

You and Your Research  
&  
The Elements of Style

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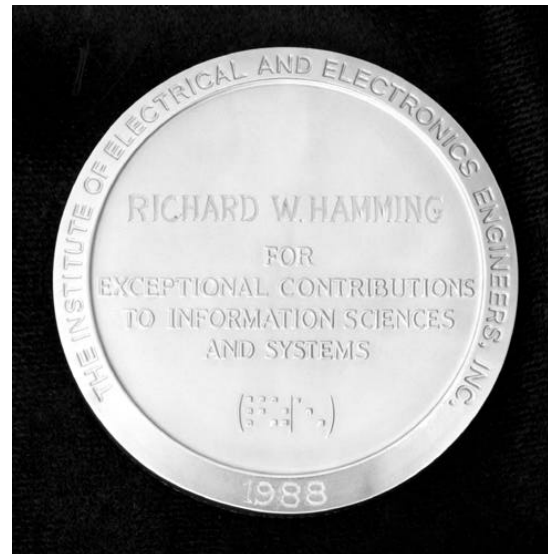
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Part I

You and Your Research

# Richard W. Hamming, 1915–1998

- Los Alamos, 1945.
- Bell Labs, 1946–1976.
- Naval Postgraduate School, 1976–1998.
- Turing Award, 1968. (Third time given.)
- IEEE Hamming Medal, 1987.



## It's not luck, it's not brains, it's courage

Say to yourself, 'Yes, I would like to do first-class work.' Our society frowns on people who set out to do really good work. You're not supposed to; luck is supposed to descend on you and you do great things by chance. Well, that's a kind of dumb thing to say.

...

How about having lots of 'brains?' It sounds good. Most of you in this room probably have more than enough brains to do first-class work. But great work is something else than mere brains.

...

One of the characteristics of successful scientists is having courage. Once you get your courage up and believe that you can do important problems, then you can. If you think you can't, almost surely you are not going to.

— Richard Hamming, *You and Your Research*

# What are the important problems?

[Hamming started to eat at the Chemistry table.]

I started asking, ‘What are the important problems of your field?’ And after a week or so, ‘What important problems are you working on?’ And after some more time I came in one day and said, ‘If what you are doing is not important, why are you working on it?’ I wasn’t welcomed after that.

— Richard Hamming, *You and Your Research*

# Develop reusable solutions

How do I obey Newton's rule? He said, 'If I have seen further than others, it is because I've stood on the shoulders of giants.' These days we stand on each other's feet!

Now if you are much of a mathematician you know that the effort to generalize often means that the solution is simple.

I suggest that by altering the problem, by looking at the thing differently, you can make a great deal of difference in your final productivity because you can either do it in such a fashion that people can indeed build on what you've done, or you can do it in such a fashion that the next person has to essentially duplicate again what you've done.

— Richard Hamming, *You and Your Research*

## Sell your work

I have now come down to a topic which is very distasteful; it is not sufficient to do a job, you have to sell it. ‘Selling’ to a scientist is an awkward thing to do. It’s very ugly; you shouldn’t have to do it. The world is supposed to be waiting, and when you do something great, they should rush out and welcome it. But the fact is everyone is busy with their own work. You must present it so well that they will set aside what they are doing, look at what you’ve done, read it, and come back and say, ‘Yes, that was good.’ If they don’t stop and read it, you won’t get credit.

— Richard Hamming, *You and Your Research*

## Part II

# The Elements of Style



# The way to think well is to write well

A man may take to drink because he feels himself to be a failure, and then fail all the more completely because he drinks. It is rather the same thing that is happening to the English language. It becomes ugly and inaccurate because our thoughts are foolish, but the slovenliness of our language makes it easier for us to have foolish thoughts.

— George Orwell, *Politics and the English Language*

# Examples, examples, examples

Jeff never saw a book with too many examples. Use lots. Even a very simple example will get three-quarters of an idea across. A page or two later you can refine it with a complex example that illustrates all the “grubbies.” But finding good examples—examples that illustrate all and only the points you are concerned with—is not easy; Jeff has no recipe. You must be prepared to spend a lot of time on it.

— Jeff Ullman on Getting Rich,  
in Knuth, Larabee, and Roberts

## Express related ideas in related ways

the French, the Italians, Spanish,  
and Portugese

My objections are, first, the in-  
justice of the measure; second  
that it is unconstitutional.

Formerly, science was taught by  
the textbook method, while now  
the laboratory method is em-  
ployed.

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the textbook method; now it is  
taught by the laboratory method.

— Strunk and White, *The Elements of Style*

# Criticize yourself, not others

When you describe your own work, you should always emphasize its limitations.

...

Always emphasize the merits of the work of your predecessors and rivals.

...

Never claim to have remedied some defect or limitation in somebody's work. Point out how good somebody's work is and say I have just made a small improvement in this particular aspect of it. Then people will be on your side.

