and read it to get a sense of sound and style. You may need to do this more than once. Then look through your own work. How does it compare? Is it fairly smooth, logical? Where are there bumps or potholes? Where is it well done? What can you do to make parts of it read more like your model or your own higher-quality sections? Using your models of good expression as a measuring stick can be very useful in pointing up instances where you need to revise and, also, those where you don't. If the first will keep you working, the second will help give you the confidence to do so. Don't be shy about admitting your successes, even if they involve a single sentence here and there. Good writing, like a fine melody, is always an admirable achievement, no matter how locally it occurs.

Writing Very Well

Opportunities for Creativity and Elegance

BEYOND THE FUNCTIONAL: "CREATIVE WRITING" IN SCIENCE

One of the most unfortunate folktales about science is that it has no room in its daily expression for creativity and personal eloquence. Except, perhaps, for a lecture by one or another towering genius (Richard Feynman is a recent icon) or a popular account by a researcher who, to the amazement of all, can "write excellent prose for the layman," scientists are presumed to inhabit a world utterly lacking in literary atmosphere, a planet not merely flat and functional, but bleak, distant, and cold. Indeed, the worst aspect to this bit of bad myth is that scientists tend to believe it themselves.

The truth, however, lies elsewhere. All forms of persuasive writing can be shaped creatively, with dashes of refinement, even beauty. Does this actually happen in science? Yes, indeed. Expressive distinction has not entirely escaped the gravity of the "scientific," by any means. It may be relatively rare—one article in a hundred, a few paragraphs in a lengthy review paper, scattered sentences in otherwise ordinary articles. But it is there, a figure in the carpet. Some observers have noted the fact: the famed paper on DNA structure by Watson and Crick (analyzed in chapter 2) has been called "a prose poem" by more than a few scientists. And though this kind of praise may well exaggerate the case, it still shows that elegance does not go unappreciated.

What does it mean to write elegantly, creatively, in science? Basically, it means producing texts that are not merely effective but *interesting* to read, those that offer a higher order of reading experience. In practical terms,

this means fulfilling all the requirements of good, functional communication in a manner that is rhetorically sophisticated and inventive. There are many techniques that graceful authors employ, either consciously or intuitively. They include, for example, modulating sentence length and rhythm; posing questions at particular points in the narrative; applying parallel structure in individual sentences; employing refined turns of phrase; coining new terminology; providing smooth transitions between paragraphs and sections; and using syntax as an echo to meaning.

Such techniques represent a high level of expressive skill no matter what field or subject is involved. But in science, special circumstances need to be considered. As writers, scientists work within a system of expressive restraint and so must be relatively subtle in their creative acts. Conventions dictate that they not show off, that they avoid drawing too much attention to their language as an aesthetic medium. In the average technical paper or report, there are particular opportunities for applying elegance and invention. Let's look at some of them.

OPPORTUNITIES

Occasions for elegance occur in many parts of a document. Of course, any article or report can be made more graceful by excellent organization and polished writing throughout. But there are also particular points in an argument where good writing can be raised to a higher level with specific purpose. Here are some of them:

- Places where there is a need for generalization. This is a chance for adding memorable or inventive phrasing. Examples include the introductory and concluding sections of a document, especially in the very first and last paragraphs.
- Similarly, the first and last portions of each individual section. This provides an opportunity for generalizing gracefully and for providing subtle transitions, for example, those that pick up on points previously made or that forecast or suggest what comes next.
- Points in the argument that call for an added degree of emphasis. This may involve introducing an important, even unexpected, result; revealing a gap in the existing literature; stating a weakness in current theory; pointing out the (magnificent, unparalleled . . .) contribution of your work; suggesting areas for future investigation.

- Places of transition, where the argument takes a new turn, for example where it embarks on a new topic or direction, a different area of data or type of measurement.
- Areas in a paper or report where the language is descriptive and less technical, for instance where some aspect of history (e.g. of the existing literature or a particular technique) is discussed.

This list is meant to be illustrative, not inclusive. Different authors have often created different chances to assert their originality. What follows, then, is a series of examples aimed at giving instances applicable to all of the above, as well as some others.

