Trees, maps, and theorems

Effective communication for rational minds

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Principiæ
Structuring thoughts

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About this book

IN QUEST OF SOLID WRITTEN SUPPORT for the participants of my training sessions, I searched libraries, bookstores, and mail-order catalogs, but to no avail: I did not find a reference that quite matched the approach I had developed. Encouraged by the feedback on my lectures and publications, I thus set to create my own book on effective communication, for my usual audiences of engineers, scientists, and managers. The outcome of this endeavor is the book you are now reading.

This book is about first principles. It is about strategy and, especially, about structure. To borrow Hemingway's words, it is about architecture, not interior decoration. It is about constructing communication deliberately and methodically. It is about reaching a given purpose with a given audience, in virtually any professional situation—and in any language.

This book is for professionals who want to master the basics, that is, to understand them clearly and apply them carefully when communicating on the job. It is for those who believe that effective communication skills are an invaluable, lifelong personal asset and who want to keep strengthening this asset. As such, it benefits students, too, notably graduate students.

This book, however, is no self-study course—no book can be. Sharpening one's skills requires practice on one's own material. Moreover, it requires feedback, for practice without feedback is of little use. Global feedback may come out of the situation (*Did I get my message across?*). A careful analysis, in contrast, requires an instructor or mentor—a human being, not a book.

This book has been described both as a minimalist user guide, with its concise instructions, carefully selected applications, and answers to frequently asked questions, and, interestingly, as a children's book, with its precise yet straightforward tone, its exposition of one topic per double page (most of the time), and its illustrations. These two descriptions are fine with me.

On what do you base your recommendations?

The guidelines in this book are based mostly on common sense and experience. They have been put to the test, not only in my own practice, but also by thousands of engineers, scientists, managers, and other professionals worldwide who took part in some of my training sessions. I hope the guidelines can be as useful to you as they apparently are to these professionals.

Moreover, my approach is no doubt influenced by my education as an engineer and scientist, and—in ways difficult to trace or to quantify—by all I have read or heard on communication.

Do you rely on empirical research at all?

Well-conducted research in any scholarly field is normally thought-provoking at the very least, so research findings should not be disregarded. Still, empirical research about communication suffers from very many confounding factors and is thus hard to generalize toward practice. In my experience, far too many people apply poorly understood research outcomes blindly, sometimes to the extent of generating myths. I would rather that they thought for themselves.

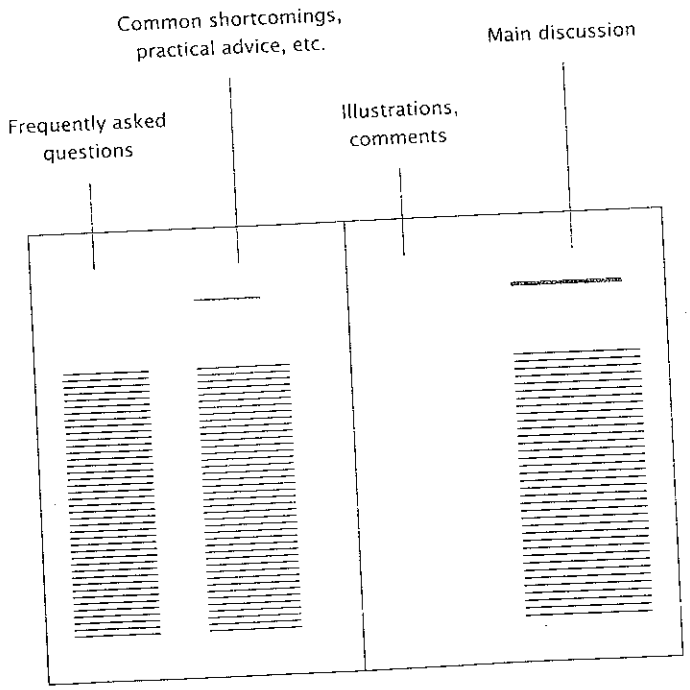
Why such a focus on counterexamples?

Remarkably, there is nothing quite remarkable about instances of effective communication: they draw one's attention to the ideas expressed, not to themselves, so they are hard to learn from by imitation without the contrasting viewpoint provided by a counterexample. Also, learning to pinpoint shortcomings in one's own practice is a necessary step toward improving on them.

How to use this book

This book was designed to propose a logical flow for the discussion while enabling selective reading of individual parts, chapters, or sections. Feel free, therefore, to read the complete discussion linearly or to jump ahead to the themes of interest to you. Topics are discussed in one double page each time (or in a small integer number of them), to facilitate their direct access or out-of-sequence processing.

The pages, too, are formatted for selective reading. The right page is reserved for the main discussion, with illustrations, limited examples, or comments placed left of the text. In relation to this discussion, the left page answers frequently asked questions collected at the occasion of lectures and workshops, set on a gray background. In the remaining space, it lists typical shortcomings, offers practical advice on specific subtopics, or broadens the discussion.



This book is organized in five parts: first, fundamentals, then written documents, oral presentations, and graphical displays, and finally application to five more specific types of document. It ends with notes and references, as well as an index of topics.

Part one, *Fundamentals*, introduces the ideas that underpin the four subsequent parts. Probably the most arduous part of the book as it lacks the examples that appear further on, it can be skimmed or perhaps skipped at first by the reader eager to start work on documents, presentations, or displays. Still, it answers many a *why* about further recommendations and, by offering a minimal set of universal principles, it equips readers for most challenges of professional communication.

Part two, *Effective written documents*, offers a methodology in five steps to proceed from scratch to a complete document, namely planning, designing, drafting, formatting, and revising the document to be created. It details each of these five steps.

Part three, *Effective oral presentations*, proposes a similar yet distinct approach in five steps: planning the presentation, designing it, creating the slides, delivering the presentation, and answering questions. Though meant to stand on its own, it does not repeat uselessly what has already been discussed in detail about written documents, in particular planning.

Part four, *Effective graphical displays*, first classifies pictures as a way to help readers choose the right representation, then discusses how to plan, design, and construct optimal graphs, and finally how to draft a caption that gets the message across.

Part five, *Applications*, illustrates how the general guidelines in the previous parts apply to five common types of documents. Specifically, it examines sets of instructions, electronic mail, Web sites, meeting reports, and scientific posters, each time particularizing earlier recommendations or adding new ones.

My thanks to...

Geneviève Casterman

for her unfailing loving support
and her shrewd business advice.

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for her review of the manuscript
and her sharp eye for consistency.

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with whom I refined my thoughts
about "choosing the right graph."

David Lougee

for a first chance to help others
sharpen their presentation skills.

... and many more people

who have attended my lectures
or workshops, have put my ideas
and recommendations to the test,
have given me valuable insights,
and have made my job rewarding.

Contents

There is nothing so practical
as a good theory.

— Kurt Lewin

Ajoutez quelquefois
et souvent effacez.

— Nicolas Boileau

Fundamentals

ALL FORMS OF EFFECTIVE COMMUNICATION—written, oral, or graphical—build on the same principles, addressing fundamental concerns of purpose, content, and form. What are we trying to achieve by engaging in communication? What must we then write, say, or draw, and how must we write, say, or draw it to reach our purpose? These are the key questions to analyze existing documents, presentations, or displays, and to create effective new ones.

This first part discusses the fundamentals of communication. After establishing what *effective communication* designates, it proposes a set of three laws that forms the very foundation of the further guidelines. As a more substantial dichotomy than the usual opposition between oral and written channels, it discusses the specificities of verbal and nonverbal codings. Finally, it examines the effectiveness of essential structures in terms of the number, hierarchy, and sequence of elements.

Fundamentals

- The name of the game
- The three laws of communication
- A thousand words, a thousand pictures
- Chains and magical numbers
- Trees, maps, and theorems

Effective written documents

- Planning the document
- Designing the document
- Drafting the document
- Formatting the document
- Revising the document

Effective oral presentations

- Planning the presentation
- Designing the presentation
- Creating the slides
- Delivering the presentation
- Answering questions

Effective graphical displays

- Understanding pictures
- Planning the graph
- Designing the graph
- Constructing the graph
- Drafting the caption

Applications

- Effective instructions
- Effective electronic mail
- Effective Web sites
- Effective meeting reports
- Effective scientific posters

The name of the game

EFFECTIVE COMMUNICATION is getting messages across. Thus it implies someone else: it is about an audience, and it suggests that we get this audience to understand something. To ensure that they understand it, we must first get them to pay attention. In turn, getting them to understand is usually nothing but a means to an end: we may want them to remember the material communicated, be convinced of it, or, ultimately, act or at least be able to act on the basis of it.

Information

A concentration of 175 µg per m^3 has been observed in urban areas

A message

The concentration in urban areas (175 µg/m^3) is unacceptably high.

A message differs from raw information in that it presents "intelligent added value," that is, something to understand about the information. A message interprets the information for a specific audience and for a specific purpose. It conveys the *so what*, whereas information merely conveys the *what*. A message is to information what conclusions are to findings. Because it makes a statement, it requires a complete sentence.

A *what* caption (a noun phrase)

Evolution of sales over the years

A *so what* caption (a statement)

Sales dropped by 40% last year

To communicate effectively, we must thus identify messages. Conveying information only is usually not enough, as it leaves the audience with the question, so what? We must moreover recognize and seize opportunities to get the messages across, for example in the captions of figures or in the titles of slides.

Often, the messages to be conveyed are numerous or complex, and the situation carries constraints. Among these are space (such as a four-page limit on a paper), time (a 15-minute limit on a presentation), and audience (background, language, etc.). Not every hindrance is a true constraint, though: for example, a suboptimal room can often be rearranged, at least to a point.

Get your audience to

- pay attention to,
- understand,
- (be able to) act upon

a maximum of messages, given constraints.

Effective communication is optimization under constraints: we must maximize, not what we write, say, or draw, but how much our audience gets out of our documents, presentations, and displays, in quantity or in quality—with a purpose in mind and under certain constraints. Because of these constraints, we cannot hope to be perfect. We can, however, be optimal.

Fundamentals

- The name of the game
- **The three laws of communication**
  - Adapting to the audience
  - Maximizing the signal-to-noise ratio
  - Using effective redundancy
- A thousand words, a thousand pictures
- Chains and magical numbers
- Trees, maps, and theorems

Effective written documents

- Planning the document
- Designing the document
- Drafting the document
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Effective oral presentations

- Planning the presentation
- Designing the presentation
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Effective graphical displays

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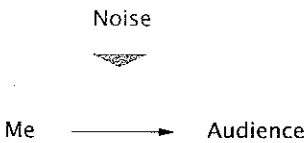
The three laws of communication

THREE SIMPLE YET SOLID PRINCIPLES are all we need to optimize virtually any instance of communication. These three "laws of communication" can be derived with a simple model of one-way communication, embodying the idea of getting messages across optimally to our audience.

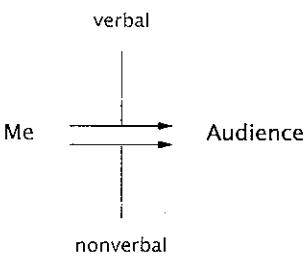
First law Adapt to your audience

To optimize under constraints, we must first identify what is and what is not under our control, and concentrate on what is. To a point, we cannot select our audience: we must take them as they come. Still, we can decide what to tell them and how. To optimize our communication, we must thus adapt to them.



Second law Maximize the signal-to-noise ratio

The simple model above is ideal: it suggests that information or messages sent from one side reach the other side intact. In practice, information may suffer losses, because of noise. To prevent losses, we must filter out the noise; alternatively, we can enhance the signal so it can withstand the noise better.



Third law Use effective redundancy

The second law is limited to prevention. When noise cannot be anticipated, it cannot be filtered out, so it results in losses. To compensate for the losses, we can tell things several times, by repeating the message or by replicating it across channels, preferably in different ways, such as verbally and nonverbally.

Can I not select my audience at all?

Early on, the audience is not necessarily given, indeed: a scientist deciding to which journal to send a paper is selecting his or her audience. Still, the range of options is often limited and, once a journal has been chosen, the audience becomes a given: the scientist can hardly select, within this audience, who may read the paper.

Can I not change or influence my audience?

You can most certainly influence your audience, such as increase their motivation or provide any prerequisite knowledge they might need. In doing so, you are already communicating with them and, essentially, adapting to them. In other words, the audience can be regarded as given in that they cannot be changed a priori. Influencing them requires adapting to them.

Why should I always be the one adapting?

You should be the one adapting to the extent that you are the one with a purpose—that is, that you want something from your audience. Much like being customer-minded in business or being user-friendly in software development, adapting to one's audience is really a question of effectiveness more than one of selflessness.

Is the audience never to be blamed, then?

Blaming the audience may help us feel better but seldom gets us anywhere, unless perhaps if blames can influence the audience positively. A more purpose-oriented approach is to regard their shortcomings as constraints—and adapt.

Real-world audiences know less

Adapting to the audience in a professional context is all the more difficult because practice in school usually develops the wrong communication reflexes. Real-world audiences and purposes differ markedly from those that students were long confronted with.

Students formally write and speak to demonstrate their mastery of a well-defined body of knowledge and, ultimately, to be graded. For such a purpose, their only relevant audience is the course instructor: a single, clearly identified person, who is normally more knowledgeable than they are about the topic and morally obliged to read their entire document or attend their entire presentation, however boring. Accordingly, successful strategies to good grades may involve including as much material as possible (especially when in doubt as to what the instructor will give extra credit for) or showing off with jargon.

Professionals, in contrast, formally write and speak to get their audiences to pay attention, understand, and (be able to) act. Such real-world audiences are unpredictably multiple (especially for documents), almost always less knowledgeable about the topic, and highly selective about what they read or attend. They have little patience with writers and, especially, speakers attempting to demonstrate the breadth or depth of their knowledge, often at the expense of the clarity or the conciseness of their discourse.

Unsurprisingly, the most common failure to adapt to one's audience, then, is to present information that is too technical or too little relevant to them. According to a common myth in academic research, a presentation should have one third that everyone in the audience understands, one third that some understand, and one third that no one understands. What can one gain with such an approach, though? Audiences have infinitely more respect for speakers who can explain complex matters in simple ways and thus give new insights. Still, the myth endures.

Adapting to the audience

EFFECTIVE COMMUNICATION always requires motivation. If we want our audience to pay attention to, understand, and act upon our messages, we are the ones who should make the effort. That is, we must adapt to them, not expect them to adapt to us. Should they be willing and able to adapt, too, so much the better, but we have no cause to assume they will.

The first law, *adapt to your audience*, is one of empowerment: it implies that we are responsible for the success of our acts of communication. If our audiences fail to get the messages, it is our problem, not theirs, as we have not reached our goal. Blaming them makes little sense: it hardly helps us optimize. From our perspective, the degrees of freedom are on our side.

Adapting to our audience is normally a spontaneous attitude in our private life. For example, we do not address children the way we address adults: we recognize the need to adapt. It is far less spontaneous an attitude in our professional life, in which we tend to regard the others as similar to ourselves.

Adapting means putting ourselves in the shoes of the audience, anticipating their situation, their needs, their expectations, etc. It implies structuring the story along their line of reasoning, not ours, and recognizing the constraints they might bring: their familiarity with the topic, their mastery of the language, the time they can free for us, etc. Whenever we are not taking a certain constraint into account somehow, we fail to adapt.

Finally, adapting to the audience suggests that, if one strategy does not work, we try a different one. If the audience failed to get the message, merely repeating it is unlikely to help: we must change the code or the channel. As the saying goes, if we do what we already did, we will get what we already got. Still, adapting to our audience does not mean losing track of our purpose. On the contrary, it means doing what it takes to get the audience to (be able to) do what we want them to do.

Teachers who stick to what they had planned to do regardless of whether the students pay attention, understand, or develop the required competencies are not adapting to their audience. Unsurprisingly, such teachers often blame it all on the students, too.

Imagine that a foreigner asks you for directions and that the only language you have in common with him is English, of which he has little command. Suppose that he did not get your first explanation. Adapting to him (assuming that you are motivated) might involve making gestures, sketching a map, speaking more slowly, pronouncing more clearly, using a simpler vocabulary and a simpler syntax—or perhaps accompanying him to where he must go.

Identifying sources of noise

Is noise always bad? Can it not be used to regain the attention of the audience?

Noise is undesirable by definition. If something helps you reach the purpose you have in mind, such as by getting the attention of the audience, you can best regard it as signal, not as noise.

Still, before introducing or tolerating anything that might attract attention, consider whether the device does not distract more than it helps, such as by stealing the attention away from you or reflecting badly on your professional image. When they are handled with a touch of humor, minor mishaps in an oral presentation can help the speaker build rapport with the audience, yet the presentation would be more impressive without them. Similarly, conspicuous clothes or jewelry can easily overshadow the message. Attendees later referring to one of the speakers as *you know, the one with the dark red jacket* remember the clothes more than the person.

How can I "increase the signal" beyond merely speaking louder?

Increasing the volume in an oral presentation or perhaps the font size in a written document seem obvious applications of the second law, as is making the data lines thicker than the axes, tick marks, or grid lines in a graphical display.

More broadly, *increasing the signal* may mean conveying stronger messages. When we do not master the language, when the transmission is unusually poor, or when the audience is tired or otherwise less attentive, we may well have to be blunt and not attempt to be too subtle, as subtleties will probably not survive the noise. While not ideal, it would be optimal in this case.

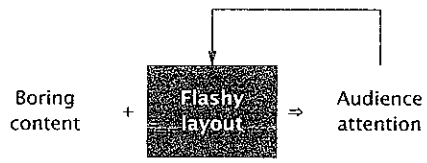
Noise comes in many forms and from many sources. In the case of a formal presentation, for example, the noise sources that most people readily think of are the audience and the environment: attendees chatting among themselves or coming in and out, mobile phones going off, noisy air conditioning, unreliable equipment (microphone, projector, etc.), building works in progress outside the room, etc. The noise source that these people forget at first is the speaker himself or herself. Noise produced by a speaker is typically more distracting than that coming from other sources, because it is part of what the audience is supposed to pay attention to. Just because it comes from the speaker, however, it can more easily be controlled than other sources.

