

I would use a descriptive summary. (5) of summary you might length restrict to write an informative have room for only arts, on the other hand, i. For that reason, you to include both types

have room for somewhat blends informative an example [Perry and

ing Nitrogen Oxides Exhausts

nical process for eliminating and furnace exhausts. it of smog and contribution, isocyanic acid—a forming pools—converts en, and other harmless ce nitrogen oxides are en effective, our new 0 percent effective. ated 99 percent of small diesel engine. If ndustrial furnaces, this e 21 million tons of ni- the atmosphere of the perimental results, this mical reactions to ex-

mary are informative. important results: the its effectiveness at re- exhaust of a test engine. though, is descriptive.

Instead of actually presenting the chemical reactions that explain the process, the summary just states that the scheme will be given. Such a descriptive treatment was necessary because the format didn't allow room for all six chemical equations.

Writing Introductions. When audiences read an introduction to a scientific document, they have expectations that have arisen from reading the introductions of other scientific documents. In general, by the end of the introduction, audiences expect answers to the following questions:

- What exactly is the work?
- Why is the work important?
- What is needed to understand the work?
- How will the work be presented?

Don't assume that your introduction must explicitly address all four questions. Depending on the work and the audience, your introduction may address only two or three of the questions. Also, don't assume that for every document the most efficient order for answering the questions is the one listed above. Again, the way you write your introduction depends on your work and your audience. In one document, you may begin your introduction by explaining what the work is. On another document, though, you may feel that your audience needs some background before learning the identity of the work. Although introductions vary in the type and order of information, introductions should be designed so that readers do not reach the middle of your document with any of these four questions still burning.

Your introduction is your first chance to define the full boundaries of your work. In the introduction, you're not cramped by space as you are in your title and summary. Therefore, you should take advantage of the opportunity:

scribe the electrical
 re two-group model
 oblem of gas break-
 of nuclear reac-
 sed on electron ki-
 ns (breakdown
 provides a con-
 eakdown above the
 he breakdown and
 nd Byszewski, 1980]

out the work that
 etails such as where
 y's relation to other

y your introduction,
 tations of the work.
 he project includes.
 is that restrict the
 ns usually go hand
 project's scope, your
 s are. Sometimes,
 ions:

ife expectancies of
 alcohol drinkers,
 who do not drink
 he al, medical,
 ree elements that
 an alcohol intake.

izes the scope, and
 tations. In this ex-
 tions because your
 that your readers
 e.

define your work,
 ow why your work
 tists and engineers
 without showing
 is that many read-

ers don't finish the document because they have no rea-
 son to work through the details. Reading scientific docu-
 ments is taxing work, and readers need incentives to keep
 going. Showing the importance of the work provides an
 incentive.

Another reason to show the importance of the work
 is money. Most scientific projects depend on outside fund-
 ing, and before someone will give away money, they have
 to be convinced that the work is important. More often
 than not, that particular someone will be someone out-
 side science and engineering. Justifying your work to
 someone outside science can be difficult. You cannot get
 away with just saying the project is important, as this
 physicist tried to do:

This paper presents the effects of laser field statistics on
 coherent anti-Stokes Raman spectroscopy intensities. The im-
 portance of coherent anti-Stokes Raman spectroscopy in study-
 ing combustion flames is widely known.

This introduction convinces readers of nothing. Instead
 of just telling readers that the project is important, you
 should show readers that the project is important, as this
 chemist did [Thorne and others, 1985]:

This paper presents a design for a platinum catalytic ig-
 niter in lean hydrogen-air mixtures. This igniter has appli-
 cation in light-water nuclear reactors. For example, one dan-
 ger at such a reactor is a loss-of-coolant accident, in which
 large quantities of hydrogen gas can be produced when hot
 water and steam react with zirconium fuel-rod cladding and
 steel. In a serious accident, the evolution of hydrogen may
 be so rapid that it produces an explosive hydrogen-air mix-
 ture in the reactor containment building. This mixture could
 breach the containment walls, allowing radiation to escape.
 To eliminate this danger, one proposed method is to ignite
 intentionally the hydrogen-air mixture at concentrations be-
 low those for which any serious damage might result.