EXAMPLE 1: INTRODUCTION AND CONCLUSION

Note this beginning to a paper entitled "Labyrinthine Pattern Formation in Magnetic Fluids":

Several distinct physical systems form strikingly similar labyrinthine structures. These include thin magnetic films, amphiphilic "Langmuir" monolayers, and type I superconductors in magnetic fields. Similarities between the energetics of these systems suggest a common mechanism for pattern formation. (Dickstein et al. 1999, 1012)

This is a highly technical opening, yet with certain raw ingredients for eloquence. The first sentence is short and dramatic, the second follows by introducing specific topics, and the third reveals the fundamental logic underlying the investigation. Three brief sentences do a great deal of necessary work, in admirable order. Let's work with them a bit:

Different magnetic fluids can form strikingly similar labyrinthine structures. In cases where similarity of structure reflects similarity in fluid energetics, a common mechanism may exist for pattern formation. Three examples for which this assumption holds true include thin magnetic films, amphiphilic "Langmuir" monolayers, and type I superconductors in magnetic fields.

Take a minute to analyze what has been done to the passage. Note the changes in sound (e.g. deletion of too many *s* words in the first sentence), the added parallel structure ("similarity of . . . similarity in"), and the new (previously hidden) logic in the second sentence. Note, too, sentence length: short, medium, long, which acts to draw the reader in

and, at the same time, allows the introduction of increasing detail. Here, meanwhile, is the conclusion to the same paper:

In conclusion, the branched patterns seen in experiment can be understood within perhaps the simplest dynamical models incorporating the competition between surface and dipolar energies. Taken together, the experimental and theoretical results indicate that an enormously complex energy landscape in the space of shapes can arise from a competition between short-range forces and long-range dipolar interactions in systems subject to a geometric constraint. A static theory of labyrinths would find only the minimum energy configurations, whereas the dynamic theories reflect the complexity of the landscape in the complexity of the labyrinths. (1015)

Again, we see the impulse toward eloquence, the desire for, and partial achievement of, making memorable statements. Let us, therefore, help things along:

To conclude, we propose that the branched patterns seen in experiment be understood within quite simple dynamical models. Such models, in contrast to static theories, will be able to incorporate the observed competition between surface and dipolar energies. Taken together, both the experimental and the theoretical results indicate that, in systems made subject to a geometric constraint, an enormously complex energy landscape may arise from this contest between short-range surface forces and long-range dipolar interactions. Static theories cannot possibly account for such competition, but derive only the minimum energy configurations required for labyrinths to form. Dynamic theories are needed to reveal how complexity of the energy landscape is reflected in the complexity of labyrinth structure.

Once more, look at what was done. Very little by way of content was added or deleted. Instead, certain elements were reordered, sentences were divided up to give each individual point its own emphasis. A word here and there (e.g. "quite," "contest," "possibly") is employed for effect, without taking anything away from the content. Note, too, the passage is a bit longer than the original and, to purists, may even seem a bit redundant. An elegant conclusion, however, produces an effect that sticks with the reader: if perused, the above will reveal no repetition, but instead a degree of overlap that helps drive the central argument home. The paragraph ends, meanwhile, with what can only be described as a transparently veiled philosophical statement, a neatly packaged "grand principle" that all scientists would recognize as one of their own. Is

there any reason to hold back from this sort of finale? Absolutely not—as long as you do it in the specific terms of your subject.

EXAMPLE 2: REORGANIZATION AND POLISH

Recall the following paragraph, part of which we examined in chapter 3 as an example of high-quality writing:

Subduction of the Juan de Fuca and Gorda plates has presented earth scientists with a dilemma. Despite compelling evidence of active plate convergence, subduction on the Cascadia zone has often been viewed as a relatively benign tectonic process. There is no deep oceanic trench off the coast; there is no extensive Benioff-Wadati seismicity zone; and most puzzling of all, there have not been any historic low-angle thrust earthquakes between the continental and subducted plates. The two simplest interpretations of these observations are: (1) the Cascadia subduction zone is completely decoupled and subduction is occurring aseismically, or (2) the Cascadia subduction zone is uniformly locked and storing elastic energy to be released in future great earthquakes. Full resolution of this issue may prove elusive. Although it is somewhat surprising that no shallow subduction earthquakes have been documented in this region, the duration of written history is relatively short. (Heaton and Hartzell 1986, 675)*

As it happens, the paper does not begin with this elegant paragraph. Instead, it starts: "This is the third in a series of four papers that lead to an estimation of the seismic hazard associated with the subduction . . . beneath North America." The passage above comes third, after a discussion of the existing literature and the key aims of the article. To revise with polish, we would reorganize the introduction to begin with the above, follow with discussion of the literature, and end with mention of the paper's goals.