Noise produced by speakers in oral presentations shows more particularly in two components: slides and delivery. Busy slides compete with the speaker for the attention of the audience, and flashy slides draw attention to themselves, not to their content. Delivery noise includes imperfect pronunciation, filler words, unnecessary gestures or mannerisms, and so on, all the way to inappropriate dress code.

Noise in documents is whatever prompts readers to stop thinking about content and start thinking about form (or perhaps about irrelevant content). Examples are an unclear structure of the document, intricate sentences, unusual or superfluous words, spelling mistakes, and distracting visual elements in the figures, the typography, or the page layout.

Noise in graphical displays includes the many forms of data distortion, as with inappropriate graph types, and all "unnecessary ink", that is, visual elements that can be erased without loss of clarity or accuracy: decorative third dimensions or gradients of color and overabundant tick marks or grid lines in graphs, irrelevant backgrounds or objects in photographs (to be removed ahead of time or cropped out), etc.

Maximizing the signal-to-noise ratio



A frequent yet hopeless attempt: salvaging uninteresting content with an "interesting" page layout. Will the document thus produced get the attention of the audience? Yes, it will—on the page layout, with little transfer to the content, if any. The flashy layout is noise.

NOTHING IS NEUTRAL in communication. The audience indeed sees and hears everything, so everything matters. What does not help get the message across detracts from it by needlessly mobilizing the audience's intellectual resources, even if for a short time. By definition, it is noise. Noise is thus more than unwanted sound: it is anything that can distract from the message (the signal) by drawing attention onto itself.

Noise can be a major impediment to effective communication. At best, it just stretches the attention span of the audience. At worst, it takes their attention entirely away from the content. As an example, typographical errors in a written document or filler words in an oral presentation can be most distracting: audience members may well find themselves on the lookout for the next typo or next *um* rather than for the next message. In graphical communication, noise easily shifts the attention from content to technology: when readers start wondering what software produced a graph instead of what experiment produced the data, they are most probably missing the point.

The second law, *maximize the signal-to-noise ratio* (or *ratios*), is all about contrast between what helps and what hinders an act of communication. The ratio between signal and noise matters more than signal or noise alone. To a point, we can thus tolerate continuous background noise, which we notice only when it varies suddenly, for example when it goes away.

Clearly, the most satisfying approach to contrast is reducing or eliminating noise: breaking the silence in a whisper is far more effective than covering the noise in a shout. Recognizing that nothing is neutral, we should thus question the relevance of anything we plan to include: words in a written document, gestures in an oral presentation, lines in a graphical display. To optimize a text or an image, we may do better to suppress, not add. By removing every unneeded drop of ink, we ensure that the audience pays attention to nothing but the message.

Identifying possible codings

Is redundancy the same as repetition?

Repetition suggests a signal at different times on one channel, as when a speaker previews his or her main points before developing them. Redundancy can be just that, but it can also be a signal across different channels at one time, as when a speaker illustrates the presentation with a slide show. Either way can be effective.

Why insist on calling it "effective" redundancy?

Not all redundancy is effective. For example, superfluous words as in *added bonus* or *oval in shape* add nothing. What is much worse still, multiple channels competing with one another, such as text-heavy slides accompanying a talk, are more harmful than helpful: each channel is indeed a source of noise for the other one(s).

Is a channel the same as a coding?

The term *channel* (or, equivalently, *medium*) refers to perception by the senses; in contrast, *coding* refers more to processing by the mind. (At times, the boundary is somewhat blurred.) For example, *paper* conveying written words or *air* conveying oral words (as sound waves) are channels, and *text* or *pictures* are codings.

What matters most for effective redundancy is codings. In first approximation, text is text, whether it is seen through the eyes or heard through the ears. A different coding, such as a picture, would be a more useful redundancy than a similar coding in a different channel, such as a second stream of text. Still, channels have their importance, in particular in terms of the nature of the noise they are subject to.

The three laws are in order of decreasing priority. To prevent losses, the first measure is to filter out the noise and, if deemed useful, increase the signal (adapting its maximum intensity to the audience). If we could filter out all noise, we would not need redundancy, at least not to compensate for losses, because there would not be any. Alas, some noise is beyond our control: attendees at a presentation may be preoccupied with something else, readers of a document may be interrupted by a phone call, etc. Using several codings is thus usually desirable.

Because nothing is neutral, most everything can be regarded as a coding, that is, as a potential source of noise if left uncontrolled and a potential signal if used well. Whether or not we like it, the clothes we wear always say something about who we are, for example. While we may decide not to worry unduly about the possible statement we thus make because it has far less impact than other codings, we may want to scrutinize our dress code for noise.

Devices we can usefully regard as distinct codings in written documents include the text itself, the set of headings in the text and in the table of contents, the page layout (revealing the structure visually), and tables or figures, all of which can be optimized.

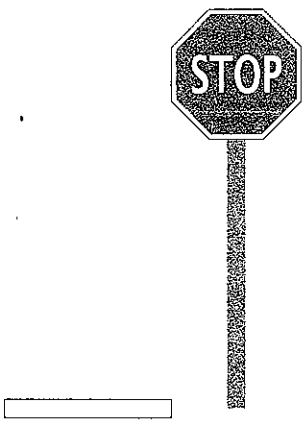
In oral presentations, codings include most of all the verbal, vocal, and visual delivery (all three being powerful devices toward convincing an audience), possibly supported by slides or printed handouts. Just because the nonverbal ones (vocal and visual) are intuitive does not mean they cannot be managed: we can thus learn to amplify our intonation, quiet body noise, or make eye contact with the audience.

Graphical displays, too, can be seen as including more than one coding. They might convey meaning through relative lengths, positions along a scale, shapes, colors, explanatory labels, captions, etc.

Using effective redundancy

TELLING THINGS ONCE is often not enough: redundancy helps restore messages damaged by noise. It should not, however, introduce noise itself, that is, distract the audience, such as when concurrent channels compete with one another. Effective redundancy, therefore, gets a given message across several times, but coded in complementary, compatible ways.

Effective redundancy works in two ways: one is compensation, the other, collaboration. First, each coding gives the audience a chance to understand the message. Motorists, for example, can identify a stop sign in three ways: color, label, and shape. If they cannot distinguish the color, they can read the label "STOP". If this label is hidden by mud or snow (or if they see the sign from the back), they can still recognize it by shape. By giving several chances, effective redundancy helps address inhomogeneous audiences. Second, all codings work together in synergy: here, color, label, and shape, when all identified, complement one another for a faster recognition of the sign.



The stop sign conveys meaning through shape, color, and label: it is the only octagonal sign, one of only two signs to be solid red (the other is the wrong-way sign), and the only one labeled "STOP" in most countries. It also comes with a white line across the lane as yet another way to mean stop.

What makes a different coding is partly a view of the mind. Though they are both verbal codings on the same medium, the text and the headings within a document can be regarded as distinct codings, used for distinct purposes. When looking for a specific part of the document, we are thus likely to flip through the pages and look at the headings but not at the text. Conversely, when we have decided to read the full document linearly, we typically read the text but skip all the headings.

Although redundancy is a choice, the multiplicity of codings may not be: some codings are unavoidable. When speaking in public, for example, we communicate through what we say (the verbal component), how we say it (the vocal component), and everything that we let the audience see about ourselves (the visual component). Any component escaping our control can carry noise or, what is worse, convey messages that work against our intent, resulting in so-called cognitive dissonance.

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- Effective instructions
- Effective electronic mail
- Effective Web sites
- Effective meeting reports
- Effective scientific posters

A thousand words, a thousand pictures

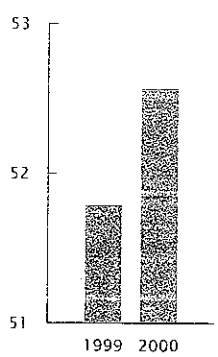
Verbal	Nonverbal
text-like	vocal, visual
Rational	Intuitive
abstract, learned	concrete, innate
Sequential	Global
slow, exclusive	fast, nonexclusive

A PICTURE IS WORTH A THOUSAND WORDS, or so they say. In reality, however, not all pictures are created equal, and the power of visual communication is too often misunderstood, not to say misused. Pictures are no panacea; some words convey concepts better than a thousand pictures.

Intellectual processes, complex and still poorly understood, can pragmatically be modeled as either verbal or nonverbal. Verbal processes are rational, able to manipulate intangible, abstract concepts whose symbolic meaning must be learned. Nonverbal processes are intuitive, almost unconscious, tuned for concrete items with nonsymbolic, quasi innate meaning. Verbal code, such as a piece of text, is sequential; as a result, it is processed relatively slowly. In contrast, nonverbal code, such as a photograph, is global and processed in an instant. Verbal and nonverbal processes are about codes, not channels: as an example, text is verbal code, whether it is heard or read.

Verbal and nonverbal processes are independent of each other so they can take place concurrently: for example, an audience can watch a static picture while listening to an explanation. Concurrent verbal processes, however, are mutually exclusive: for example, an audience cannot both read text on the screen and listen to spoken text, unless perhaps if it is the same text.

Nonverbal codings, being intuitive, usually have more impact than verbal ones. To some extent, they are also more credible: we believe tone of voice and body language more than words. Dissonance between verbal and nonverbal codings can be put to good use in irony and in humor, when we let our audience know nonverbally that we do not mean what we say verbally, but is otherwise dangerous. Thus a pictorial representation of what *not* to do is misleading, even when it is accompanied by a text explanation, unless the *not* is expressed visually, too. Likewise, graphs can be intentionally or accidentally deceptive, and no amount of text can fully correct the visual deception.



Although the left scale tells us (rationally) that the difference between 1999 and 2000 is 1.5%, the visual code prevails: we keep from the graph a strong, lasting feeling that the value for 2000 was twice that for 1999.

Removing visual noise

Why are nonverbal codings more credible?

Body language is typically more spontaneous than words are: nonverbal codings are harder to control, hence less likely to be manipulated (the body never lies, according to the proverb). As audience members, we might reason thus and decide to believe the body. More probably, however, we do not reason about the conflict: we absorb nonverbal codings unconsciously, without the analytical filter we apply to words. In other words, we believe nonverbal codings because we have no process to disbelieve them. We instantly sense that the words are untrue.

Can I never include text on presentation slides?

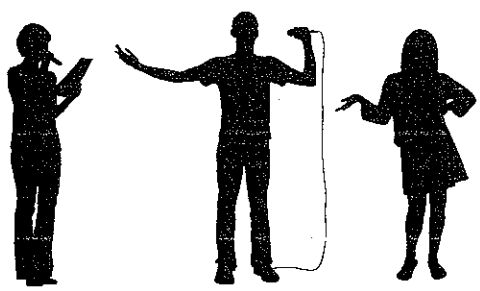
If your oral presentation must discuss a text, for example a novel or an article from a treaty, you might be justified in including some of it on your slides: this text is your very material and no longer a mere support for it. If you do, limit the text excerpts to those strictly needed to make your points. When showing the slide, read the text excerpt out loud for the audience, so they can read it together with you, then have their mental text processor available to handle what you have to tell them about the excerpt.

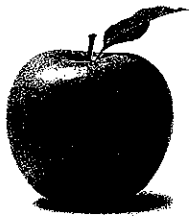
Text, here, implies sequential processing, as in a sequence of words whose order is dictated by syntax, or perhaps a sequence of sentences. Words that do not form a text and can thus be read in any order, as the labels on a diagram, are less of an issue on slides, since they do not conflict as much with concurrent spoken text. Conversely, animated visual representations, while not textual, are processed sequentially: it may be hard to watch an animated diagram and follow spoken discourse at the same time.

Pictures are powerful, and what is powerful is risky. In a verbal coding, and possible connotations aside, the conventional meaning is all that really matters: the word *apple* means "apple"—no more, no less. In contrast, in a visual coding, everything matters: the minutiae of the shape, the shades of color, etc. If such details help get a relevant message across, they are welcome indeed; otherwise, they are noise. Pictures, in other words, carry a higher potential for noise than text. It is usually easier to choose the right word than to come up with the right picture.

When details are irrelevant or otherwise undesirable, as is usually the case in technical communication, photographs can best be replaced by sober line art, less likely to carry irrelevant details. A human hand in a realistic illustration, for example of someone inserting an extension card in an electronic device, is not just any hand: it has a color, gender, and age, not to mention social status and grooming habits. A more schematic representation (line art) displays a hand with which more viewers are able to identify.

Even the most sober line art has its limits, however. The mind is so prompt to recognize visual patterns that it often interprets images in unintended ways. For example, it is as good as impossible to draw a person—or even an animal—without conveying an attitude, which may or may not be well received. Such an attitude, so conspicuous in most clip art, is noticeable even in silhouettes and in stick figures.





A picture excels at representing something intuitive, for example a real object. At the same time, it is condemned to be concrete: it cannot convey abstract ideas (at any rate not unambiguously).

As an example of the ubiquitous visual ambiguity, the attitude of this little boy is read differently by different people: is he serene, sad, interested, absentminded? What do *you* see in this picture?

Visual codings, being intuitive and global, are more effective for conveying intuitive or global information. For example, maps convey relative positions more rapidly than words can, drawings describe objects more clearly than words can, and facial expressions show emotions more subtly than words can. Visual codings that mimic facial expressions such as ";-)" have thus emerged in such plain-text media as electronic mail, to convey meaning that relies on intuition—typically humor.

Visual codings, by contrast, are less effective for expressing abstract concepts. A given pictorial representation illustrates only one instance of a concept so easily expressed in words. As an example, a photograph of an apple does not say "apple": rather, it indicates a specimen of specific variety, maturity, etc. as suggested by the apple's visible shape, texture, and color. Nonsymbolic representations are condemned to be concrete, even if schematic drawings can "abstract" irrelevant details, thus broadening the drawing's suggested meaning somewhat.

Visual codings, moreover, lack the accuracy that words are endowed with through conventional association of meaning. Just like Rorschach inkblots, they are intrinsically ambiguous: being intuitive and concrete, they suggest a meaning instantly and may well suggest a different meaning to each viewer, often unable to imagine anyone else "seeing" anything else.

In a sense, a word is worth a thousand pictures, too. Indeed, verbal codings can express abstract concepts unambiguously and concisely, even if not intuitively. As an example, the word *apple* designates any apple and thus transcends all pictures, which can show specimens only. Words can convey concepts that nonsymbolic codings cannot, for example interdiction: showing it visually requires a convention, such as a red circle.

In essence, verbal and nonverbal codings are complementary. They are perhaps the essential form of effective redundancy.

Fundamentals

The name of the game
The three laws of communication
A thousand words, a thousand pictures
Chains and magical numbers
Trees, maps, and theorems

Effective written documents

Planning the document
Designing the document
Drafting the document
Formatting the document
Revising the document

Effective oral presentations

Planning the presentation
Designing the presentation
Creating the slides
Delivering the presentation
Answering questions

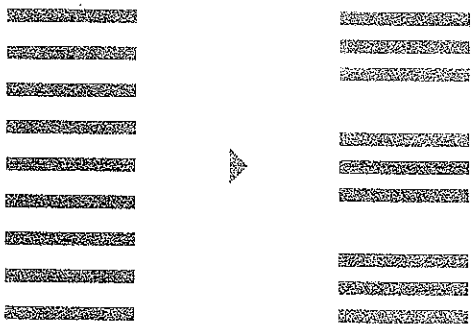
Effective graphical displays

Understanding pictures
Planning the graph
Designing the graph
Constructing the graph
Drafting the caption

Applications

Effective instructions
Effective electronic mail
Effective Web sites
Effective meeting reports
Effective scientific posters

Chains and magical numbers



OUR CAPACITY FOR PROCESSING unstructured items of information presented together is severely limited. Series of items, or lists, tax our short-term memory, key to mental processing, and become rapidly unmanageable as the number of items grows beyond just a few. *Processing* and *short-term memory* suggest random access to the items. Longer lists can of course be committed to long-term memory by rote learning, but this memory provides sequential access only: if we forget one link in the chain, we often cannot go on. As a rule, we can process items in random fashion if we can see at a glance how many there are, without having to count.

An *item* is whatever we can, to a point, recognize and process as a unit. To make a long list easier to process, we can group items into fewer, higher-level items, thus creating a hierarchy (a list of lists): a series of three series of three items is easier for a human brain to process than a single series of nine items. For the higher-level items to be recognized as units, however, the original items must be grouped logically, not arbitrarily. This logic must be made explicit or be readily recognizable for the audience. Visual clustering helps show the groups, too.

Balanced, multidimensional structures, in other words, match our mental patterns better than longer, unidimensional ones. Chains, structured along a single dimension, must be accessed in sequence. Trees, structured hierarchically, add a dimension. They offer, not a sequence of items, but a sequence of choices, in the form of recursive branching. They can thus organize a large number of items while offering few enough options in every choice to enable random processing of these items. With the cascade of choices kept short enough, they provide an overview of the collection of items in a way chains cannot. They are thus easier to apprehend, navigate, and remember, and constitute a more robust framework, for example to build a case: whereas a chain is only as strong as its weakest link, a weak argument in a tree does not invalidate the other ones.

Chains just do not communicate well

How about numbering the items, so readers can "see at a glance how many there are"?

"Seeing at a glance how many items there are" is a reliable sign of nonsequential perception. This perception is about *seeing* all the items; *being told* how many there are does not help.

Is sequential processing necessarily a problem?

Admittedly, linear material—for example a set of step-by-step instructions—may at first seem to require no more than sequential processing. Still, a hierarchical structure would give users an overview of the steps to be performed, thus preparing them mentally for the tasks ahead. Moreover, a long list often intimidates readers. Tree structures typically look more accessible.