— Tony Hoare, Marktoberdorf 2006

## Avoid non-referential this

While it sounds pedantic at first, you get a huge increase in clarity by chasing the “nonreferential this” from students’ writing. Many students (and others) use “this” to refer to a whole concept rather than a noun. For example: “If you turn the sproggles left, it will jam, and the glorp will not be able to move. This is why we foo the bar.” Now the writer of this prose fully understands about sproggles and glorps, so they know whether we foo the bar because glorps do not move, or because the sproggles jammed. It is important for students to put themselves in the place of their readers, who may be a little shaky on how sproggles and glorps work, and need a more carefully written paragraph.

— Jeffrey D. Ullman, *Advising students for success*,  
CACM 52(3):34–37, March 2009

# Technical Writing

1. Symbols in different formulas must be separated by words.

Bad: Consider  $S^q$ ,  $q < p$ .

Good: Consider  $S^q$ , where  $q < p$ .

2. Don't start a sentence with a symbol.

Bad:  $x^n - a$  has  $n$  distinct zeroes.

Good: The polynomial  $x^n - a$  has  $n$  distinct zeroes.

3. Don't use the symbols  $\cdot \cdot$ ,  $\Leftarrow$ ,  $\forall$ ,  $\exists$ ,  $\ni$ ; replace them by the corresponding words. (Except in works on logic, of course.)

— Donald Knuth, Notes on Technical Writing

# Technical Writing

7. There is a definite rhythm in sentences. Read what you have written, and change the wording if it does not flow smoothly. For example, in the text *Sorting and Searching* it was sometimes better to say “merge patterns” and sometimes better to say “merging patterns”. There are many ways to say “therefore”, but often only one has the correct rhythm.
13. Many readers will skim over formulas on their first reading of your exposition. Therefore, your sentences should flow smoothly when all but the simplest formulas are replaced by “blah” or some other grunting noise.

— Donald Knuth, *Notes on Technical Writing*

# Technical Writing

14. Don't use the same notation for two different things. Conversely, use consistent notation for the same thing when it appears in several places. For example, don't say " $A_j$  for  $1 \leq j \leq n$ " in one place and " $A_k$  for  $1 \leq k \leq n$ " in another place unless there is a good reason. It is often useful to choose names for indices so that  $i$  varies from 1 to  $m$  and  $j$  from 1 to  $n$ , say, and to stick to consistent usage. Typographic conventions (like lowercase letters for elements of sets and uppercase for sets) are also useful.

— Donald Knuth, Notes on Technical Writing



## Omit needless words (1)

In this section, we describe some of the highlights of the research area. We discuss some of the most significant, elegant, and useful algorithms, and some corresponding lower bound results

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— Leslie Lamport, Handout on unnecessary prose,  
in Knuth, Larabee, and Roberts

## Omit needless words (2)

Since the literature in this area is vast and varied, we have found the selection and organisation of these results to be a formidable task. We have chosen to simplify our task by restricting our attention to four major categories of results: shared memory algorithms, distributed consensus algorithms, distributed network algorithms and concurrency control.

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## Omit needless words (3)

Each of these categories has a very rich research literature of its own, and we think that together they provide a representative picture of work in the area. Still, our description is incomplete, since we neglect many interesting topics.

Although we are neglecting many interesting topics, these four areas provide a representative picture of distributed computing.

— Leslie Lamport, Handout on unnecessary prose,  
in Knuth, Larabee, and Roberts

## Study the masters

Vigorous writing is concise. A sentence should contain no unnecessary words, a paragraph no unnecessary sentences, for the same reason that a drawing should contain no unnecessary lines and a machine no unnecessary parts. This requires not that the writer make all his sentences short or that he avoid all detail and treat his subjects in outline, but that every word tell.

— Strunk and White, *The Elements of Style*

Part III

Conclusion

- P. R. Halmos, How to Write Mathematics, in *Selecta: Expository Writing*, Sarason and Gilman, editors, Springer-Verlag, 1983.
- Richard Hamming, *You and Your Research*, Bell Communications Research Colloquium, 7 March 1986, transcribed by J. F. Kaiser.
- C.A.R. Hoare, “Envoi”, in *Essays in Computing Science*, C.A.R. Hoare and C.B. Jones, editors, Prentice Hall, 1989.
- Donald E. Knuth, Tracy Larrabee, and Paul M. Roberts, *Mathematical writing*, Mathematical Association of America, 1996.
- George Orwell, “Politics and the English Language”, in *Inside the Whale and Other Essays*, Penguin, 1969.
- William Strunk Jr and E. B. White, *The Elements of Style*, Longman, 1959 (4th edition, 1999).
- Edward Tufte, *The Visual Display of Quantitative Information*, Graphics Press, 1982 (2nd edition, 2001).

- Any well written fiction or non-fiction.

You don't need luck, but you are lucky!

The computer age is barely half a century old.

Computing has yet to find its Galileo, Kepler, or Newton.

It could be you!