Can the above paragraph, meantime, be improved? Let's try.

Subduction of the Juan de Fuca and Gorda plates has presented earth scientists with a dilemma. Despite compelling evidence of active plate convergence, subduction on the Cascadia zone appears to be a relatively benign tectonic process. There is no deep oceanic trench off the coast; there is no extensive Benioff-Wadati seismicity zone; and most puzzling of all,

4. In the succeeding examples, I have adapted parts of the article by Heaton and Hartzell to my purposes, revising the actual sections to varying degrees. Despite this treatment, it should be clear that this is generally a good example of an eloquent paper in the earth sciences.

there have not been any historic low-angle thrust earthquakes between the continental and oceanic plates. The two simplest interpretations of these observations are: (1) the Cascadia zone is completely decoupled and subduction is occurring aseismically, or (2) the Cascadia zone is uniformly locked and storing elastic energy to be released in future great earthquakes. Although it is somewhat surprising that no shallow subduction earthquakes have been documented in this region, the duration of written history is relatively short. Full resolution of this issue may prove elusive.

In this case, I have done very little by way of revision. The word “subduction” or “subducted” was replaced in a few instances to reduce over-repetition of terms (very common in scientific writing). In the second sentence, the phrase “has often been viewed as” was changed to “appears to be,” since, from the foregoing sentence, it is the process of subduction, not views of it, that forms the stated dilemma. The final two sentences have been reversed: this is not only good for logic, but also for sound and rhythm. Graceful opening and closing paragraphs usually begin and end with short sentences. On the other hand, nothing was done to the eloquent, even oratorical third sentence, with its wonderful parallel structure. Note how effectively and concisely the three points are delivered (three is the magic number here, stemming from an ancient rhetorical formula, as in Lincoln’s famous “of the people, by the people, for the people”).

EXAMPLE 3: USE OF QUESTIONS

Use of questions is a simple literary technique that is only sometimes employed in science, but it can be a graceful and effective accent that serves to add emphasis, introduce new material, or refocus a discussion. Posing a question adds a bit of drama:

Cholesterol and related sterols are not uniformly distributed within the membranes of eukaryotic cells. Why is this so? Here we seek an answer by considering the effects of these flat, disklike molecules on lipid bilayers.

A question can orient and hold the reader’s attention, break up an extended discussion, or turn the narrative in a particular direction:

It has been observed that annual cycles of measles epidemics occur in areas where the birthrate is high. What are the limits to such a correlation and how can they be established? Previous models have assumed an average, therefore constant, birthrate, ignoring any effects that might result from seasonal variations.

There are also more restrained forms of asking questions, if the overt query seems too bold for your particular publication venue:

Measurement of ultrashort pulses is a demanding task. The question has been asked: how can our existing instrumentation be improved? Our results suggest that . . .

Or, in an even more subtle style:

Recent climatic modeling has revealed that maximum flux of anthropogenic carbon into the Northern Ocean occurs farther north than previous inventories would suggest. To investigate why this might be the case, we examined two mechanisms of transport . . .

The onset of AIDS appears associated with an extension of HIV infection beyond the lymphoid organs into tissues such as the brain. Just how this occurs is unclear, but it seems probable that infected cells are among the responsible agents.

Note that the posing of questions does not have to be restricted to the opening portions of a document. It can also be appropriate to the main body of your discussion,

During the analysis of experimental results, the question arose: what mechanisms might account for the single-file transfer of particles in this setting?

your conclusions,

Is slip along the Cascadia subduction zone a benign process, occurring slowly as aseismic creep? Or alternatively, is elastic strain energy accumulating along this zone, and if it is, what is the nature of earthquakes that may result?

or even in headings,

Cascadia Subduction Zone: Locked or Unlocked?

Single-File Particle Transfer: Where and How Does It Occur?

Inserting questions into your document should be done sparingly. Queries of this type are forceful signposts for the reader: use them too often and you risk making your audience feel they are being manipulated (a great failure for any author). Place your questions in carefully chosen locations. As always, if you’re experimenting with this technique and are somewhat unsure of its results, have a colleague read what you’ve written. Better yet, have two or three read it.