Is text not processed sequentially anyway?

A verbal list, even short, must indeed be read sequentially: word after word, item after item. *Nonsequential* here refers to the initial (visual) perception of the list of items and, especially, to their manipulation in short-term memory, where they can be, in a sense, "seen" together, reviewed in any order, and finally passed on to long-term memory in a structured manner.

Must presentations always have three points?

Presentations need not have three main points: some topics are better structured in two, four, or perhaps five points. Still, because a structure in three points communicates particularly well, you might want to give it a try systematically, without forcing it on your topic if it does not fit.

While they are harder to process, chains are easier to create than trees, because they need local effort only: they can be constructed one item at a time, with little or no attention to the structure as a whole. As the examples below illustrate, chain structures are frequent in verbal code (written or spoken text) and in nonverbal items (slide shows, graphs, etc.) alike, each time taxing the intellectual capabilities of the audience—and, in one case, of the speaker.

Long series of short sentences—perhaps written in the simplistic belief that shorter sentences are easier to read—make for hard-to-read paragraphs, even if each sentence individually is very readable. The same holds for long series of short paragraphs.

Chains of premodifiers need not be long to create uncertainty as to which words are being modified. They are often found on restaurant menus (*Grilled Applewood Smoked Bacon Wrapped Mission Figs*) and in scientific publications (*Fuzzy-Logic-Controller-Based Cost-Effective Four-Switch Three-Phase Inverter-Fed IPM Synchronous Motor Drive System*).

Writing down and committing to memory the text of a presentation places the speaker at the mercy of the slightest memory lapse: the rest of the text usually cannot be recalled past any missing words (and a gap in the text would be noticeable anyway).

Showing many slides as part of an oral presentation easily creates a disorienting impression of linearity, especially if all slides have the same visual design, that is, unless there are contrasting slides meant to reveal the hierarchical structure of the material.

Graphical displays such as pie charts that include too many items not only face the spatial challenge of labeling all segments clearly but also fail to give an overview of the data. As an alternative, bar charts can display hierarchical groups of data more easily.

The question, of course, is how long a list can reasonably be, that is, how many items presented together are too many. Rather than blindly apply a single, dogmatic "magical number," let us see how small integers can usefully guide our practice of communication. As it happens, there is magic everywhere.

Zero is perfection, as in zero superfluous words on a page zero useless gestures in a talk, zero unneeded ink in a graph. Aiming for zero noise means much hard work for something the audience will *not* notice—frustrating, yes, but effective.

One is focus, as in one theme per document or presentation, one message per paragraph or slide, one idea per sentence. One is consistency and univocality, a prerequisite to meaning in verbal codings: synonyms and homonyms are suboptimal.

Two is a bit, a binary alternative. It is thus the simplest form of classification, as in specialist versus nonspecialist or verbal versus nonverbal. Two is a duality, with all its appeal and all its limitation, as in good and evil, night and day, yin and yang. Besides opposition or complementarity, two is redundancy across channels or codings—a potentially effective approach.

Three is the simplest complexity: it corresponds to a triangle (the first polygon), the number of dimensions in physical space, and the number of colors required to generate all the others. Three is of course a direct extension of two, one that breaks the duality, as by introducing gray between black and white. Interestingly, three is how we group digits in large numbers for increased readability. It is a common-sense upper limit in many cases, for example on the number of heading levels that can meaningfully be numbered together (*Section 2.4.1*). Pragmatically, three is probably the optimal number for items that must be grasped rapidly and remembered easily, such as steps in a procedure or main points in an oral presentation. Three items simply work well—for speaker and audience alike.

I thought seven was "the" magical number and a universal upper limit. Is it not so?

George Miller's now famous article published in 1956 in *Psychological Review*, "The magical number seven, plus or minus two: Some limits on our capacity for processing information," is frequently misunderstood and misquoted. It derives seven as a rough asymptotical limit from experiments that are in fact little relevant to the type of communication discussed here. Anyway, to reduce the risk of processing errors, we should limit the number of items presented together to fewer than the asymptotical value. Pragmatically, we could use the lower bound of Miller's proposed 7 ± 2 interval, namely five.

How can I group items in a table that is not otherwise structured?

You can always group the rows visually by five (or fewer), as by skipping space every five rows or, when space is at a premium, by alternating the background color for groups of five rows. Though not dictated by logic, such a grouping makes the rows of the table easier to read off, especially when the columns are set far apart.

Should rating scales not have some kind of neutral between positive and negative?

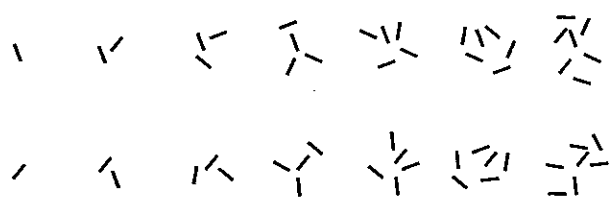
The middle point provided by an odd number of options may be desirable, but it can become an easy noncommittal retreat (though perhaps mitigated by an out-of-scale *no opinion* option). Still, three options (+/o/−) provide no degree of positive or negative appreciation, while five are already enough to drive some respondents into avoiding the two extremes systematically.

The difficulty is combinatorial

The abrupt saturation, beyond five, of our capacity for processing a set of items presented together may come as a surprise. Going from five to six items means adding only 20% to the sequence, whereas going from two to three is adding 50%—a lot more. We might thus expect processing six items instead of five to be 2.5 times easier than processing three instead of two, yet experience suggests otherwise.

One plausible explanation is combinatorial analysis. Because the key to apprehending sequences fully is the possibility to process them nonsequentially, we should reason, not in terms of sequence length, but in terms of nonsequential combinations. A set of n items can be combined in $n!$ (factorial n) ways, a function that grows much more sharply than n. Going from two to three items means multiplying the possibilities by three (from $2! = 2$ to $3! = 6$); going from five to six items, by contrast, means multiplying them by six (from $5! = 120$ to $6! = 720$). This model would explain not only why six items are so much harder to handle than five but also why key items benefit from being fewer than five (three items being thus 20 times less demanding).

The sequential process required beyond five items applies to visual codes, too, as soon as their details have to be processed one by one. As an example, how easily can you identify below the differences between upper and lower drawing, besides rotation? First global, the comparison becomes sequential as the number of items increases, unless (part of) the figure becomes meaningful to you as a whole.



Four is a square (2^2): it is a combination of two binary options. Four is therefore a useful number of answers for rating scales (++/+/−/−−), as it embodies a cascade of two binary choices: first, is it rather positive or negative; next, is it a little or a lot. Four is also a direct extension of three: whatever works well in threes might also work, though not nearly as well, in fours. While large numbers are usually set in groups of three digits, a year such as 1984 is set as a single group of all four digits, with no apparent readability problem (yet it is read in English as *nineteen eighty-four*, or 2 × 2 digits). As another example, whereas *Section 2.4.1* is reasonably easy to situate mentally or to remember, *Section 2.4.1.3* is immediately much harder.

Five is a handful: it is the number of fingers on a human hand but also the limit above which we must count items to know their number—unless they are organized visually in groups of five or less, as can usefully be done with rows in long tables. It is thus a useful upper limit on the number of items in a list.

Six is... just after five, the same way that four is just after three. Consequently, if five is a useful maximum number for a group of items not otherwise structured, then six is just past the limit. In other words, six might work for some people, in some cases.

Seven is many: it is usually too many for the communication to be effective. In a sense, seven is the smallest numerousness, in the same way three is the simplest complexity: seven items presented together are just too numerous to be manageable. Apart perhaps for overwhelming the audience economically, seven is not a particularly useful number for communication.

From the eight numbers above, and beyond the obvious zero and one, you might remember the first three prime numbers: two for effective redundancy, as with verbal versus nonverbal; three as an optimal number—fast to grasp, easy to remember; five as the maximum number that ensures global processing.

Fundamentals

- The name of the game
- The three laws of communication
- A thousand words, a thousand pictures
- Chains and magical numbers
- Trees, maps, and theorems
  - Balancing the structure
  - Allowing easy navigation
  - Stating messages first

Effective written documents

- Planning the document
- Designing the document
- Drafting the document
- Formatting the document
- Revising the document

Effective oral presentations

- Planning the presentation
- Designing the presentation
- Creating the slides
- Delivering the presentation
- Answering questions

Effective graphical displays

- Understanding pictures
- Planning the graph
- Designing the graph
- Constructing the graph
- Drafting the caption

Applications

- Effective instructions
- Effective electronic mail
- Effective Web sites
- Effective meeting reports
- Effective scientific posters

Trees, maps, and theorems

STRUCTURE IS A VIEW OF THE MIND. While one scheme may well seem more logical than alternative ones, none is inexorably prescribed by the material to be presented. Organizing material involves choice, so it allows optimization. The optimal structure is the one that makes the most sense for the audience. In other words, it is easy for the audience to recognize and remember, it can be navigated effortlessly even if not memorized, and it limits the need for navigation.

Organizing knowledge effectively requires a hierarchy: a tree, not a chain. At the same time, any instance of communication is trapped in time and forms a sequence: a chain, not a tree. At an elementary level, verbal discourse is indeed sequential: words, sentences, etc., are read or heard one after the other, and their order largely determines the meaning of the text. At a higher level, even reasonably self-sufficient components such as independent chapters, slides, or graphical displays are presented in a certain sequence. In an oral presentation, this sequence is imposed by the speaker; in a document, it is proposed by the writer but ultimately chosen by each reader, who elects both what to read and in what order to read it. Still, sequence there is: even highly selective readers cannot read two different chapters of a document at the same time.

Engineering our communication, then, is a triple challenge: we must organize our material into a well-balanced hierarchy, reveal this hierarchy through what is unavoidably a sequence in time, and ensure that the sequence we propose or impose suits the logic of the audience—and all of this, at all levels, from an entire document or presentation all the way down to a single sentence, which embodies the structure of an idea. Here again, effective redundancy is sure to help. A structure already revealed by verbal discourse can be visualized ideally by nonverbal code, processed globally. The layout of pages or slides (and, especially, of the table of contents or preview) thus plays a key role in revealing a structure to the audience.

How should I number the sections?

As a rule, use the so-called decimal numbering, as in *2.4.1* to indicate Subsection 1 of Section 4 of Chapter 2: it makes the hierarchy apparent. In contrast, selecting a single number or letter for the subsection, as in *IV* or *D*, fails to reveal its place within the overall structure: readers may not remember what it is the fourth part of, especially if they must interrupt their reading or when they are browsing through a document.

To remain readable, decimal numbering is best limited to three levels. Fourth-level headings, if any, can be set without a number. Similarly, when a book includes parts, the part number can probably be omitted from the numbering of the part's chapters, sections, and subsections.

Why a different number of levels and of items for written documents and oral presentations?

Listeners are in a far less favorable situation than readers to process the material presented: for example, they cannot choose their rhythm, cannot reread a part they did not understand, and have fewer visual clues about the structure (as offered to readers by a document's layout). They therefore cannot assimilate as complex a structure as readers can and should thus be presented, when possible, with simpler ones.

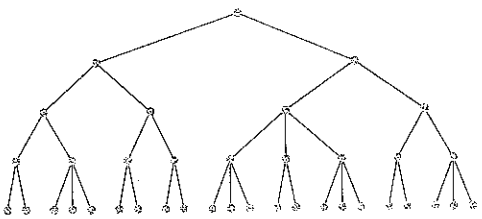
Also, presentations and documents normally differ in their purpose. Oral presentations are for convincing an audience of the key messages, while written documents more often attempt to convey a large or complex body of material. Presentations can thus typically accommodate a simpler structure, whereas (long) documents often require a somewhat more elaborate one.

Common ineffective structures

Long documents (reports, theses, procedures, etc.) tend to include too many levels in their hierarchy, perhaps with few items at each level—a structure that extends in depth, often with heading numbers such as 2.3.2.1.1.2 that no longer allow readers to visualize the hierarchy. Here, "too many levels" mean more than three or just more than necessary, as when there are almost more headings than text.

At the same time, there is of course nothing wrong with deeply structured thinking. What is suboptimal is turning each item of a mental tree into a heading. Perhaps each lowest-level item in one's mental tree can be written as one paragraph or one sentence, with fewer (levels of) headings in the tree structure.

Deep structure



Flat structure

Shorter documents for less specialized audiences, such as magazines and newsletters, often simplify the hierarchy to an extreme, keeping only one level of heading. In the process, however, they end up with many headings at this level—a flat structure, by no means easier to assimilate than a deep one.

For a well-balanced structure, generate for yourself a complete table of contents. Are there many levels? Many headings on few pages? Single subbranches?

Balancing the structure

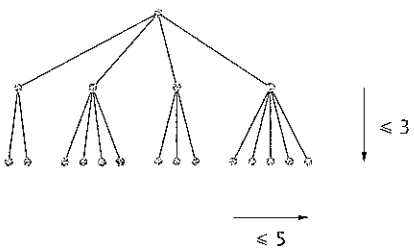
AN EFFECTIVE STRUCTURE IS HIERARCHICAL, not sequential. Furthermore, it consists of a limited number of levels and a limited number of items at every level. Each such item must form a meaningful entity—one comparable in scope to other entities at the same level, within and across branches. Items within a branch should be preceded by a component that gives a motivation for the branch, previews its structure implicitly or explicitly, and perhaps states its main messages. (The guidelines below apply to the levels of the tree revealed through headings and perhaps numbering, such as chapters and sections, not to levels such as paragraphs and sentences.)

As a rule, use fewer hierarchical levels than items per level, for we handle recursion with even more difficulty than lists. In written documents, endeavor to limit the number of levels to three—for example, chapters, sections, and subsections. If you must group paragraphs within a subsection, consider unnumbered headings, which would not appear in the table of contents. In oral presentations, limit yourself to one level for a short presentation, perhaps two levels for a longer one.

Limit the number of items per level, too, like you do for lists. In written documents, aim for no more than five subbranches for each branch, to afford readers a global view of the branch. Should you seem to need more, group closely related ones and substructure the entity thus obtained with paragraphs. If you have too many chapters, try grouping them into parts. In oral presentations, consider a body in exactly three points.

Before dividing a branch in subbranches, provide a global view. In written documents, include a paragraph (or more) between the heading of, say, a section and that of the first subsection. Among other things, this paragraph must let readers know what the subsections are, as a form of effective redundancy with the set of headings in the text and in the table of contents. In oral presentations, include a preview just before the body.

Well-balanced structure



With up to three levels in the tree (chapters, sections, subsections) and up to five items at each level, a balanced document could thus have up to $5^3 = 125$ subsections, which is plenty for most material. Exceptions to this limit of 5^3 are of course possible when justified.

Navigation: more than a Web site story

What is wrong with a detailed table of contents on several pages? Does it not enable readers to locate precisely what they are looking for?

Readers may or may not know what to look for in a document (or what the document calls it). When they do, they are best helped by an index, not a table of contents, no matter how detailed. When they do not, or more generally to form an overview of the material, they will normally go through the table of contents hierarchically, not sequentially, identifying first the chapter most likely to be of interest for their purpose, then the section within this chapter, and so on. If they cannot see the whole structure at once, they have to process it sequentially; they miss an overview of the major entry point (chapters).

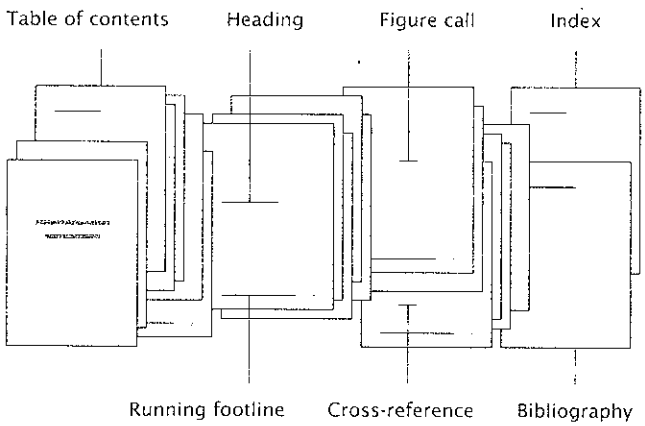
An alternative to limiting the number of levels presented is to provide two tables of contents: a global one, limited to the top level (chapters), then a fully detailed one. In a sense, the first is a table of contents of the table of contents.

Why must links use the wording of the map?

If links use a different wording from the map to express destinations, readers may be able to find whatever information they are seeking but not to visualize their itinerary, as the links point to places they cannot put on the map. Thus they cannot easily know when and why they might have been there before, which is a major factor in deciding whether to go there.

Using exactly the same wording on the map and in links is a simple issue of consistency: always calling a given thing by the same name helps the audience recognize this thing easily and avoids ambiguity—in links and elsewhere.

Hypertext, in a sense, predates the electronic age. While the term suggests clickable links (hyperlinks), the idea of linking a piece of text to another piece of text is not a recent one. And although new media open new possibilities, effective paper documents have provided for centuries both the motivation and the means for readers to jump to other parts of the page, to other pages, or to other documents.



Effective paper documents, in particular the longer and strongly structured ones such as books, carry a surprising amount of navigational information, both by nature and by contents. As physical sets of pages, they provide clues to where readers are, such as near the beginning. Numbered headings and running headlines or footlines can further help readers locate their current position in a structure already made explicit through a table of contents. This table, perhaps together with a text overview near the end of the introduction, enables readers to make informed decisions regarding where to go. So does an index, along a different logic. Finally, the references to bibliographical entries, to tables and figures, and to other parts of the document are as many "hyperlinks"—just not clickable ones.

Allowing easy navigation

AN EFFECTIVE STRUCTURE CAN BE NAVIGATED effortlessly if made visible. To this end, give the audience a map, tell them at all times where they are on the map, and tell them (when appropriate) where they can go with respect to the map.