Although most work has a practical application,
 don't assume that you have to show a practical applica-

jects exist for the sole
 up cases, you cannot
 share your curiosity.
 should raise the same
 you began the work:

Ganymede and Cal-
 ire near twins: rock-
 about 5000 kilometers
 water by volume. The
 m is their albedo: Cal-
 has dark patches sepa-
 r discusses how these
 ntly. [LLNL, 1985]

1 devote to justifying
 on your audience. If
 ld, you may not have
 our readers might im-
 e. However, not justi-
 ce. Your audience, in
 ts.

rs expect an introduc-
 understand the docu-
 background informa-
 it ()wer depends on
 now about your work.
 out the effects of a
 human immune sys-
 ternal scientific and en-
 ne background would
 self. However, if your
 sts, then much of the
 ng else, perhaps a re-
 from previous space

nce knows about your
 vrite the background
 he rest of your career

on one document, you can't begin at the lowest stratum of science with Euclid or Archimedes and cover everything in between. You have to be selective. For instance, if it were 1913 and you were Niels Bohr writing the theory of the hydrogen atom, you might assume your readers were familiar with Balmer's equation for wavelength and Coulomb's law of force, but not with Rutherford's nuclear model for the atom, which was proposed in 1911. You might then start your paper at an "elevation of knowledge" somewhere just below Rutherford's work.

No matter how much your readers know about your work, you should be selective with background material, particularly in journal articles. Because most formats for journals have tight space constraints, you should provide background on those things that your audience really needs. Many scientists and engineers mistakenly assume that they have to provide a historical discussion with each document. If a historical discussion serves your readers in the document, then provide it. However, in many documents, other kinds of information such as definitions of key terms are more important.

Also, don't assume that all background information must go into the introduction. Sometimes, if you have a lot of background information, your document will read more efficiently if in the introduction, you restrict yourself to background that applies to the entire document. In other words, if the background is pertinent to only one section of the middle, then place that background within that particular section. If you have a lot of overall background information, you might place that background information in a separate section following the introduction so that the background information does not overwhelm the other aspects of the introduction.

The last expectation that an audience has for an introduction is the mapping. In general, the longer a document is, the more important the mapping of the work becomes. This principle is not only true in scientific writ-

ication. Anyone who has
 : revival understands this
 iv. The preacher has no
 ough, is that most South-
 ee-point sermons. In
 her states in the begin-
 ed—say Sin A, Sin B, and
 vers those three sins, one
 l. Once the preacher has
 on is over and you sing
 pping of the sermon's
 n to know at any given
 how much longer the
 ongregation in the South
 ng, that information is
 y on Sin A, you know
 still and breathe slowly.
 in C, you relax a little,
 d, and slide your thumb

or your documents will
 er of a revival sermon,
 the same. Consider the
 of "nuclear winter"

Smoke on the earth's
 ar war. In the first sec-
 ar scenario in which
 ons detonate. The sec-
 ludes assumptions for
 m resulting fires, the
 e, and the altitudes at
 mosphere. In the third
 s that show how the
 nd months following
 , we discuss how the
 at smoke distribution.

: strategy, you are ob-

ligated to stick with it. Nothing makes a congregation
 more restless than a preacher who promises to talk about
 three sins and then covers four.

You might ask what is the point of mapping the
 document in the introduction, when the summary has
 already done that. Two reasons exist. First, by mapping
 the document at the end of the introduction, you make a
 nice transition from the beginning to the middle of the
 document. Second, in some documents, the reader de-
 sires a justification for why you organized the document
 as you did. For instance, in an evaluation article, why do
 you discuss Option A before Option B? A summary does
 not have space to provide this kind of information; an
 introduction does.

Middles of Documents

The middle, or discussion, of a scientific document
 simply presents the work. In the middle, you state what
 happened as well as how it happened. You state the re-
 sults, show where they come from, and explain what they
 mean. What organization problems must you surmount
 in the middle? In writing the middle, you select a strat-
 egy and then convey that strategy to the audience in your
 choice of headings and subheadings. There are many logi-
 cal strategies in scientific writing: chronological strate-
 gies, spatial strategies, flow strategies, as well as the tra-
 ditional strategies, such as cause-effect, that you studied
 in high school. The names of these strategies aren't so
 important. What's important is that you choose a logical
 strategy that is appropriate for your audience. Also im-
 portant is that you reveal that strategy through your head-
 ings and subheadings.

Choosing an Appropriate Strategy. To describe your
 work, you can draw from a number of strategies. Which