EXAMPLE 4: TRANSITIONS

One of the distinguishing features of any written document lies in the elegance of its transitions—how it knits together its various pieces, establishing a smooth flow between them. A simple technique for doing this is to announce, at the end of your introduction, what topics you will be discussing and then to proceed to do this in the same order mentioned, with each topic included in the headings of the following sections.

For example, the paper mentioned above on the Cascadia subduction zone and its potential for earthquake activity ends its introductory opening something like this:

In this report, we extend the work of previous authors by systematically comparing trench bathymetry, gravity, and shallow seismicity for a world-wide sampling of subduction zones. It is hoped that by pursuing this line of investigation, one or more analogs may emerge for consideration.

The sections of the report that follow would ideally include topics like this: Trench Bathymetry and Gravity; Seismicity; Specific Comparisons; Analogs: Do They Exist?; Earthquake Potential along the Cascadia Subduction Zone; Conclusions.

Such linkage is needed in functional writing too, of course. Elegance enters in the logic of the general plan, but also in transitions that are given *between* individual sections. For instance, the first section (Trench Bathymetry and Gravity) could begin with the sentences

The Cascadia subduction zone is unusual in that it has virtually no bathymetric trench. To begin to assess just how anomalous this is, we have constructed profiles of bathymetry and free-air gravity for many circum-Pacific convergent boundaries.
and end with

We note, in particular, striking similarities in both bathymetry and gravity profiles between Cascadia and the subduction zones of Colombia and southern Chile. This raises the question of seismic activity.

These sentences obviously pick up on the opening, while providing flow into the next section (Seismicity). But note too that they provide a first answer to the opening query—how anomalous is Cascadia—and thus establish a question-answer pattern that might be pursued in each suc-

ceeding part of the paper. Indeed, the next section could then begin like this:

A second apparent anomaly associated with the Cascadia subduction zone is the remarkable paucity of shallow earthquakes. While this seems puzzling for a major plate boundary that is undergoing 3–4 cm/yr of convergence, it bears asking whether and to what degree analogous conditions may exist elsewhere.

Note how several levels of transition are employed. First, we have carried forward the idea of (and the word) “anomaly” presented in the opening of the earlier section. Second, we now propose a possible contrast term, “analog,” implicit in the final sentences of that section and mentioned in the last part of the introduction. Third, we emulate—without copying, but instead by adding variation to—the question-answer pattern mentioned above. Notice that Colombia and Chile, as possible analogs, are not mentioned. On the one hand, the relevant similarities must be established in relation to worldwide comparisons (this is simply good science). On the other hand, keeping them out here leaves the reader with a slight edge of anticipation, a heightened interest: will these same areas rise again out of the mix? Proceed, gentle reader . . .

EXAMPLE 5: WORD CHOICE

Choosing specific words is one area where inventiveness can be employed in an immediate way. The elegant writer consciously varies his vocabulary, trims repetition. At times, he will seek an unusual or unexpected word to create added interest. Look at one of the previous examples and a rewrite of it (bold type indicates changed words and phrases):

In conclusion, the branched patterns seen in experiment can be understood within perhaps the simplest dynamical models incorporating the competition between surface and dipolar energies. Taken together, the experimental and theoretical results indicate that an **enormously complex energy landscape** in the space of shapes can arise from a **competition** between short-range forces and long-range dipolar interactions in systems subject to a geometric constraint.

To conclude, the branched patterns seen in experiment can be understood within simple dynamical models that **embrace** competition between surface and dipolar energies. Taken together, both the experimental and theoretical results indicate that, in systems made subject to a geometric constraint, an **energy landscape of enormous complexity** may arise from this

contest between short-range surface forces and long-range dipolar interactions.

Only a few words have been replaced, yet they give the passage a new elegance. The word "embrace" is fully acceptable and certainly no more ambiguous than "incorporate," but much more interesting and suggestive. Meanwhile, "contest" helps us avoid repeating "competition" and adds something extra, a note of struggle.