Effective maps provide an immediate overview of the territory they chart. They usually include a strong visual component. In written documents, readers should see the tree structure at a glance in a table of contents before reading the first word. In Web sites, this table of contents, often called a site map, can be a two-dimensional diagram instead of a vertical list. In oral presentations, the preview can be shown on a slide, besides being spoken and perhaps underlined with gestures.

No matter how many pages it appears on in the end, too detailed a table of contents is hard for readers to process globally and, especially, to remember in a form that helps them navigate the document. Two levels is probably all they can absorb at first, even though a document can have up to three levels. For an oral presentation, subtract one everywhere: up to two levels in the tree, and one in the preview.

To provide an immediate overview, a map should be visible as a whole. As a counterexample, a table of contents running on several (double) pages offers partial views but no overview. Maps, however, need not display the complete depth: they can be limited to the top two levels, such as chapters and sections; each chapter can then include a local map, listing its sections and its subsections—not unlike road maps at different scales.

Audience members need to be reassured about where they are. Because they may wonder about it at any time, let them know at all times, for example in a running footline in a document. When it is impractical to do so at all times, as in oral discourse, let them know often, so they never have to wait long for help, should they feel lost at any time. To tell them where they are, use the same wording (or identifying picture) as on the map.

... protected by copyright.

A cryptic hyperlink: where does it lead?

... protected by copyright (see Terms of use for information on authorized reproduction).

A better hyperlink: it refers to the map and allows a better informed decision.

In written documents, audience members must also be told where they can go, as in a cross-reference in a paper document or a hyperlink on a Web site. So they can orient themselves and visualize their itinerary, indicate possible destinations like locations, with the same wording or picture as on the map. Provide whatever information will allow informed decisions.

Building from the top down

Is it not better to have the message as a climax, so as to maintain the interest of the audience?

Professional audiences listen to presentations or read documents chiefly because they hope to find in this way the information they need. They easily lose patience when what they read or listen to does not seem relevant to them, all the more so when they are pressed by time. Hence, they have little tolerance for suspense, at least whenever it lasts longer than an instant. Presenting last what an audience wants to know first or most of all is more likely to make them *lose* interest. Details acquire their full relevance and significance in the light of the conclusion.

Keeping the audience interested is not a purpose in itself, really; getting the message across is, and this does not require forcing the audience to read or listen to everything. If they "buy it" early, they need not go on reading or listening to the supporting details for us to be successful.

A message placed early has a practical benefit, too: if audience members must stop reading or listening at any time, they will more likely have read or have heard our message already.

Must I not detail everything I have carried out if only so others can reproduce my experiment?

In scientific publications, whatever experiments help support the conclusions must indeed be described in enough detail to allow replication. Still, *enough detail* does not mean every detail: it means every *relevant* detail. These details need moreover not stand in the way. Because they seldom, in themselves, convey messages, they can often be relegated to an appendix or, for a presentation, to a companion document.

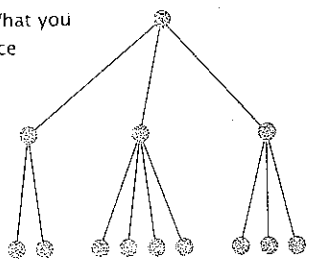
As a rule, identify your message(s) early, not only for your audience within a given written document or oral presentation but also, first of all, for yourself when designing this document or this presentation. If you do not quite know what you are heading for, you have no relevant way to select what to include and what to leave out: you will likely include more than what is necessary to get your message across. Identifying the message at the end of the process and relocating it upfront is better than leaving it at the end (or, worse, including no message at all), but it does not promote careful content selection.

Top-down approach applied to an oral presentation

1 **Main message** What you want your audience to remember

2 **Main points** What supports this message

3 **Subpoints**



Ask yourself first, *If my audience is to remember only one sentence from my entire oral presentation, what must it be?* The answer is your main message. Repeat the question at each level, broadening out as you go down (a few sentences, instead of one).

The top-down strategy works for entire documents or presentations and also for individual paragraphs or slides. Identify the message that the paragraph or the slide must convey; then—and only then—select the information and format that will convey this message optimally (instead of first developing the exact contents of the paragraph or slide, then searching for a suitable message to tack on to it).

Stating messages first

Motivation	Make the audience receptive to the topic of the document
Message	Once you have their attention, tell them your main message
Details	Next, support this message: tell them how you got there
Appendix	Last of all, present separately what fewer will want to know

AN EFFECTIVE STRUCTURE PRESENTS MATERIAL in the order in which the audience is most likely to want to learn it, thus minimizing the navigation required—or the impatience of an audience who cannot navigate, as in oral presentations. It presents first what the audience is primarily interested in and afterwards what is less important or less urgent to them. It presents separately what fewer of them will want to know (perhaps in a companion document for an oral presentation).

Professional audiences want to be told the message (that is, the *so what*) early, though not without proper motivation first, for messages make little sense out of context. They usually have little patience for "detective stories" that do not reveal the bottom line until the end. The details of an investigation are indeed largely irrelevant until we know the outcome of it. In other words, a chronological structure reporting work done in the order in which it was done, with conclusions at the end, works poorly: it focuses on the authors, not on the audience. An effective sequence presents first the motivation (the *why*), then the main message(s), and finally the details of the work.

A useful model, one that breaks the chronological paradigm, is that of mathematicians. When reporting their work, these normally present their conclusion first, calling it a theorem, then detail their hard work for those interested. In doing so, they strive to limit the details to whatever is strictly needed to prove the theorem, giving preference to the most elegant (that is, the simplest) proof of all. Thus a report is not a story of the work: it needs neither narrate every detail of the work nor report events in the sequence in which these took place.

The theorem–proof sequence is a useful model at all levels, not only for entire written documents or oral presentations, but also for single paragraphs or slides: these can usefully state a message upfront, then develop it verbally or visually, respectively—a prototypical way of getting messages across.

Prose is architecture,
not interior decoration,
and the Baroque is over.

— Ernest Hemingway

Effectiveness of assertion
is the alpha and omega of style.

— G. Bernard Shaw

Effective written documents

WRITTEN DOCUMENTS are valuable references. Although documents may well remain unread, they can also be reread many times or be read at the most convenient moment for each reader. In a context where many media compete for the attention of the readers, documents must allow each reader to assimilate effortlessly just what he or she needs to know. Their essential quality is therefore to be readable, that is, clear, accurate, and concise.

An effective way to go from scratch to a complete document proceeds iteratively in five steps. First, plan your document: gather your thoughts about the writing task. Second, design it: organize your material into a clear, well-structured hierarchy. Third, draft it: turn your ideas into paragraphs and sentences. Fourth, format it: take care of the visual component. Finally, revise it: test it and improve it iteratively until it is optimal, that is, the most effective it can be, given certain constraints.

Fundamentals

- The name of the game
- The three laws of communication
- A thousand words, a thousand pictures
- Chains and magical numbers
- Trees, maps, and theorems

Effective written documents

- **Planning the document**
  - Defining your purpose
  - Identifying your audience(s)
  - Selecting your content
- Designing the document
- Drafting the document
- Formatting the document
- Revising the document

Effective oral presentations

- Planning the presentation
- Designing the presentation
- Creating the slides
- Delivering the presentation
- Answering questions

Effective graphical displays

- Understanding pictures
- Planning the graph
- Designing the graph
- Constructing the graph
- Drafting the caption

Applications

- Effective instructions
- Effective electronic mail
- Effective Web sites
- Effective meeting reports
- Effective scientific posters

Planning the document

PLANNING IS THINKING about what we are to create. It thus means distancing ourselves from the situation and making sure we know everything we need to know in order to write an effective document. It is best carried out looking out our window, not staring at a text-processor one.

One systematic way to think about the document is to answer a set of questions about it. An effective and mnemonic set, unsurprisingly, consists of the five basic interrogative words starting with the letter *w*: *why*, *who*, *what*, *when*, and *where*. (The sixth interrogative *how*, conveniently not starting with *w*, is not an initial question: it points to the strategy, determined later on the basis of the answers to the other five questions.)

The five planning questions

Why	Purpose
Who	Audience
What	Content
When	Time constraints
Where	Space constraints

The five planning questions are not equally hard to answer. The constraints of time and space (*when* and *where*), critical as they are, are often easy to identify. Harder to determine are the purpose (*why*), the audience (*who*), and the content needed to reach this purpose with this audience (*what*). These three are tightly linked: the purpose expresses what the audience should (be able to) do after reading the document's content.

Planning need not take long but should be done with care, because it has a far-reaching impact. Poor planning results in unnecessary iterations before the writing process converges on the optimal document—when it has time to converge at all before the resources are up—and may result in writer's block (the inability to proceed with writing). The less time we have in total, the fewer iterations we can afford, and consequently the more time we should devote, proportionally, to planning.

When unclear initial ideas about the document to be created make planning hard, a possible strategy is to start drafting at once, in order to clarify our ideas. Sooner or later, though, we will need to go through the planning and designing steps, and to adapt our draft accordingly—an unavoidable iteration.

Should the purpose always be identified first?

Because it plays a deciding role, the purpose is often best identified first. Still, sometimes you know you need to react toward someone before deciding exactly what you want to reach, in which case you have identified your audience before determining your document's purpose.

I often have difficulties identifying my purpose. Any suggestions to make this process easier?

If you are writing a document at the request of someone (client, boss, etc.), ask this person what he or she identifies as the purpose for it. Placing the document in a broader framework helps, too. Is it, for example, part of a project? If yes, how is the document contributing to it?

When the purpose seems difficult to identify, an effective approach is simply to talk about it with someone else, such as a direct colleague. Talking out loud obliges one to turn thoughts into words, making them easier to work with. Your colleague will probably ask you questions, too, which will catalyze your thought process, and he or she might actually suggest a purpose.

What if I am convinced that the document I have been asked to write serves no purpose?

If you are deeply convinced that the document will make no difference, today or in the future, take up the issue with whoever has requested it, explaining that you can hardly write effectively without a clear idea of the document's purpose. (If the document is a contractual requirement, but you suspect that no one will ever read it, do write it, but do not spend much time on it.)

Common shortcomings

A communication purpose is more than a reason for writing: it gives a direction, suggests a strategy, provides a metric for success by enabling authors to visualize the outcome of the communication act.

A first typical shortcoming, then, is simply writing a document without having a clear purpose in mind. Indeed, many authors do have a reason for writing (*because my boss told me to report my research*) but do not visualize any potential or desired action on the part of the audience. The reason for writing can be confused with personal motivation, such as *I want to make an original contribution to science*, which can of course be a worthwhile pursuit in itself but does not constitute a communication purpose, because it does not involve the audience in any way. It is perhaps a motivation for carrying out the work but not for reporting on the work thus carried out.

Rational minds who do understand that a purpose for writing involves the audience may still fall short of identifying an observable outcome as part of it. They seem content with reaching the second step (*I want my audience to understand how it works*) and do not anticipate any action for the audience. The question these people might ask themselves is, *why do I want them to understand how it works?* Or perhaps, *how will I see that they understood?* That is, *what will this understanding in fact achieve?*

Finally, some otherwise clearly identified purposes may lead to ineffective communication strategies. Such is the case of purposes focusing on what are symptoms of excellence rather than sources of it (*I want my audience to be entertained by my text*) or expressing personal and often hidden agendas (*I want my boss to be impressed with my writing*). While these may well reflect legitimate aspirations, they offer no guarantee of helping authors reach a more fundamental professional purpose, namely get the audience to (be able to) act upon messages.

Defining your purpose

PURPOSES ARE THE ONLY METRIC against which to gauge the effectiveness of documents. A document is effective to the extent that it reaches its purpose—period. Accordingly, we can hardly determine the most suitable writing strategy without first having identified a purpose for our document. This purpose simply captures the change that the document is to produce: what must be different after it has been read? All communication is purpose-driven and, unsurprisingly, this purpose is defined in relation to both audience and author.

Effective purposes focus on the audience. They identify, not what the author should achieve, but rather what the readers should (be able to) do as a result of reading the document. This potential action may be understood broadly as anything involving the audience actively, even if only intellectually. Still, expressing it in observable terms helps envision a strategy: it is thus more useful to say we want the audience to *be able to disassemble the device* or to *sign the contract* rather than to *understand* or to *agree*, which cannot be observed as such. Audience-centered purposes moreover anticipate the purpose that readers bring to the communication: why will they read?

Although audience-centered, purposes acquire full meaning only in relation to an author. When identifying your purpose, identify your role in the communication: answer the question *who am I in relation to both my purpose and my audience?* or *why am I the person writing this document?* The audience will likely want to know, so be prepared to clarify it for them.

The purpose is implicit in the idea of getting messages across, defined as getting our audience to pay attention, understand, and (be able to) act upon our messages: it is the ultimate step. The first two steps, by contrast, are mere means to this end. For example, getting our audience to read a whole document is not a purpose in itself: if they (are able to) do what we want them to do without reading every word, so much the better.

Technical terms are not jargon

Since technical terms are so useful, how about using them for nonspecialists, too, but adding a glossary as an appendix to the document?

Readers can assimilate only so many new terms at a time, so beware of introducing too many. A glossary can certainly help, but it is best used redundantly: the (few) new terms must still be introduced in the text. If you include a glossary, let readers know about it, lest they never see it.

Is every reader really either a specialist or a nonspecialist?

As with all dichotomies, dividing the readers in just two groups is simplistic, and specialism is obviously a continuum that can be divided into as many groups as called for. For example, you might want to place your direct supervisor midway between specialists and nonspecialists: probably not quite as specialized as you are while still more specialized than most readers. Thinking in terms of just two groups, however, is a useful basis for reasoning about audiences.

For specialists, must I include conclusions? They can draw these themselves, right?

Readers as specialized as you are should be able to draw conclusions as well as you do, indeed. Of course, just because they can does not mean they will: interpretation is seldom trivial. Also, few readers are in as good a position as you are to interpret your own findings. It is therefore more constructive to include your conclusion and let the readers specialized enough to have an opinion on this conclusion disagree with it if they choose to. At least, you provided a basis for their thinking—and perhaps for a dialogue.

Technical terms are not the same thing as jargon. Defined in technical dictionaries, they are meant to make the document clear, accurate, and concise for as many readers as possible (within specialists). Jargon, by contrast, always reduces the readership to a "chosen few." It can happen purely by accident, such as when new employees unknowingly pick up company-specific terms and use these elsewhere. More often, though, it is caused by careless writing or, worse, by a desire to impress rather than help.

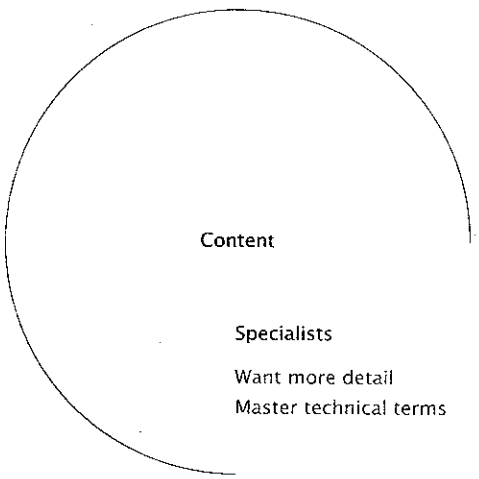
The 040 has a built-in 882.

The Motorola processor 68 040 has a built-in floating-point unit 68 882.

Technical terms are explicit, while jargon is cryptic. In the sentence *The 040 has a built-in 882*, readers who do not know what an 040 is would probably not know where to look for an explanation either. In the revised sentence, less specialized readers might of course not understand *floating-point unit*, but at least they have an idea of what the author is talking about (part of a processor) and they can also look for a definition in a technical dictionary.

Unexplained abbreviations easily become jargon: they needlessly exclude those readers who would understand the spelled-out form (including those who used to know this form and can use a reminder). Moreover, even a well-known acronym may expand to distinct meanings. Does *IP* stand for *intellectual property* or *Internet protocol*? Or *intraperitoneal*? Despite the presence of contextual clues, readers who readily recognize one meaningful expansion may not immediately think of the alternative ones (assuming that they are even aware of alternatives) and may therefore be misled, even if temporarily.

Identifying your audience(s)



AUDIENCES ARE MULTIPLE, for each reader is unique. Still, readers can usefully be classified in broad categories on the basis of their proximity both to the subject matter (the *content*) and to the overall writing situation (the *context*). The challenge lies not so much in addressing a given category as in dealing with a mixed audience. The strategy is twofold: identify which part of the audience matters for your purpose and, for written documents, layer the information presented, so each reader can access only what is relevant to him or her.

Although knowledge forms a continuum, readers can usually be placed in one of two groups: those who already know much about the subject matter (*specialists*) and those who know little about it (*nonspecialists*). Clearly, specialism is relative: everyone is a specialist on some subjects and a nonspecialist on others. Moreover, even a group of all specialists could be subdivided into more specialized and less specialized readers. As with any structure, the two groups are a view of the mind.

Specialists and nonspecialists differ in the type of information they are primarily interested in. Specialists want more detail: they can understand the technical aspects, can often use these in their own work, and require them anyway to be convinced. Nonspecialists need more basic information to bridge the gap between what they know and what the document discusses: more background at the beginning, to understand the need for and importance of the work; more interpretation at the end, to understand the relevance and implications of the findings.

Specialists and nonspecialists differ as well in the vocabulary they master: specialists readily understand technical terms; nonspecialists do not. Technical terms, whenever appropriate, are effective: they are both precise and concise, and they help present the author as a specialist, thus enhancing credibility. For nonspecialists, they should be replaced by paraphrases or, if they are particularly desirable, be carefully introduced.

Are primary readers specialists and secondary readers nonspecialists?

The two audience typologies are independent; that is, primary readers can be nonspecialists and secondary ones specialists. For example, most executives are not (or no longer) specialists of all that they read about as primary readers. Conversely, specialists (re)reading a document in the future are definitely secondary readers.