Here's another example:

A central tenet of biomineralization is that the nucleation, growth, morphology, and aggregation of the inorganic crystals are regulated by organized assemblies of organic macromolecules. Control over the crystallochemical properties of the biomineral is achieved by specific processes involving molecular recognition at inorganic-organic interfaces. (Mann et al. 1993, 1286)

This is fairly clear, functional writing. We can appreciate here the use of the word "tenet" instead of the more common "concept" or "principle." But the rest of the sentence needs a little help, mainly because of word choice and word organization. Try this:

A central tenet of biomineralization holds that the nucleation and growth of inorganic crystals, as well as their morphology and aggregation, are governed by structured assemblies of organic macromolecules. For a particular biomineral, crystallochemical control depends upon processes that involve molecular recognition along inorganic-organic interfaces.

Compare the differences closely. Nothing is lost in the change, except perhaps the attempted parallel structure between "inorganic crystals" and "organic macromolecules" in the first sentence, which didn't work in any case. We have replaced a number of ordinary words of general meaning ("is," "regulated," "achieved") with more graceful equivalents ("holds," "governed," "depends upon"), and have shortened a five-word phrase down to a two-word alliterative ("crystallochemical control").

Words are much more than linguistic bricks, to be piled on one another. Very often in scientific writing, we feel the need to repeat technical terms, almost to the degree of absurdity, as if they were such misery. This feeling comes from the sense that there are no alternatives:

Fracture analysis endeavors to measure the spacing and aperture of individual fractures, frequency of fracture occurrence, and the total extent of the fracture network.

This type of writing is, at best, barely functional. It is equivalent to a form of terminological dumping. Try, instead,

Fracture analysis is an attempt to measure the spacing, aperture, and frequency of fracture occurrence, as well as the dimensions of the relevant structural network.

Adding elegance through word choice can also involve deleting certain unnecessary elements, cleaning up, in other words.

EXAMPLE 6: PHRASING

Refined phrasing in science? But there are many opportunities and much evidence for this. In fact, with its articulated demands for brevity and concision, scientific writing is one of the very *best* places for the felicitous turn of phrase. Note that the classical aphorism or maxim—a much admired literary model through the ages—derived much of its elegance from placing complex thoughts into highly confined form ("As the scale bends to a weight, so must a balanced man yield to circumstance" [Cicero]). While our aim in science is not necessary to set the literature aglitter with gems, we should recognize that creative phrasing is a common option, at times even with a drop of humor.

There are no final techniques for this type of writing that can be relied upon—except, of course, for emulating the work of others. Here are a few examples that I have collected in recent months:

1. A dearth of direct evidence urged us to search for the missing parameters.
2. Gravity waves in the lower atmosphere, forced by flow over mountains, have been observed and modeled for many years.
3. The role of the transfer matrix t is merely to modify this balance quantitatively as long as the lattice is perfectly periodic.
4. Blood vessels are the life-giving conduits that connect our tissues and our organs.
5. Research on thin polymer films has proven to be a drama of re-found opportunity.
6. Multiple schemes for single measurements have too often yielded perplexing results.
7. During the years of its early development, the technique of synchronous laser pumping was advanced by a scattering of research teams.
8. The free energy of any physical system is rarely if ever free, but must instead be liberated by one or more conditions.

Notice in these phrases the use of sound and rhythm (examples 1-3), the artistic compression and neatness of word choice (4-6), and the employment of humor (7-8).

Such writing is excellently used as an occasional spice in a document, giving it flavor and finesse, raising it above the level of the ordinary. It is easy to overdo, however. Being too clever, or clever too often, will trivialize your subject. The best writers know to leave the reader affected and wanting more. To satiate completely, as Seneca says, is to erase an impression. A few, well-placed pearls will be sufficient for any single text.

EXAMPLE 7: METAPHOR

Contrary to what is often said, and far too often advised, the use of metaphor is alive and well in scientific composition. Scientific literature virtually teems with metaphoric terminology: white dwarf star, killer T-cell, RNA editing, plate tectonics, quantum charm, reporter genes, structural relaxation, molecular target, and so forth. True, these terms only begin as metaphors, when they are first coined. Over time, with standardized usage, they lose this charge and become identified with the phenomena they represent (i.e. they are no longer figures of speech in the active sense). But what they reveal, without question, is how strong and accepted the metaphorical impulse remains in science.

In what ways can this be applied to writing, in the ordinary sense? In fact, such application happens all the time, though usually in subtle fashion. Note this example once more (in its original form):

In conclusion, the branched patterns seen in experiment can be understood within perhaps the simplest dynamical models incorporating the competition between surface and dipolar energies. Taken together, the experimental and theoretical results indicate that an enormously complex energy landscape . . .

Here are some others:

Synapses are focal points of communication between nerve cells.

One of the most dramatic events in the fossil record is the explosive diversification of marine invertebrates early in the Cambrian period.

It was soon realized that determining the exposure history of individual grains was complicated by meteoroid impact "gardening" on the lunar surface.

Convection in this case consists of nearly two-dimensional turbulence, with meandering plumes . . . that drift westward.

After reading these examples, look through your models and see where similar uses of figurative language appear. You'll note that it doesn't happen very often, only at particular points in an argument or document. On the other hand, for any given text, it may not happen at all—if the needed conditions do not arise.

Metaphors tend to enter scientific speech when authors reach for a descriptive word outside the normal pale of technical terminology. In some cases, this is done to fill a gap; in other cases, its purpose (consciously or otherwise) seems more imaginative and aimed at making the text more interesting. Writers might freely adopt a term from elsewhere in their discipline, from another field, or from ordinary speech. All of these approaches are entirely acceptable, provided that the chosen word or phrase is appropriate to the case.

In the above examples, figurative language appears in the form of both nouns and modifiers. One case (the third sentence) attempts (it seems) to coin a new term—note how the quotations serve to qualify the attempt, but also to let the reader know that the writer is being consciously inventive. New terms, of course, are being proposed all the time in science; this is both a necessity, as new phenomena are revealed, and an impulse, as individuals try to make a mark on their field. If you are lucky enough to be in a position to suggest a new term for your field, please do so thoughtfully, with a degree of intelligence (as a negative example, using comic-strip characters to name planetary features has the effect of appearing juvenile and trivializing). Such instances are revealing: they show us places where the wider culture enters into science in a direct way, therefore that scientific speech is hardly as flat and instrumental as is so often maintained.

IN THE END: LITERARY FINESSE IS KNOWING WHEN TO STOP

Just a brief final note. In nearly all cases, true authorial expertise in science lies in subtlety and restraint, not showmanship. There is certainly room here and there for play, whether this involves chiseling a suggestive phrase or coining a clever term. But on the whole, these opportunities are relatively rare. Science is reserved in its discourse; this is a historical condition, as I've said (chapter 2), but also a kind of knightly code.

Several times in the foregoing sections I've stated the importance of using one or another form of elegant writing on a selective basis. Let me here emphasize this once more. If you find yourself drawn to some of the techniques mentioned above and wish to experiment with them in a document you're working on, by all means do so with multiple blessings, but try to be conscious of the effects you're creating and how often you're creating them. Remember that anything you produce will eventually have to pass through the editorial gate, which can be quite narrow. If you have any doubts, show it to two or more colleagues and note their response (you may have to weigh this somewhat against what you know of their own literary inclinations). Editors and reviewers usually begin to object at the point where a document becomes too overtly personal, when "science" becomes subservient to self. The challenge for the sophisticated writer is to make his or her mark on a text, while drawing only momentary or background attention to the fact. This, in itself, is a considerable achievement. Elegance and restraint share bread, even in the lab.