By definition, I am writing for primary readers, so why should I worry about secondary ones?

Above all, worry about the readers who matter for you to reach your purpose. A quick reply sent by electronic mail may acceptably include little or no context, because secondary readers are generally few and probably unimportant. In contrast, a document that is worth archiving is one for which secondary readers do matter. Contextual information for secondary readers is usually a useful reminder for primary ones, too. In general, then, documents can usefully address both primary and secondary readers.

To address secondary readers, how about simply referring to a previous document?

Referring to a previous document as a sole way of providing context is hardly reader-friendly: it obliges readers to find this document first and to search through it for whatever context they might need to understand the document they actually want to read—an ill-defined task. Most readers will therefore not bother to do so, hence their understanding will be suboptimal. Such a reference is best provided redundantly, for those interested in more context or history.

Keeping all readers in mind

Writing for a mixed audience is always a challenge: we must give to the secondary readers information that we assume the primary readers know already. How to do so, yet keep these readers interested? The solution, conceptually, is simple: just ensure that each sentence makes an interesting statement, one that is new to all readers—even if it includes information that is new to secondary readers only. This approach is illustrated in the example below, in which a few words of clarification go a long way.

> We worked with IR.

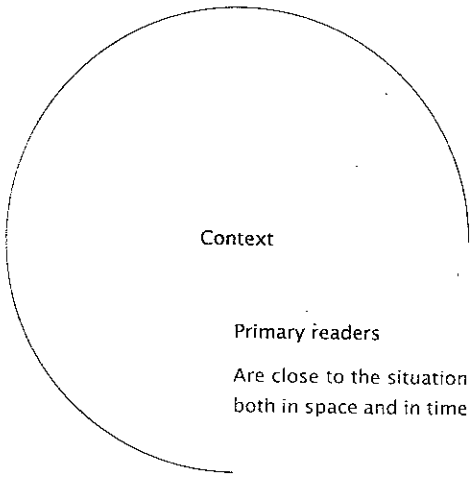
A statement involving an unexplained abbreviation is cryptic for secondary readers who do not know what *IR* is and are left to wonder about its nature: is it a chemical, a computer code, "infrared", etc.?

> We worked with IR. IR stands for Information Resources and is a new department.

Clarifying IR in an independent sentence, however, may be regarded as patronizing by primary readers. These then exclaim, *Hey, I know that!* when reading the second sentence, which tells them nothing new.

> We worked with the recently launched Information Resources (IR) department.

A sentence that is appropriate for all readers states something new to all, while including information that is new to some and a useful reminder to others. Secondary readers thus learn about IR. Presumably, primary readers know what IR is but may not have in the front of their mind that this department was "recently launched". While not telling them anything they do not know, these two words will put them in a certain frame of mind for their further reading.



Besides proximity to the subject matter, readers can be sorted on the basis of their proximity to the situation (the context), both in space and in time. Those close to the *here and now* are *primary readers*; any other ones are *secondary readers*. Clearly again, everyone is a primary reader on some matters and a secondary one on others, depending on their situation.

Primary readers are usually well-defined: they are the people we have in mind when we are writing the document. They are the ones expected to (be able to) act about the content of it and are thus listed under *to* in the header of short documents or electronic mail. Typical primary readers are our direct boss or colleagues, or our contact person at a client organization.

Secondary readers, on the other hand, are often ill-defined: they are the people who are sent a document for information (as listed under *copy to* or *cc*), but also those who obtain it via unpredictable routes, for example from a primary reader or from a library or archive. Typical secondary readers are distant colleagues, higher hierarchy, other people at a client's, or simply whoever will read the document in a few months or a few years (including, very often, the authors themselves).

Quoting the original information when replying to electronic mail is one example of context used as reminder for primary readers while informing secondary ones. Such quotes are best kept short (the minimum needed to remind readers of the point addressed).

To be understandable to both primary and secondary readers, documents must include context. Primary readers, who are close to the *here and now*, normally know the context but may not be thinking of it when starting to read; they benefit from a reminder, bringing it back to the front of their mind. Secondary readers, by contrast, are not (or no longer) aware of the context, so they need to find it in the document itself.

Context upfront not only broadens a document's readership, it is also essential for "getting our audience to pay attention": well phrased, it (re)establishes the importance of the subject and usefully prepares primary and secondary readers alike for the story told by putting them in a desired frame of mind.

Why must I be selective in a written document? Readers can select what they want to read.

You should admittedly be even more selective for an oral presentation than for a document. Still, unnecessary material dilutes the message. Moreover, lengthy documents are intimidating enough that their reading may be postponed (*I will read this big report... when I have time*), even when only a small part of them, such as the executive summary, must in fact be read. Should you nonetheless include much material, do give your readers the means to be selective by providing adequate navigational features. Just because readers need not read everything does not mean they know what they must read.

I am writing an article for a scientific journal: is my audience not made of specialists only?

Readers of scientific literature can be regarded as specialists indeed. Specialization, however, is relative, and few readers are as specialized as the authors, who usually studied the topic in great depth. Beware, therefore, of thinking that all readers already know what you know. Among less specialized readers are newcomers to the field, notably young doctoral students; people involved in multidisciplinary research, who are for example specialists of a technique but not of all the fields in which it is applied; and people having to review numerous papers or abstracts across a given field, as when serving on the program committee of a large conference.

Underestimating one's audience is not better than overestimating it, but it is less frequent. Broadening a document's readership without sacrificing accuracy is a worthwhile endeavor for scientific papers as for other documents.

Turning the story around

Deciding what to include in a document and what to leave out is difficult, especially when reporting on a large body of work. To select content effectively, we must first identify our main messages, that is, the conclusions of our work. Most people, however, draw conclusions as they are writing: expressing their thoughts into words catalyzes their thinking. Alas, this approach is all but selective: the authors are writing for themselves, not for their audience.

Typically, authors proceed in chronological fashion.

First of all, they describe almost everything they have carried out as part of the work they report on. — **Work done**

↓

Next, they write down everything they have obtained as a result of carrying out the work described. — **Findings**

↓

As a final step, they think about what they can conclude from it all (what readers want to know most). — **Conclusions**

A more selective approach to deciding what content to include in a report turns the chronology around.

First, figure out your conclusions, that is, select the main messages to be conveyed to your audience. — **Conclusions**

↓

Then, determine which findings are both necessary and sufficient to support your main messages. — **Findings**

↓

Finally, decide in how much detail to describe the part of your work that led to the findings reported. — **Work done**

Selecting your content

CONTENT SHOULD BE LIMITED to whatever material serves the purpose and should be organized in a way that suits the audience. In other words, we should be highly selective, including only the material needed, not all material available. Being selective requires having a clear vision before writing. If we do not, we may well have to write the document twice: once for ourselves, to figure out our main messages, and once for our audience, to get these messages across effectively.

Audiences are seldom, if ever, homogeneous: they combine specialists and nonspecialists, primary and secondary readers. Effective documents, therefore, elegantly address all of these: they provide enough detail for the specialists while enabling any nonspecialist to understand the motivation for the work and the outcome of it; they satisfy the needs of the readers *here and now* and of those far from *here* or years from *now*.

The key to addressing mixed audiences in a written document is structure. At their most global level (their *macrostructure*), effective documents place first the parts that most readers are interested in, then those parts that only knowledgeable and interested readers will read. At the most detailed level (the *microstructure*), effective sentences carefully interlace new material with known material, to offer enough to readers who know less without appearing patronizing to the others.

Effective documents for any audience also take into account the purpose that readers bring to the communication. Thus they anticipate and answer the questions that these readers are likely to have, not only by including the right information but also by presenting this information in the right sequence. These questions may not match the ones we have as authors. In describing work we did, for example, we may be interested in the *how* when readers want to know the *why*, *who*, and *what*. We may thus want to clarify why we did the work, including perhaps who asked us or in what capacity we decided to do it.

Fundamentals

- The name of the game
- The three laws of communication
- A thousand words, a thousand pictures
- Chains and magical numbers
- Trees, maps, and theorems

Effective written documents

- Planning the document
- Designing the document
  - Breaking the chronological model
  - Including a global component
  - Designing fractal documents
- Drafting the document
- Formatting the document
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Effective oral presentations

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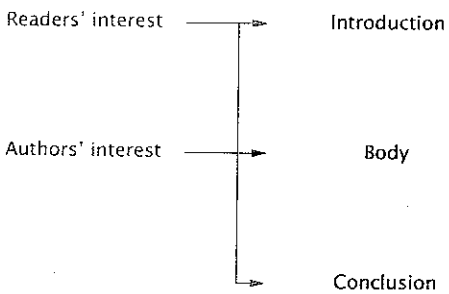
- Understanding pictures
- Planning the graph
- Designing the graph
- Constructing the graph
- Drafting the caption

Applications

- Effective instructions
- Effective electronic mail
- Effective Web sites
- Effective meeting reports
- Effective scientific posters

Designing the document



PLACING FIRST what readers are primarily interested in: there lies the foundation of effective document design. Readers, however, have other interests than authors: there lies the explanation for so many ineffective documents. Effective documents are audience-oriented, not self-centered.

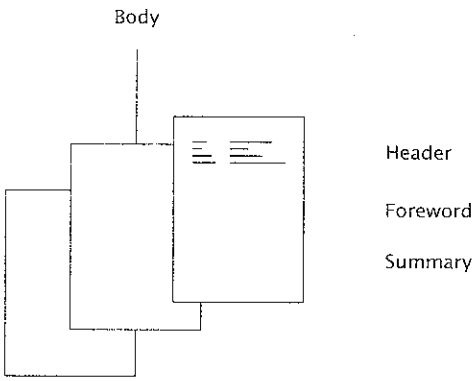
Authors all too often report their work in a chronological way. They present the motivation for the work in an introduction (the *before*), detail this work in a body (the *during*), and report its outcome in a conclusion (the *after*). In this way, they match the work process closely, often all the way to the relative time spent on each part: many authors spend much time writing the body of their reports or articles, exactly like they spent much time carrying out the work, but devote comparatively little time to writing both the introduction and the conclusion.

Readers, in contrast, are primarily interested in the motivation for the work and in the outcome of it, not in the work itself. First of all, they need to relate the work to a broader context much more than they need to understand how it was done, all the more so if they are nonspecialists or secondary readers. Next, they want to know how they are affected by this work, that is, what the findings of the work mean in their own case. In a chronological document, they thus read the introduction, then often go straight to the conclusion, skipping the body. Specialists might later read (parts of) the details in this body, if only to convince themselves of the validity of the conclusion.

A chronological structure, in other words, is straightforward for authors but suboptimal for readers: it requires navigation. Effective document designs, therefore, break the chronology: they place first what the readers are primarily interested in. This first component also provides readers with a global view that helps them assimilate details, should they read (parts of) the body. Such a global component can usefully be included in front of more detailed material at any level in the document.

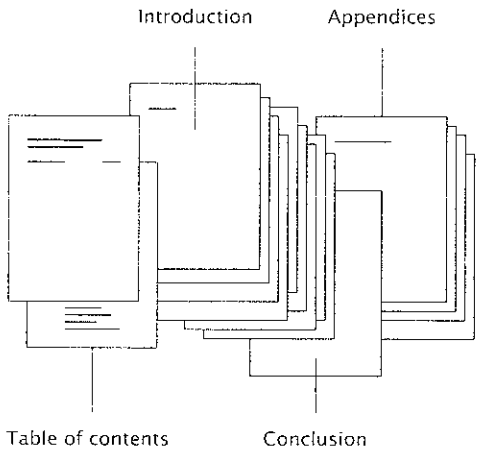
Designing short and long documents

Short and long documents alike usefully include a global component that makes sense on its own, whether or not it is redundant with any other part.



When the document is short (a few pages, perhaps) and addresses a homogeneous audience, it need not be abstracted: the foreword would not differ sufficiently from the introduction, whether in extent or in technicality, and neither would the summary from the conclusion; in each case, one of the two is enough. Still, the document can usefully present the material in the order in which readers want it, with the motivation for and outcome of the work upfront—together with the header on the first page. You can think of the resulting structure equivalently as having an abstract but neither an introduction nor a conclusion or as having, in fact, no abstract but a conclusion placed right after the introduction. Either way, what follows the first page is the body.

A multipage letter can include a global component, too, and be signed at the bottom of the first page, with more detailed material on subsequent pages, perhaps each with its own heading. You can choose to think of it as a one-page letter with attachments instead of a multipage letter, but the idea remains.



When the document is longer than just a few pages and all the more so when it is supposed to address a mixed audience of specialists and nonspecialists (two conditions that are frequently met in practice), it does benefit from including a redundant abstract. Indeed, the introduction and conclusion are likely too long to constitute a useful global component and too technical for the less specialized readers. A distinct global component, made of a foreword and a summary inspired by (but not copied from) the introduction and conclusion, will tell all readers what they want to know first of all and most of all. Ideally, it fits on the very first page, with the header.

Although documents may display the abstract as one block of text so as to be economical with paper, they should nonetheless include both motivation and outcome in it, that is, the *before* and the *after*.

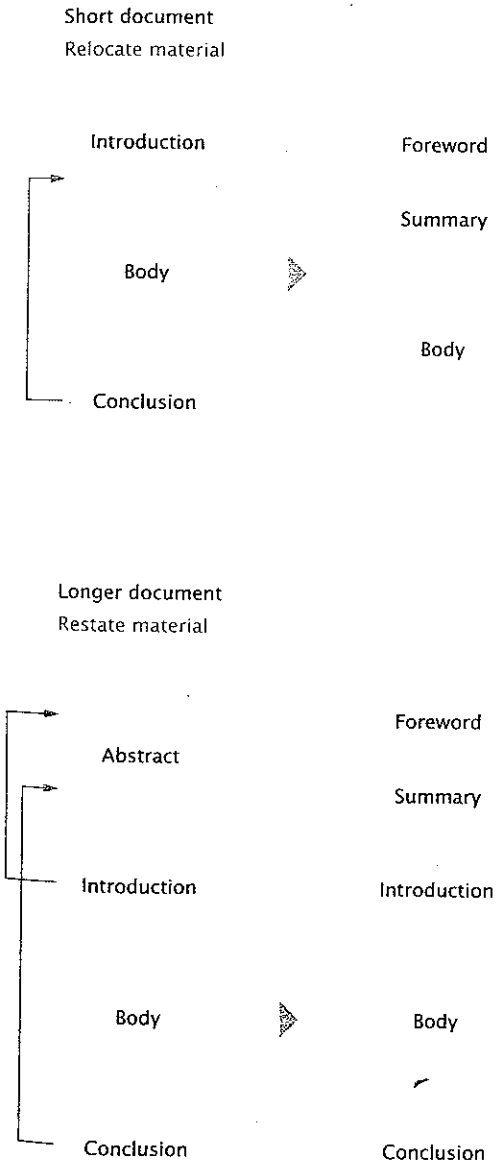
Breaking the chronological model

THE READERS' PRIMARY INTEREST in the *before* and *after* suggests two strategies for effective design. First, devote sufficient time to drafting the introduction and conclusion, for these parts are typically read first of all and most of all. Second, order the material, not *chronologically*, but logically, that is, in the order in which readers are most likely to read it.

A chronological story can be made reader-friendly in two ways. One way is to relocate the conclusion after the introduction, before the body; this solution works best for short documents and for homogeneous audiences, such as nonspecialists only. Another way is to maintain the chronological structure as is but to precede it with a component that restates, in a concise and somewhat different way, what readers want to know first, as a form of effective redundancy most appropriate for longer or more complex documents, addressing mixed audiences.

Short or long, documents can thus usefully include a global, stand-alone component, stating upfront the motivation for and outcome of the work. Accordingly, this global component, known under such names as *abstract* or *executive summary*, comprises two parts: the *before*, usually known as *foreword*, and the *after*, usefully named *summary* in a restricted sense. These two parts vary widely in absolute and relative lengths from document to document, even if they are best kept short. An abstract, in other words, is all but a condensed full story: in a sense, it reports the starting point and the end point only.

Global components serve many purposes. By telling the story in a compact, audience-oriented way, they are the only parts that most readers need to read: they thus save these readers much time and effort. For those readers who end up reading the whole document, they provide the necessary framework to understand and mentally structure the subsequent details. For all potential readers, they are a powerful selection tool: they help them decide whether to read (parts of) the document.



Is the foreword identical to the introduction?

The foreword has exactly the same structure as the introduction, but it is normally shorter and also less specialized than the introduction. It must indeed be understandable to all readers, including less specialized ones. These readers, typically executives, may have different stakes in the need than the specialists. This difference is reflected in the foreword and introduction.

If it seems hard to write a foreword that differs from the introduction by being either shorter or less technical, you might apply the strategy for short documents: in place of an abstract, relocate the conclusion after the introduction.

How can I write an abstract for documents that are in essence detailed, such as minutes of a meeting, specifications, or procedures?

The foreword should pose no specific problem: it accounts for both the document and the work that led to it, as usual. For example, it explains why a meeting was needed, who called it, etc.

The summary can in this case best be regarded as what the audience needs to know most of all or what will help them understand the details. For a meeting, it includes decisions and actions. For specifications (and for similar documents), it might be what is new or special about them, or simply an overview of the device specified.

Is an objective the same as a need?

An objective is half a need only: it corresponds to the desired situation but does not capture the actual one. As such, it fails to justify a task.

Equivalent terms

The proposed model of global component (abstract) is applicable to almost any professional document reporting some "work done" in the broadest sense. Because it builds on the universal interest shown by professionals in the motivation for and outcome of the piece of work reported, it is just as effective for a business report as for a scientific publication. Still, it is traditionally called or described differently by different professional or even corporate cultures. Below are equivalent terms frequently encountered.