The Review Process

Contents and Discontents

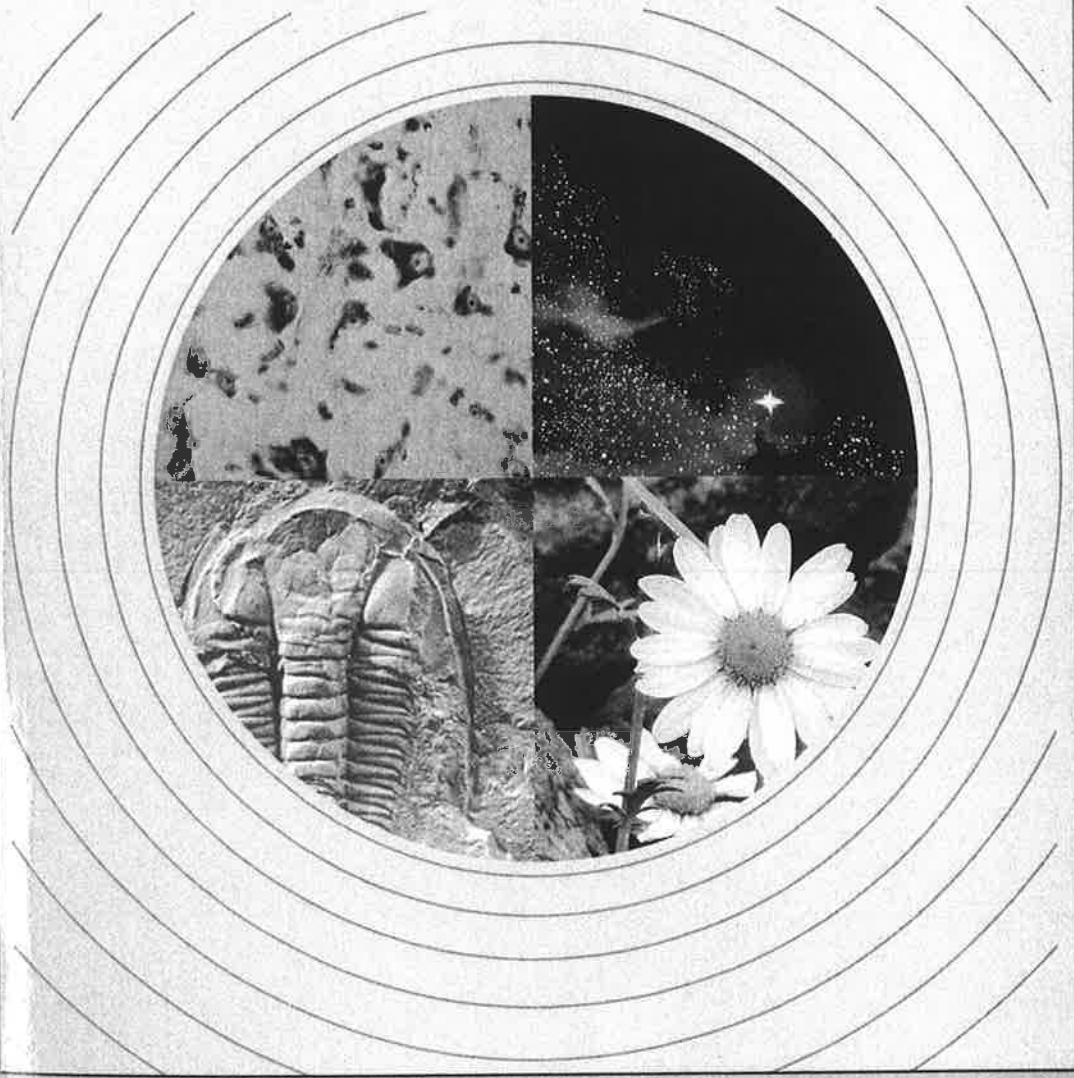
EDITORS AND WHAT THEY DO

Editors have one of the most difficult, thankless, and important jobs in all of science. The journal editor, in particular, is usually a scientist (one of us) and a volunteer, who gets no remuneration for his or her efforts, but who must keep up his or her own research, teaching, corporate responsibilities, and publishing attempts without skipping a beat, while somehow taking on the added jobs of literary manager, quality-control expert, and policeman of the field. This is the situation on the professional level. On the human level, meanwhile, the editor's work involves trying to minimize the indiscretions of others and, therefore, casting the stones of failure and success, hurt and happiness, on every side, all in the name of better science. Which helps explain why the editorial profession in science, like certain gases, is both noble and volatile.

Another point should be admitted. The strength and direction of a scientific field largely rise and fall with the quality of its editors. Bluntly put, editors have power and influence. Their specific work is to act not only as gatekeepers but as architects, to determine how wide or narrow a range of subjects will be accepted, which incoming articles are worthy of review, who will review them, what type of comments are to be made, whether these comments are to be accepted on face value, and what the final decision will be regarding acceptance, acceptance with major revision, or rejection. These are all critical steps in determining what science is published. Well-written articles on topics of signif-

Why V. well.
Sings to birds
sing to birds

THE CHICAGO GUIDE TO
COMMUNICATING
SCIENCE



SCOTT L. MONTGOMERY

Whether you are a graduate student or a senior scientist, your reputation rests on the ability to communicate your ideas and data. In this straightforward and accessible guide, Scott L. Montgomery offers detailed, practical advice on crafting every sort of scientific communication, from research papers and conference talks to review articles, interviews with the media, e-mail messages, and more. He avoids the common pitfalls of other guides by focusing not on rules and warnings but instead on how skilled writers and speakers actually learn their trade—by imitating and adapting good models of expression. Moving step-by-step through samples from a wide variety of scientific disciplines, Montgomery shows precisely how to choose and employ such models, where and how to revise different texts, how to use visuals to enhance your presentation of ideas, and why writing is really a form of experimentation.