Abstract (the generic term used here) is often used in academic writing but less so in the business world, where a report's global component is usually called *executive summary*, because it enables executives (who are often less specialized) to make decisions. Scientists, engineers, and managers alike may also speak of an *extended summary*, usually to suggest that it encompasses both the motivation (foreword) and the outcome (summary in a restricted sense). A foreword is sometimes called *purpose statement*, because it justifies both the work and the document.

The items in the abstract have several names, too. You may prefer to think of the *need* as a *problem* or an *issue*, but these may be needlessly restrictive: the need may be an *opportunity*, too; furthermore, an intellectual need may be thought of as a *question*. A *task* requested by others can be called a *mission*; one focusing on the means more than on the people can be regarded as the *approach* or *method* used. The *object of the document* is sometimes labeled *rhetorical purpose* (although this term is also used for the foreword as a whole, resulting in confusion); when it announces the structure of the document, it can be regarded as an *overview* or as a *preview*. The *findings*, when numerical, are the *main results*. The *conclusion* is the *main message*, also known as *take-home message*, a term perhaps more used for oral presentations. Finally, the *perspectives* are also known as *future work* or perhaps *next steps*.

Including a global component

TO TELL READERS what readers primarily want to know, abstracts include two parts: a foreword and a summary. The foreword, which is similar in nature to the introduction, focuses on the situation *before* the work was done. In contrast, the summary, which is similar in nature to the conclusion, focuses on the situation *after* the work. Effective abstracts include little or no information from the document's body.

The foreword accounts for both the work and the document. First, it states the need for the work reported, as a difference between the actual and desired situations, possibly preceded by whatever context helps understand this need better. Next, it states the task carried out, without detailing what was done. (Strictly speaking, because it corresponds to the *before* part, it states what the authors had decided or been asked to do; usually, this is what they actually did, too.) Finally, switching from a content point of view to a rhetorical one, it establishes the object of the document, that is, what the document does or covers, and possibly what the readers should do with it.

Foreword The *before*	Context	Why the need is so pressing or important
	Need	Why something needed to be done at all
	Task	What was undertaken to address the need
	Object	What the present document does or covers
Summary The *after*	Findings	What the work done yielded or revealed
	Conclusion	What the findings mean for the audience
	Perspectives	What the future holds, beyond this work

The summary states and, especially, interprets the outcome of the work. First, it mentions the findings or main results. Next, it clarifies what these findings mean, given the audience and the need. So doing, it may recommend a course of action for the audience to address the need. Beyond looking back at the need, it might look ahead and offer some perspectives.

Formulating tasks and objects

What exactly is the difference between task and object? Can these not be combined?

Task and object differ in focus. Schematically, the task states what the authors did, whereas the object establishes what the document does. The first thus focuses on the work carried out; the second, on the communication of this work. Should you combine the two, focus on the task (*Therefore, we developed a new method to* ...), rather than on the object (*This paper presents a new method to* ...): the task follows the need more logically and clarifies who did the work. Also, beware of mixing up places and tenses, as in *In this report, we measure* ..., which makes no sense: you do not in fact measure anything in the report; you did so, presumably, in the lab.

What does the task become for a review paper?

As author of a review, you can regard your job as reporting the work of others, in which case you sum up this work, collectively, in the task (*Over the last twenty years, researchers have* ...), or as reporting your review work, in which case you state so in the task. The need, of course, must be adapted; in the second case, it must be the need for a review of research in the field.

Should a scientific abstract include an object?

The object of the document must orient readers as to the document's contents and structure, so they can decide whether (or what) to read. When it merely repeats what the need and task already state or clearly imply, it is best omitted. Such is often the case for experimental work, for which the body is predictably structured as *Materials and methods, Results, Discussion.*

Of the many ways to formulate tasks and objects, some are more logical or more readily recognized.

The task must clarify not only the work carried out but also the agents who carried it out. If these are the authors of the document (the most usual case), it is best phrased in the active voice and first person (*we measured, we developed, we implemented*, etc.). If not, as for a review paper, it is logically phrased in the third person, preferably in the active voice (*In recent years, researchers have investigated* ...), more informative and usually more readable than an impersonal construct (... *has been investigated*).

The task can be effectively connected to the need by a phrase before the subject. A simple *therefore* is usual enough, but the desired part of the need is often an elegant option (*To increase the speed, we redesigned* ...). This initial phrase can be used to clarify any requesting party, too (*At the request of the Senior Management Team, we redesigned* ...).

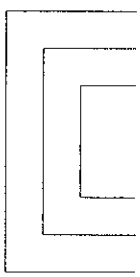
The object, in contrast, focuses not on the authors but on the document itself. Thus, it can best use the document as grammatical subject of the clause (*This report summarizes, This paper presents*, etc.). Such a phrasing is equally appropriate for objects of parts of the document (*Chapter 3 compares* ...).

Task and object differ also in the tenses they use. The task, like all references to the work carried out, is best set in the past (or the present perfect) tense. The object, like all references to actual documents, is atemporal and thus best set in the present tense.

Whereas choosing a grammatical subject for a task or an object is straightforward (*we, this report*, etc.), selecting a suitable verb for it is more challenging. Did we *examine, analyze*, or perhaps *investigate*? Does the document *present, explain*, or *report on*? The verb, not the subject, carries the strength here.

Thinking in concentric layers

Abstracts can be thought of as made of four concentric layers. At the center is "communication," a rhetorical layer focusing on the document. Around this rhetorical layer is a "work done" layer, consisting of the task (*before*) and the findings (*after*). It focuses on the authors, who usually have carried out the task and generated the findings. Around this "work done" layer is a "problem–solution" layer, comprising the need (*before*) and the conclusion (*after*). This one focuses on the readers, who, presumably, are concerned by the need and must have the findings interpreted, in view of this need. Finally, around this "problem–solution" layer is an optional "situation" layer, comprising the context (*before*) and the perspectives (*after*). It focuses neither exclusively on the readers nor exclusively on the authors (perspectives might involve either of them); in a sense, this is an "anyone" (or an "everything else") layer.



Context	Anyone	
Need	Readers	*What you want ≠ what you have*
Task	Author(s)	*What I/we did to address the need*
Object	Document	*What the document does/covers*
Findings	Author(s)	*What I/we found, doing the task*
Conclusion	Readers	*What these findings mean to you*
Perspectives	Anyone	

Established from a chronological point of view (*before/after*), the abstract in two distinct parts can easily be reinterpreted in terms of the motivation (the *why*) and outcome (the *what*). The first part (the *before*) might be known to some readers, for these might well have pointed out the need and ordered the task, so the news appears in the second part (the *after*). Still, the first part not only informs those who did not know, it also prepares those who did to assimilate the message(s) optimally, by reminding them of the context and of the need, thus placing both the task and the document in perspective.

Common suboptimal abstracts

While any abstract missing one or more components is suboptimal, three types are particularly frequent: *promissory*, *out of the blue*, and *self-centered* ones.

Promissory	Out of the blue	Self-centered
Context		
Need		
Task		Task
Object		
	Findings	Findings
	Conclusion	
	Perspectives	

An abstract including the motivation (the *before*) but not the outcome (the *after*) is most frustrating: it promises but does not deliver, obliging readers who would have had enough with a good abstract to dig in the details in an effort to find the message. It is perhaps acceptable as a proposal submitted to a selection committee long before a conference but far less so as the abstract of a final document.

An abstract including the outcome (the *after*) but no motivation (the *before*) comes out of the blue. The findings, appearing first, are easily confused with context. Moreover, the conclusion is usually impossible to understand properly without a need. While it may seem acceptable to primary readers, well aware of the need and task, an out-of-the-blue abstract is cryptic for secondary ones, who are not.

An abstract that is limited to a task and findings, with no real motivation (need) and no real message (conclusion), is self-centered: it ignores that which the audience most wants to know. It makes them wonder what this document has to do with them, as well as what they are supposed to do about it.

The need is well known to my audience. Should I still include it in the document?

A need is bound to a point in space and time. It might be known to primary readers, but not to secondary ones. Moreover, primary readers seldom have it in mind as they begin to read and might not see it the way the authors see it. A carefully stated need thus puts all readers in a favorable frame of mind for their reading.

The foreword part of the abstract establishes motivation and, to some extent, relationship. It always plays an important role. Of course, it can be brief or presented as already known, especially when the audience is clearly defined (it might start with *As you may remember, ...*).

Is having the motivation in the introduction not enough? Why should it be in the abstract?

Whereas titles are the very first selection tool, abstracts are the main one. If an abstract fails to include motivation, readers are more likely to stop reading than to look for it elsewhere, such as in the introduction—all the more so when the abstracts are available free of charge, whereas the full documents must be purchased.

I must write an abstract limited to 100 words. This is very short. Can I drop any item at all?

When the number of words is severely limited, condensing or combining items is preferable to suppressing any, for all of them play a role. When needed, context, need, and task can often be written as one sentence (*In the framework of ... and in an effort to ..., we investigated ...*). At times, the object can be expressed implicitly.

Conveying the motivation and the outcome

The two key questions, *why* and *(so) what*, can be associated symbolically or mnemonically to the two parts of the abstract and, within these parts, to each item, with its respective slant.

The first part of the abstract implicitly answers the question *why* at every step. The context answers the question *why now*: it explains how the recent history and current situation led to the need. If reader-oriented, the need implicitly answers the question *why you*: by reading it, readers should perceive the document's relevance to them, that is, understand why it was sent to them or decide whether to select it for reading. In turn, the task implicitly answers the question *why me/us*, clarifying what the authors have to do with the stated need. Finally, the object answers the question *why this document*, that is, *given the need and the task, what are the document's purpose or contents? And what should we, readers, do with it?*

Why? Motivation	Context	Why now	*My/our or your current situation*
	Need	Why you	*Why this is in fact relevant to you*
	Task	Why me/us	*What I/we have got to do with it*
	Object	Why this document	
What? Outcome	Findings	What	*What resulted from the task done*
	Conclusion	So what	*What these findings mean to you*
	Perspectives	What now	*What I/we or you should do next*

The second part of the abstract similarly answers the question *what* at every step. Thus the findings merely state the *what*, that is, *what have I or we found by carrying out the task?* The conclusion (the message) answers the question *so what*, typical of readers who cannot guess whether some findings mean good news or bad news, or how good or how bad it is. Closing the outermost loop of the multiply nested structure, the perspectives, like the context, focus on temporal aspects and answer the question *what now* or, equivalently, *what next*.

What is wrong with a heavily technical abstract? If readers do not understand it, can they not see that they are not part of the intended audience?

Giving up on a document because one plainly does not understand is such a negative choice. Is it not infinitely more constructive to enable all potential readers to understand our abstract and, with this understanding, decide rationally whether they can benefit from the document?

Unlike the document, the abstract will be read by virtually all readers, be it as a selection tool. Consequently, a reader-friendly abstract is one that is understandable to the least specialized of our readers (while still useful to specialists).

Should I write the abstract first or last, that is, before or after writing the complete document?

Writing the abstract after the whole document usually makes for better abstracts. Writing it before the document, however, usually makes for better structured, more selective documents. Perhaps you can write abstracts first *and* last?

In a similar way, writing the introduction early typically makes, not for better introductions, but for better research, because it helps clarify, for the authors at this point, what they have, what they want, and how they hope to find it.

Must foreword and summary be labeled thus?

The foreword and the summary do not need to be labeled; neither, in fact, does the abstract. Global components, be they abstracts or other, are mainly identified as such by their location. Above all else, they must be in the right place.

Creating useful headers

Whatever the document is, the header must allow its correct routing, filing, and selection for reading or other processing, such as destruction. Readers mostly select on the basis of the title and author(s), so these should be prominent. Equally important yet too often absent in online documents is a date and, for unambiguous reference, a unique identifier, such as a reference number. This identifier should then appear on each page next to the page number, so the page can be traced even if it becomes loose.

The title of a report or of an article, or, equivalently, the *subject* of a memorandum or electronic mail, is a challenging element to write. To remain visual, it must be kept short—a question of visual length on paper or on the screen more than of word count. The question is, what do we tell in these few words?

Titles, like documents, can be structured effectively in two parts: a global one and a more specific one, perhaps separated by a dash or a colon, or written as a title and subtitle. The two parts work together like a funnel, gradually narrowing down the topic (*Project meeting on Fri 20 Apr: revised agenda*). Used in isolation, the first part would be too vague (what about the "project meeting on Fri 20 Apr"?) whereas the second one would lack its framework (the "revised agenda" for what meeting?). The titles of related documents can have the same first part and distinct second parts, making for easy sorting (*Project meeting on Fri 20 Apr: list of attendees*).

Whether the distribution list is part of the header is debatable. Clearly, it plays a role for selection, as when recipients want to know whether they are listed under *to* or under *cc*. In any case, it should not stand in the way of more important information. When it is long, it is best moved out of the header and onto a page of its own, inserted where it can easily be located without being overly prominent, such as after the first page—or after the last one.

Allowing informed decisions

The abstract, with its two parts, allows two decision moments. After reading the first part (the motivation), readers can gauge their interest for the topic and for the document. Only those who care enough about both will go on reading. After reading the second part (the message), they can normally take action about the need and, again, decide whether to quit or read on. This decision will be influenced by their confirmed interest but depends largely on their need for the details. Specialists typically want the details, either because they can use them in their own work or because they wish to assess the quality of the work done and, with it, the credibility of the message.

Header	Title		
Screening	Author(s)		
		Is this for me?	If *yes*, go on to the foreword
Foreword	Context		(If *no*, then stop reading now)
Motivation	Need		
	Task		
	Object		
		Do I care?	If *yes*, go on to the summary
Summary	Findings		(If *no*, then ...)
Outcome	Conclusion		
	Perspectives		
		Do I need more?	If *yes*, go on to the document

A very first selection tool, however, is the header preceding the abstract, specifically the document's title and author(s), and possibly the mention of the reader's name under *to* or *cc*. The global component of a document is thus best regarded as comprising three parts: header, foreword, and summary. For most documents, notably short to medium-length reports, the three parts together should ideally not exceed one page, as it increases the probability of their being read immediately, as opposed to the report being set aside for later selection. Having to turn a page seems to be quite a psychological barrier.

Below is the executive summary of a short report addressed by the tax officer to the CEO and CFO at Amazing Belgian Chocolates (ABC), in preparation for a meeting in which the issue will be discussed; the other members of the committee appear in *cc*. All of them are aware that ABC, selling its products on the Belgian market, owes Value Added Tax (VAT) to the Treasury, while sister company Choc Export, exporting ABC's products, can claim VAT refunds.

As of April 2007, the Belgian legislation authorizes VAT consolidation among the members of a group. Such a VAT group could be an opportunity for us at Amazing Belgian Chocolates and for our sister company Choc Export: our VAT payments could be used to offset their (notoriously slow) VAT refunds, positively affecting the cash flow of both companies. Filing a consolidated VAT return for the VAT group thus formed, however, would require that we adapt our accounting practices as well as our IT systems.

As a first step toward evaluating the benefit for us of forming a VAT group together with Choc Export, I prepared a rough estimate of the potential savings and, in agreement with our CFO, Linda Thielemans, I contacted a tax consultant at Van Belle & Partners to verify that ABC and Choc Export meet the criteria for constituting a VAT group under the new decree.

In preparation for our upcoming committee meeting on Wed 13 Jun, this note sums up my findings so far and maps out what I identify as the next three steps, to be discussed in committee and approved by you.

My rough estimate suggests consolidated savings in excess of 20 000 euros per year, and the reply from Van Belle & Partners is positive on all points. Accordingly, I recommend that we move forward with the project by carrying out these three tasks: (1) with the accounting teams of both companies, evaluate the required adjustments to the systems and the costs associated with implementing them; (2) if the anticipated savings exceed these costs, request authorization from the VAT administration; (3) once it is authorized, implement the VAT group.

The context, limited in this case to a single sentence, is sufficient to situate the need in both time (April 2007) and space (Belgium). Next comes the need, presented as an opportunity, not a problem. All the same, it represents a gap between ABC's current situation and a more favorable alternative, which is desirable for the readers.

Given the audience of executives, the task is explicit on processes. The author's function (tax officer), normally indicated in the header, can justify that she went ahead and "prepared a rough estimate" but perhaps not that she engaged expenses for legal consultation, so the task clarifies that the CFO backed her. It also indicates who the consultant is, thus answering a possible question from the CEO.

The object of the document says not only what the report covers but also what the readers should do with it (prepare the meeting).

The summary in itself (findings, conclusion, perspectives) is set here as one solid paragraph, but, if longer, it could also be divided in two or three paragraphs, as is the case for the foreword above. Conversely, this foreword could be set as a single paragraph, too: at less than 200 words, it is still reasonably short. Which option is best (one paragraph or several) depends also on the page layout.

Below is a possible abstract for a scientific article published in a journal (abstracts of research reports for internal use in an organization would be similar). Such an abstract addresses other researchers. Still, in an effort not to be needlessly technical, it limits acronyms to those strictly useful for conciseness: thus, it introduces *ILT* (which it uses three times), but it avoids *AAA* for *abdominal aortic aneurysm*, even though this acronym is used in the article itself.

Context — provides background for less specialized readers and, so doing, establishes or recalls the importance of the problem.

An aneurysm in the abdominal aorta will rupture as soon as the wall stress exceeds the wall strength at any location, thus threatening the patient's life. Elective surgical repair, however, is costly and risky. Evaluating wall stress to predict the risk of rupture is therefore essential toward patient management, yet current models suffer from several limitations. Among others, they do not consider the presence of an IntraLuminal Thrombus (ILT), a fibrin structure present in variable degrees in 75% of aneurysms. Using computed tomography and finite elements, we investigated whether the presence of ILT alters the distribution or the magnitude of the wall stress in aneurysms of the abdominal aorta. This paper reports the wall stress distribution in four patients and discusses the impact of the ILT configuration.

Need — motivates the audience by stating the difference between the desired and actual situations.