He also traces the evolution of scientific expression over time, providing a context crucial for understanding the nature of technical communication today. Other chapters take up the topics of writing creatively in science; how to design and use graphics; and how to talk to the public about science. Written with humor and

eloquence, this book provides a unique and realistic guide for anyone in the sciences wishing to improve his or her communication skills.

Practical and concise, *The Chicago Guide to Communicating Science* covers

- Writing scientific papers, abstracts, grant proposals, technical reports, and articles for the general public
- Using graphics effectively
- Surviving and profiting from the review process
- Preparing oral presentations
- Dealing with the press and the public
- Publishing and the Internet
- Writing in English as a foreign language

SCOTT L. MONTGOMERY is a consulting geologist, writer, and independent scholar. He has authored hundreds of papers, articles, monographs, and reports in the geological sciences, as well as several textbooks and translations. He is also the author of several books on the history of science and scientific language, including *Science in Translation: Movements of Knowledge through Cultures and Time*.

Cover images (clockwise from lower left): detail of trilobite by Riccardo Levi-Setti; detail of neurons, courtesy of the Loyola University Medical Education Network-LUMEN; dark nebula, Photodisc; wild daisies, Photodisc.

Chicago Guides to Writing, Editing, and Publishing

THE UNIVERSITY OF CHICAGO PRESS

WWW.PRESS.UCHICAGO.EDU

ISBN 0-226-53485-5



9 780226 534855



90000



On Writing, Editing, and Publishing
Jacques Barzun

Getting into Print
Walter W. Powell

Writing for Social Scientists
Howard S. Becker

Chicago Guide to Preparing Electronic Manuscripts
Prepared by the Staff of the University of Chicago Press

Tales of the Field
John Van Maanen
A Handbook of Biological Illustration
Frances W. Zweifel

The Craft of Translation
John Biguenet and Rainer Schultze, editors

Style
Joseph M. Williams
Mapping It Out
Mark Monmonier
Indexing Books
Nancy C. Mulvany

Writing Ethnographic Fieldnotes
Robert M. Emerson, Rachel I. Fretz, and Linda L. Shaw

Glossary of Typesetting Terms
Richard Eckersley, Richard Angstadt, Charles M. Ellerston,
Richard Hendel, Naomi B. Pascal, and Anita Walker Scott

The Craft of Research
Wayne C. Booth, Gregory S. Colomb, and Joseph M. Williams
A Manual for Writers of Term Papers, Theses, and Dissertations
Kate L. Turabian

Tricks of the Trade
Howard S. Becker

A Poet's Guide to Poetry
Mary Kinzie

Legal Writing in Plain English
Bryan A. Garner

Getting It Published
William Germano

THE CHICAGO GUIDE TO COMMUNICATING SCIENCE

SCOTT L. MONTGOMERY

THE UNIVERSITY OF CHICAGO PRESS
CHICAGO AND LONDON

To Kay and Shirley

The University of Chicago Press, Chicago 60637
The University of Chicago Press, Ltd., London
© 2003 by The University of Chicago
All rights reserved. Published 2003
Printed in the United States of America

12 11 10 09 08 07 06 05 2 3 4 5

ISBN: 0-226-53484-7 (cloth)

ISBN: 0-226-53485-5 (paper)

Library of Congress Cataloging-in-Publication Data

Montgomery, Scott L.

The Chicago guide to communicating science / Scott L.
Montgomery.

p. cm. — (Chicago guides to writing, editing, and publishing)
Includes bibliographical references and index.

ISBN 0-226-53484-7 (alk. paper) — ISBN 0-226-53485-5 (pbk. :
alk. paper)

1. Communication of technical information. 2. Communi-
cation in science. 3. Technical writing. I. Title. II. Series.

T10.5 .M65 2003

501'4—dc21

2002072627

∞ The paper used in this publication meets the minimum require-
ments of the American National Standard for Information Sci-
ences—Permanence of Paper for Printed Library Materials,
ANSI Z39.48-1992.