Task — states what the authors undertook to address the need, in the first person (*we*), past tense.

Object — clarifies what the paper covers without repeating the task, in the active voice, present tense.

Findings — state the main results in a way that both less and more specialized readers find helpful.

In all four patients, the presence of an ILT altered the stress distribution and reduced the peak stress by 6 to 38% ($p = .067$), depending on the geometry. As a consequence, it should be taken into account in any patient-specific model of aortic aneurysms for evaluating the wall stress and the risk of rupture. Still, it may also adversely affect the wall strength and will therefore remain the focus of future work.

Conclusion — interprets findings (states the *so what*)—in this case, all the way to a recommendation.

Perspectives — broaden the view with any further needs and tasks.

With just under 200 words, the above abstract can convey the motivation for and outcome of the work with some accuracy, without intimidating readers by its length. Still, and when allowed by the journal, it is best set in two paragraphs (foreword, summary). An abstract under 150 words is challenging to write; one over 250 words is seldom justified for an article.

Common shortcomings

Should every item at every level begin with a global component?

If an item constitutes a meaningful entity, surely there is something general to be said about it, before each of its constituent parts is detailed. At the very least, you can prepare the readers for the item's structure, even if this structure is already shown by a set of headings. Indeed, headings are often seen but not read. Moreover, they are not seen together when the item spans several pages, so they provide no global view.

Can the global component of a chapter or section be its first section or subsection?

The global component of a chapter or section is really a level above sections or subsections: it belongs to the chapter or section as a whole, so it is best placed directly under the heading of this chapter or section, before any heading of section or of subsection. (As a minor point, doing so results in a clearer page layout, too.)

Is an object still required when readers are used to a structure (for example, when it is identical to that of matching items in other documents)?

Primary readers might be used to a structure, but any secondary readers, almost by definition, cannot be: an object is thus a necessity for them and may be a useful reminder to other readers. However, avoid presenting as new something that is known to your readers, lest you appear patronizing. If the structure is usual, say so. For a section on *Results*, you might thus write *As usual, our results come from three areas: ...*. You would list here the areas in question again, before discussing each of them in a subsection.

As a clear confirmation of the usefulness of telling the beginning of the story and the end of it together in one place, some scientific journals now require that authors announce their conclusion at the end of the introduction. Similarly, many authors start the conclusion section (at the end of the document) by restating the need, the task, or even the object of the document, which appear in the introduction. Introductions or conclusions structured in this way, while well-meant, needlessly duplicate the abstract. With a well-written abstract, readers are equipped for the complete article; the introduction should be limited to the *before*; the conclusion, to the *after*.

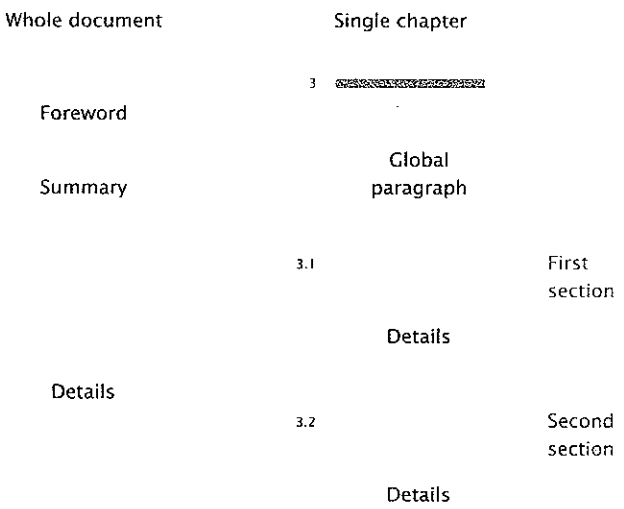
Even if deemed unnecessary as part of the abstract, the object of the document should certainly appear in the introduction, typically as a final paragraph starting with *This document is organized as follows* and then listing what each chapter or section covers, preferably in the active voice (*Chapter 2 reviews ...*). The chapters or sections, in turn, should include a global paragraph upfront, to orient the readers.

Two headings that follow each other immediately, such as those of Section 2.4 and Subsection 2.4.1, are usually an indication that a global paragraph is missing. At times, however, the first subsection is precisely what is needed for a global paragraph, so we can simply delete that subsection's heading (and, of course, renumber the subsequent headings). Usually, the heading thus deleted was of little use, as in *General description* or *Preliminary remarks*.

The presence of a paragraph between the heading of a section and that of its first subsection does not, in itself, guarantee an effective mental preparation of the readers for the structure ahead. In particular, such paragraphs often miss the *object of the section*, (the local equivalent of the object of the document), especially when they have been built by relocation of other items, rather than written for the purpose.

Designing fractal documents

EFFECTIVE DOCUMENT DESIGNS ARE FRACTAL. They exhibit an identical structure—global component, then details—for the whole document and for each of its constituent items at any level, such as the chapters, sections, and subsections, in fact all the way down to the level of individual paragraphs.



Like documents, chapters (or sections or subsections) should begin with a global component, perhaps just one paragraph, typically located before the heading of the first subbranch (for a chapter, before the first section). This global paragraph might contain any and all items of a foreword and summary. At the very least, it must include an object, preparing readers for the chapter's structure, but it can also usefully set forth a motivation for the chapter or the chapter's main messages.

Chronological chapters (or sections or ...) can often be turned into global-detailed ones in the same way that documents can. Any conclusion section, for example, can be moved upfront as part of the chapter's global component and be suppressed where it was—or for long chapters, be restated briefly upfront.

Fundamentals

- The name of the game
- The three laws of communication
- A thousand words, a thousand pictures
- Chains and magical numbers
- Trees, maps, and theorems

Effective written documents

- Planning the document
- Designing the document
- **Drafting the document**
  - Stating and developing messages
  - Expressing ideas
  - Being clear, accurate, and concise
- Formatting the document
- Revising the document

Effective oral presentations

- Planning the presentation
- Designing the presentation
- Creating the slides
- Delivering the presentation
- Answering questions

Effective graphical displays

- Understanding pictures
- Planning the graph
- Designing the graph
- Constructing the graph
- Drafting the caption

Applications

- Effective instructions
- Effective electronic mail
- Effective Web sites
- Effective meeting reports
- Effective scientific posters

Drafting the document

CAREFULLY WRITTEN DOCUMENTS are reader-friendly, just like carefully designed software is user-friendly. They are simple and direct, trying to help the readers, not to impress or confuse them; in a word, they are readable. They not only contain the right information in the right place but also phrase this information in a way that is easy to read. Hence, they allow readers to spend as little time as possible on the text and as much of it as possible on the ideas expressed.

Readable written documents are clear, accurate, and concise. They carry a single, readily understandable meaning. They tell "the truth, the whole truth, and nothing but the truth." And they achieve clarity and accuracy in as few words as possible. Clarity, accuracy, conciseness (in that order) are the priorities at the level of the paragraphs, sentences, and individual words.

Text entities at different levels have different functions, hence they may require different approaches for optimal readability. Paragraphs convey messages, ideally in a stand-alone way: each paragraph thus states its message first, then develops it in theorem-proof fashion. Sentences state ideas, in one-to-one correspondence: short sentences can express simple ideas, while longer sentences are required for more complex ideas. Well-chosen words contribute to a clear, accurate, concise text.

Writing simply does not suggest simplifying the material but conveying the complexity of this material in the simplest way, something many of us have learned to do about mathematics. We thus have been taught to "simplify fractions," for example to replace 679/194 by the more readable, yet equivalent $^{7}/_{2}$; we have seen the advantage of a change of coordinate system to describe an object or a phenomenon with simpler equations; we have been rewarded for deriving the "most elegant" proof of a theorem. Still, when useful, we know how to approximate, that is, to simplify the material to the desired level of accuracy, as when writing $\pi \approx 3.14$, which is in fact a correct statement.

Must every paragraph convey a message?

Every paragraph must have a unifying theme (a reason for its sentences to be set together) and must serve the purpose of the document. Often, this theme is a message, but not always. An introductory paragraph, for example, may not hold a true message, expressing a *so what*. Conversely, a one-paragraph abstract typically comprises several messages, at various levels. Whether or not its theme can be considered a true message, each paragraph should orient the readers as to its content and its structure.

I find it difficult to ensure that each paragraph states a message upfront. Any suggestion?

As much as possible, determine what you want to say with each paragraph before you write it. You could even write all the first sentences first, that is, before writing the rest of any paragraph, as a way to envision the structure of a section. Together, these sentences answer the question, *what ideas must my audience remember here?*

After writing, you can inspect each paragraph. If the message is at the end, move it to the front, adjusting the paragraph as needed. If there is no message, question the paragraph's function.

Is there a maximum length for paragraphs?

Each paragraph should have whatever length it needs to develop its message appropriately. Some might be short—as short as one sentence, perhaps—while others are comparatively long. Long paragraphs can be visually intimidating, though; paragraphs that must get the attention of the audience are therefore best kept short.

Stating the message upfront

Paragraphs that fail to clarify their topic upfront are frequently misleading. In the example below, the first two sentences suggest that the paragraph discusses "single-use, disposable medical devices," then the third sentence reveals that what it does, actually, is compare two types of medical devices.

> Single-use, disposable medical devices are packaged and sterilized by the manufacturer. Their packaging must provide protection, facilitate sterilization, maintain sterility, ... Reusable devices, by contrast, must be ...

> Medical devices may be broadly divided into two categories, disposable and reusable, having different sterilization requirements. Single-use, disposable devices are packaged and sterilized by the manufacturer. Their ... Reusable devices, by contrast, must be ...

More common than a missing topic is a message that appears too late and therefore lacks visibility. Such is typically the case in a paragraph structured chronologically with its conclusion at the very end, thus giving the proof before stating the theorem, or one postponing the *so what* until after the *what*, as when describing a figure before interpreting it.

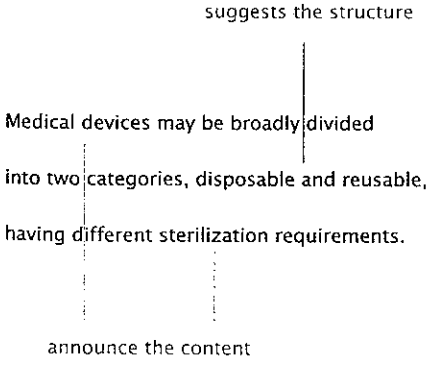
> Figure 2 shows the evolution of the Ge content in the SiGe layer. Obviously there is a nearly linear decrease of the Ge content with increasing fluence. Knowing the ...

> The germanium content decreases linearly with increasing fluence (Figure 2).

Stating and developing messages

PARAGRAPHS ARE THE ESSENTIAL structuring components of the document: they appear even in short documents that are not otherwise divided into sections, such as letters. They retain document characteristics that sentences do not. First, paragraphs—like documents—tell a story of their own: effective paragraphs remain understandable even in isolation, whereas many otherwise effective sentences do not. Second, paragraphs convey messages: each states and develops one.

Paragraphs, like full documents, should remain meaningful (to a point, that is) even out of context. Each paragraph must have its reason for being, namely to convey a certain message. Conversely, each message usually deserves its own paragraph: one paragraph per message and one message per paragraph. Paragraph size then simply depends on message complexity: more complex messages typically require longer paragraphs. As with sections, the optimal granularity is also a question of balance between paragraph length and paragraph number: few long paragraphs are hard to read; so are many short ones. In most cases, a sequence of one-sentence paragraphs makes little structural sense: messages are stated but not developed.



Effective paragraphs, like effective documents (or chapters), state their message early, ideally as early as the first sentence. A well-written first sentence, not unlike a well-written abstract, enables the readers to decide whether to read the paragraph, by announcing its content and by suggesting its structure. With prominent key words, first sentences help the readers locate quickly the paragraphs that are most relevant to them or find again some information they remember having read. By reading the first sentence of every paragraph, the readers should be able to form a good idea of the document's content.

After stating its message, an effective paragraph develops it along an appropriate structure, typically revealed by the way in which the various sentences are connected to one another.

Need paragraphs always be parallel or serial?

Paragraphs need not always be entirely parallel or entirely serial. They may use a combination of the two structures, or be "pseudo-parallel," (lining up comparable yet not identical subjects). To be readable, however, they should not miss opportunities for a parallel or serial structure, such as introducing a switch in subject (A – C) that does not reflect a switch in topic (yielding A–B C–A, instead of the parallel link A–B A–C) or positioning a new item (C) before an item (B) mentioned in the previous sentence (yielding A–B C–B, rather than the serial link A–B B–C).

Is the parallel structure not boring to read?

Parallelism may seem to encourage repetition. Not so, however: unpleasant repetitions must of course be removed lest they become noise, but not by uncalled-for variations in structure. When attempting to "parallelize" a paragraph, you can remove resulting repetitions by using pronouns and by combining related sentences, not unlike rewriting $3ax + 5ay$ as $a(3x + 5y)$.

How should I punctuate a displayed list?

The rules for punctuating displayed lists vary from book to book (and language to language). Whichever you decide to apply, be consistent. For written documents, consistency suggests using in lists the general rules of punctuation and capitalization: thus, capitals and periods for full sentences, and commas or semicolons to separate phrases or clauses within a sentence. For oral presentations, the desire to be visual may suggest dropping the punctuation marks in lists (and perhaps in some other text items).

Drafting effective lists

Common not only in written documents but also on oral presentation slides, lists too often exhibit shortcomings that render them plainly ineffective. Lists are for displaying comparable items in a way that encourages their comparison or memorization, not for making a loose set of items look organized. Whether they are displayed (with or without bullets) or typeset as part of a solid paragraph, lists should

- comprise few items (in other words, five or fewer), to allow their nonsequential, visual processing;
- introduce the items by a clause (or part of one), to let the readers know what the list is about;
- phrase all items in a grammatically similar way, to reflect in the form the parallelism of content.

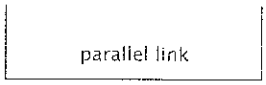
The manner in which the items are phrased should obviously be a grammatically correct continuation of the introductory component. The use of bullets to reveal items does not alter the rules of grammar.

- To prepare a meeting, define its purpose
- You must also prepare an agenda
- Everyone should receive this agenda
- Does everyone know who the others are?
- The chairperson should not be secretary
- Ground rules may be appropriate, too
- Always review the purpose and agenda

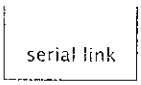
When preparing a meeting,
- define the purpose and agenda,
- send the agenda to all participants.

As you start the meeting,
- welcome and introduce participants,
- clarify the roles (chair, secretary, etc.),
- set up ground rules if appropriate,
- review the purpose and the agenda.

The nozzle includes a scatterer. It is easy to mount.



The nozzle includes a scatterer. This scatterer is easy to mount.



Above all else, sentences within a paragraph are connected by content: one element in a sentence, normally its subject, points to an element in the previous sentence. A reference to the previous subject is best done with a personal pronoun (*it*, *they*, *we*, etc.), whereas a reference to the previous object or other item appearing at the end of the previous sentence is best indicated by a demonstrative adjective (*this*, *such*, etc.). By analogy with elementary electrical circuits, we might call the first case a parallel link and the second case a serial link.

Parallel or serial links can be repeated for several sentences: a parallel structure lines up sentences with the same subject,

Recent years have seen an increased popularity of codes based on the Diabolo algorithm. Speed is a main advantage of these codes, compared to the traditional Demon ones. Also, one can implement them reasonably easily, and it is possible to extend them so they can handle hybrid transforms. On the other hand, they require about 45% more memory, but this is less critical with today's architectures. Typical applications are ...

> In recent years, codes based on the Diabolo algorithm have become increasingly popular. Compared to the traditional Demon codes, they are about twice as fast, are reasonably easy to implement, and can be extended to handle hybrid transforms. As a drawback, they require about 45% more memory, a less critical limitation with today's architectures. Typically, they are applied to ...

whereas a serial structure chains sentences by using what is introduced in one sentence as the subject of the next sentence.

All current implementations of the Diabolo algorithm are based on the so-called Angel transform. F. Angel first described this transform in [2]. The idea is to separate the data into high and low values before proceeding with generation. The implementation then stores the high and low values separately ...

> All current implementations of the Diabolo algorithm are based on the so-called Angel transform. This transform, first described by F. Angel [2], separates the data into high and low values before proceeding with generation. The high and low values are then stored separately ...

Both structures can be used to construct entire paragraphs. The parallel structure, using the paragraph's topic as subject of all its sentences, is the more readily applicable of the two. The serial structure is well suited to introductory paragraphs, organized from general to particular, and to substructures, for example within a more complex parallel-serial paragraph.

Common shortcomings

I have been told to write in the active voice. How can I then use the topic as the subject?

Do not confuse *active voice* and *first person.* The subject of a verb in the active voice need not be a person; it can be an inanimate object, as in *This paper presents* or *The results show.* Even if you choose to write in the first person, the topic is largely expressed in the verb, too. If you write *we decided,* readers will understand that the sentence is about a *decision* you made, although this word is not the sentence's subject. If all the sentences use *we* as subject, however, readers may feel you are talking about yourself.

I can recognize instances of main information in a subordinate clause, but how can I fix them?

To improve an instance of main information in a subordinate clause, proceed in two steps, as follows. First of all, delete the main clause, so the subordinate clause is now the main one. Then, identify what you have lost, if anything, and add it back, keeping your new main clause.

As an example, if your original sentence reads *Figure 3 shows that the simulation worked well,* first delete *Figure 3 shows that*: your sentence now simply reads *The simulation worked well.* You have, however, lost the link with Figure 3; just put it back, either as a subordinate clause (*As Figure 3 shows, ...*) or simply in parentheses at the end: *The simulation worked well (Fig. 3).*

In contrast, if your sentence is something like *It was observed that the simulation worked well,* you lose little by deleting *It was observed that.* Quite on the contrary, the simpler statement *The simulation worked well* has more impact, especially as the first sentence of a paragraph.

To avoid a passive voice, authors may end up using a subject that is in fact not the paragraph's topic.

> Table 5 summarizes the results of our tests. These results show the superiority of ...

> The results of our tests are summarized in Table 5. They show the superiority of ...

or better, with the details in a subordinate clause,

> The results of our tests, summarized in Table 5, show the superiority of ...

Focused on their work, scientists too often describe an observed phenomenon in a subordinate clause and state in the main clause that it was observed.

> Figure 2 shows that, in most experiments, the rate was lower at higher temperature.

> In most experiments, the rate was lower at higher temperature (Figure 2).

Impersonal main clauses of the form *it is ... that ...* also relegate the message to a subordinate clause, weakening the point they try to draw attention to.

It is clear that ...	Clearly, ...
It is obvious that ...	Obviously, ...
It is a surprise to us that ...	Surprisingly, ...
It can be concluded that ...	In conclusion, ...

Expressing ideas

SENTENCES ARE FOR CONVEYING IDEAS. Well-constructed sentences, therefore, stem from well-constructed ideas or, conversely, suggest clear and accurate ideas to the readers. Effective sentences reveal the structure and sequence of ideas logically, yet without taxing the readers' short-term memory.

With each sentence, strive to convey one idea and one only. How long the sentence should be thus depends on the idea expressed. Simple ideas can be conveyed in simple sentences consisting of an independent clause; complex ideas require complex sentences, then consisting of a main clause and one or more subordinate clauses. What constitutes a single idea is of course a view of the mind. As recommended for sections and paragraphs, an optimal division into single ideas strikes a balance between few long sentences and many short ones.

A sentence (or a clause) consists of a subject and a predicate, that is, a verb phrase asserting something about the subject. Because subject and verb are central in conveying meaning, they should be selected with care. As a rule, use the "subject" of the expressed idea as grammatical subject of the sentence. If all sentences in a paragraph cover the same topic, this topic can consistently be the subject, yielding a parallel structure.

When writing complex sentences, state the main information in the main clause and relegate the subordinate information to subordinate clauses. Such sentences prioritize the ideas, giving maximum impact to what is most important. They can effectively address mixed audiences, by placing the *new to all* in the main clause and the *new to some* in a subordinate one.

We agreed last week that I would contact Van Belle & Partners about VAT consolidation between ABC and Choc Export. I just did. They believe that the criteria set forth in the April decree for constituting a VAT group are satisfied by these two companies. This means that we can now move forward with ...

As we agreed last week, I contacted Van Belle & Partners about VAT consolidation between ABC and Choc Export. In their opinion, these two companies satisfy the criteria set forth in the April decree for constituting a VAT group. Consequently, we can now move forward with the idea ...

Keeping together what goes together

Is there a maximum length for sentences?

There is no absolute maximum for the length of a sentence, especially when this sentence comprises several clauses: readability stems from structure, not length. The average length of sentences is nonetheless best harmonized with that of paragraphs, to avoid an imbalance.

In languages that locate the verb, or part of it, at the end of a clause, the length of this clause is a direct measure of distance between subject and verb, and should then be kept reasonable.

How can I fix an overly long subject, while keeping it in subject position?

Admittedly, turning a sentence around makes the subject become the object, so it may well shift the sentence's focus in an unwanted way. As an alternative, especially for long subjects that are lists of items, try a forward reference. Instead of writing *..., ..., and ... were carried out*, put the list beyond the sentence (after a colon), and simply replace it by a phrase pointing to it, as in *The following three tasks were carried out.*

Should I rely on readability formulas?

Formulas assessing the readability of a piece of text on the basis of its average word length, average sentence length, and similar measures have little applicability to educated audiences. Most were developed for school-age children reading in English as their first language, hence they must be extrapolated with caution, if at all. For example, educated non-native speakers are often more familiar with long technical terms than with short words having several meanings.

A long subject with a short predicate may be logical, but it is difficult to process. It is a common issue with tasks or objects expressed in the passive voice.

A finite-element simulation of the principal component's critical subparts was performed.

We performed a finite-element simulation of the principal component's critical subparts.

Equally difficult to process is a new item positioned before an item that refers to the previous sentence.

.... Chapter 4 of the *Safety handbook for the laboratory* discusses this issue.

.... This issue is discussed in Chapter 4 of the *Safety handbook for the laboratory.*

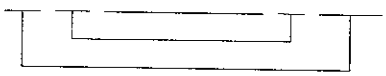
Finally, long parenthetical information in the middle of a sentence is best relocated at the very end of it.

Two hours later, a standard breakfast, consisting of 4 slices of buttered bread, 1 slice of cheese, 1 slice of ham, jelly, and 2 cups of coffee or tea, was served to the subjects.

Two hours later, the subjects were served a standard breakfast, consisting of four slices of buttered bread, a slice of cheese, a slice of ham, jelly, and two cups of coffee or tea.

Although logically constructed, some sentences prove hard to read because they strain the readers' short-term memory. When two related sentence parts, such as a subject and a verb, are far away from each other, readers must store the first part in their short-term memory (not knowing what to do with it) while processing the sentence further; only when they reach the second part can they attribute meaning to the two together. A similar difficulty arises when the two related sentence parts are close to each other, but the first one happens to be long.

Dick, who, when Jane arrived, left, returns.



Although short, the above sentence is hard to read because of its embedded structure (a subordinate clause within another one).

What makes a sentence hard to read, then, is the necessity to store items before they can acquire meaning. In contrast, sentence length, frequently decried as hindering readability, is but a symptom: the longer the sentence, the higher the risk of taxing the short-term memory of the readers. Short or long, however, sentences with two or more levels of nested clauses will likely be hard to read. In contrast, carefully constructed long sentences can be almost as easy to read as short ones, while conveying relationships that short sentences could not.

In other words, look out for distance issues in your writing: keep together what goes together, within and across sentences, and place short items before long ones as much as possible. Moreover, to help readers figure out quickly how a sentence relates to previous ones (so they need not store it to do so), show links with connection words: conjunctions, adverbs, etc.

Some information is intrinsically hard to convey in a sentence, no matter how well written. It might then be better conveyed more visually, for example as a formula, a table, or a diagram.

The sensors were built on a silicon substrate prepared with 370 nm SiO_2 and 160 nm Si_3N_4, and consist of a 215-nm-thick Ti/Pt heating element, 165-nm-thick TiW/Au electric contacts, and a 286-nm-thick SnO_x gas-sensitive layer.

The sensors were built on a silicon substrate made of SiO_2 (370 nm) and Si_3N_4 (160 nm). They consist of three layers:

▩	a heating element	Ti/Pt	215 nm
▩	a set of electric contacts	TiW/Au	165 nm
▩	a gas-sensitive layer	SnO_x	286 nm

Rational minds never do anything

Is the passive voice always suboptimal?

The passive voice can be effective, for example to use a certain topic as the sentence's subject, as part of a parallel or serial structure. Its use must not be judged in isolation but in context. (Used as a default, however, it is suboptimal.)

Can I write "the authors" instead of "we"?

Writing *the authors* is as accurate as writing *we* (except near a reference call, where it might seem to designate the authors of the document referred to). However, it is not equally concise.

Can I clarify the agent with a reference call?

Writing *It is believed [5]* in an attempt to mean *The authors of [5] believe* remains ambiguous. All the reference call indicates to the readers is that they can find more on this belief in [5].

Are there ineffective uses of the first person?

The first person is best used exclusively to refer to the authors for tasks, decisions, beliefs, etc. If used too often or in reference to other people, it loses impact through dilution. For example, it is unnecessary for objects of the document. Instead of writing *In this chapter, we present*, write about the chapter: *This chapter presents.* Also unnecessary in most documents is a *we* designating the reader and the author together, as in *We see in Equation 4 that* ..., a first person that ends up relegating the main information to a subordinate clause. (Such a collective *we* might be useful in tutorials, but it should then not be mixed with a *we* that means *the authors.*)

In an attempt to sound objective, many documents seem to imply that their authors never do anything. A task as simple as *We analyzed the data* typically sees its agent removed (*The data were analyzed*) and often its action verb nominalized (turned into a noun): *An analysis of the data was carried out.* Authors might have been taught in school, usually without rationale, never to write in the first person, or have figured it out from the documents they read. Powerful cultural influences quickly lead to myths: many authors now regard the first person as taboo.

More than a question of style, the widespread use of the passive voice raises an issue of accuracy—the concern here is the missing agent, not the voice or grammatical person, even if the three are linked. Admittedly, the agent may not matter or might be understood from context; in such cases, however, the outcome likely matters more than the action: *The analysis of the data indicated* .... Often, though, knowing *who did it* makes a difference to readers, so a task almost always requires an explicit agent. As another example, the main clause *It is believed* is ambiguous: it may be interpreted equally well as *The authors believe* or as *The community believes.*

Overuse of the first person unpleasantly suggests that the authors are in fact writing about themselves, not about their topic. As an alternative, authors can focus on outcome, not action, and clarify their role with a first-person subject in a subordinate clause (*The option that we selected is* ...) or a possessive (*Our analysis suggested a new course of action:* ...), in particular as part of a parallel or serial structure. A collective is another option (*The team decided* ...).

In documents having a single author, a first person plural (*we*) not otherwise clarified lacks accuracy (the author and who else?). It is thus best replaced the first time it appears by an explicit expression: *My supervisor and I* or *My department*, for example.

Being clear, accurate, and concise

WORD CHOICE AFFECTS READABILITY: unusual words make a text unclear; uncalled-for passive voices make it inaccurate; wordy expressions make it longer than necessary. Typing or language mistakes are a major source of noise, too.

For clarity, use words with a known, unambiguous meaning for your audience. Thus, for specialists, use technical terms, but avoid jargon. For nonspecialists, prefer common words, used consistently; avoid synonyms. For non-native readers, beware of so-called false friends (*faux amis*) and of words with multiple meanings; avoid idioms and cultural references.

For accuracy, select each sentence's subject and verb carefully. Identify the agent whenever this agent matters to the readers, as with verbs that imply a human judgment or responsibility, such as *decide*, *believe*, or *recommend*. If you are the agent, consider using a first person. Express the action with a verb, not with a noun. By default, cast this verb in the active voice, even with an inanimate subject (~~*with this method, the volume is underestimated*~~ → *this method underestimates the volume*).

For conciseness, use the shortest phrase allowing the desired level of clarity and accuracy. Avoid ineffective redundancies (*fewer* ~~*in number*~~), wordy expressions (~~*in the event that*~~ → *if*), and nominalizations (~~*perform an examination of*~~ → *examine*). Replace frequently used phrases by acronyms, typeset these and these only in capitals, and introduce them systematically. To avoid repetitions, try combining closely related sentences.

The number of triangles that are used to describe a mesh can be scaled up or down. This can be achieved by performing edge collapses and vertex splits, respectively, as shown in Figure 6.

The number of triangles used to describe a mesh can be scaled up or down through edge collapses or vertex splits, respectively (Figure 6).

Conciseness is a second-draft optimization. On a first draft, concentrate on expressing messages clearly and accurately. Then look for opportunities to say the same in fewer words.

Fundamentals

- The name of the game
- The three laws of communication
- A thousand words, a thousand pictures
- Chains and magical numbers
- Trees, maps, and theorems

Effective written documents

- Planning the document
- Designing the document
- Drafting the document
- Formatting the document
  - Designing intuitive page layouts
  - Achieving simplicity and harmony
- Revising the document

Effective oral presentations

- Planning the presentation
- Designing the presentation
- Creating the slides
- Delivering the presentation
- Answering questions

Effective graphical displays

- Understanding pictures
- Planning the graph
- Designing the graph
- Constructing the graph
- Drafting the caption

Applications

- Effective instructions
- Effective electronic mail
- Effective Web sites
- Effective meeting reports
- Effective scientific posters

Formatting the document

FORMATTING IS ABOUT STRUCTURE, not about aesthetics. An effective page layout conveys the structure visually, as a form of effective redundancy, yet without drawing attention onto itself, lest it create noise. Like careful phrasing, it goes unnoticed: readers take note of content, not of form.

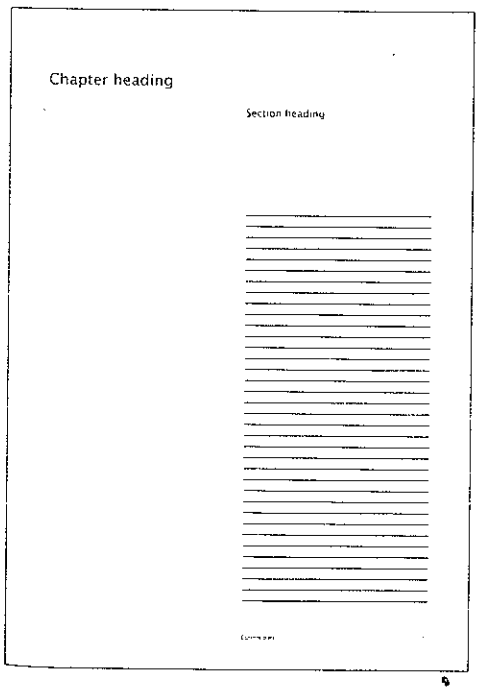
Visual structure is primarily a matter of spatial arrangement (where items are) and secondarily a matter of visual aspect (how items look). Much can be achieved with spacing alone: the margins and the possible indentations, the line spacing, the space between paragraphs or between headings and text, and juxtaposition, clustering, or alignment of items on a page. Type variation, such as a change in face, size, weight, or color, should merely reinforce what is already conveyed by position.

In contrast to text, a page has two dimensions. A page layout can do more than break a text into a vertical sequence of lines: it can use the horizontal dimension of the page, too, to enrich the visual structure and thus provide additional entry points to the readers. For example, a narrower main column of text (as on this page) leaves space for illustrations and other items directly next to the text, thus opening up a second dimension.

Creating a page layout is more than tinkering with a text file. It requires coming up with a global picture of the final page. This picture can be described as a design grid: a set of points, lines, and areas that guide the positioning and dimensioning of all items consistently and harmoniously across the pages.

Aesthetics, of course, does matter—ugliness distracts. Still, it is best regarded as a consequence of effective formatting, not as a purpose in itself. Even beautiful pages should reveal the structure and thus invite the readers to process the texts, not dazzle the readers to the point that they not wish to read. More than beauty, formatted pages should possess elegance, a quality implying appropriateness, simplicity, and harmony.

The grid used for the right pages in this book, showing the column of text (right) and the grid subset for aligning the illustrations (left).



Should drafting always precede formatting?

Logically, a text must have been drafted before it can be formatted, so *drafting* appears before *formatting* in the methodology proposed here. Still, the format might pre-exist or be designed before the text is drafted. Layout constraints, as on the length of texts, should be identified early, so the texts can be optimized accordingly.

Should I prefer boldface or italics for emphasis?

Boldface and italics have different properties. One can notice bold words merely by looking at the page, without actually reading any text. As a consequence, boldface should be reserved for that which readers must notice at a glance, that is, almost solely navigational information: headings, "pseudoheadings" such as *Warning* next to a warning (but not the warning itself), and identifiers such as *Figure 4* under a figure (but, again, not the caption itself). Bold words within a sentence make little sense: typically, they cannot be assigned meaning in isolation. Italicized words, by contrast, do not stand out at a glance but still provide enough emphasis to stand out when the sentence is being read.

How can I use color optimally?

Color in page layout is a dangerous temptation: use it whenever it helps convey the structure, not whenever you can. Use it redundantly, too: not everyone distinguishes colors equally well. Unless you master color design, use few colors, perhaps just one (besides black) in a few tints. Design the page in black and white first, then apply color in touches wherever it adds value. Of course, use this color scheme consistently.

Common shortcomings

As a common violation of the proximity principle, many reports formatted with direct-manipulation text processors show headings as close (or closer) to the previous paragraph as to the next paragraph, probably as a typing error, not as a design choice.

3.2 Implementation ▷ 3.2 Implementation

Ideally, any piece of text should be typeset in a way that keeps together what goes together. In practice, however, few can. Among these few are headings on more than one line, which can be cut by hand.

3.2 Implementation in the long term ▷ 3.2 Implementation in the long term

Finally, many documents leave little empty space on the page and thus afford little design freedom. Often, they attempt to make headings prominent by setting them in a much larger or heavier type, which looks cramped between paragraphs of text. In most cases, a heading need not be (much) larger than the body text; instead, it needs enough space.

3.2 Implementation ▷ 3.2 Implementation

Designing intuitive page layouts

PAGE LAYOUTS, like all visual displays, should be intuitive: they should use no arbitrary codes; rather, they must rely on natural principles of proximity, similarity, prominence, and visual sequence. An effective layout reveals the structure of a page at a glance, before the readers even start reading.

When designing a page or spread, group related items visually. Leave more distance between unrelated items than between related ones. For example, leave more space above a heading (between the heading and material preceding it) than below it. Display a caption closer to the corresponding figure or table than to other items on the page, such as other figures or tables. Avoid breaking a line of text between tightly connected items, as in cross-references (Figure|9) and values with units (4|km).

To be intuitive, be visually consistent: format identical items identically, similar items similarly, different items differently. For example, format all same-level headings in the same way (same typeface, type size, relative position, etc.). Conversely, format headings at different levels in visibly different ways, not only in the document, but also in the table of contents. Strive for visual consistency within each document separately but also across comparable documents, as within a collection.

To indicate hierarchy, display more prominently those items that rank higher or that are more important. For example, leave more space around the higher-level headings, set them in a larger or heavier type, or combine several such features. Prominence stems from contrast, so beware of visual inflation: the more items you emphasize, the less they will stand out.

Finally, make sure that each page guides the readers visually along a useful reading sequence or, alternatively, that it gives a clear picture of possible entry points. Where will readers likely look first? Why? Is this where you want them to start? Where do you want them to go next? Is the transition clear?