Writing about Data

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Joining Sentences with Subordinators

One of the biggest differences between mature, effective writing and more basic writing is that mature writers use subordinators to show relationships between ideas. The more complex the information that you are writing about, the more important subordinators are. Unfortunately, when beginning writers start using subordinators, they often produce sentence fragments or punctuate sentences incorrectly. Therefore, this chapter has the following goals:

1. Encourage you to use subordinators to connect ideas together.
2. Show you that subordinators can be used in either the beginning or the middle of sentences.
3. Ensure that you understand the correct rules for punctuating subordinators.

What is a subordinator?
Subordinators are words that join sentences and help us highlight a variety of relationships between ideas, including cause/effect relationships, contrasts, conditions, and concessions. Here are the subordinators we use most often:

Subordinator	**Logical Relationship**	**Example**
although, though, even though, while, whereas	Contrast/concession	While we can model X-ray emissions, such an approach is often laborious, time-consuming, and impractical.
because, since	Cause/Result	The tuff absorbed a great amount of water after the earthquake because it consisted of porous material.
if, unless, when, where	Condition	The stress cannot be reproduced if the blocks are too large.
before, after, when, whenever, until, as soon as	Time	Some heart attack victims in our study confessed that they phoned clients and rescheduled meetings before they called an ambulance.

When we put a subordinator in front of a sentence, we change the sentence from an independent clause to a dependent (or subordinate) clause. Here's a quick review of independent and dependent clauses.

Independent clause: Contains a subject and verb and can stand alone as a complete thought. An independent clause is a sentence.

Examples of independent clauses:

Jim studied.
It was very noisy.
Our class meets at 9:00 in the morning.

Dependent clause: Contains a subject and verb, but can not stand alone as a complete thought. A dependent clause cannot stand alone as a sentence.

Examples of dependent clauses:

When Jim studied.
Because it was very noisy.
After our class meets at 9:00 in the morning.

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Note that all of the dependent clauses above begin with a subordinator, such as *when*, *because*, *after*. To turn these dependent clauses into complete sentences, we need to add an independent clause.

When Jim studied, **dependent clause**	he became anxious. **independent clause—can stand as a complete sentence**
Because it was very noisy, **dependent clause**	he got into a fight with his roommate. **independent clause—can stand as a complete sentence**
After our class meets at 9:00 in the morning, **dependent clause**	I need coffee. **independent clause—can stand as a complete sentence**

These sentences can also be written so that the independent clause comes first:

Jim became anxious **independent clause—can stand as a complete sentence**	when he studied **dependent clause**
He got into a fight with his roommate **independent clause—can stand as a complete sentence**	because it was very noisy. **dependent clause**
I need coffee **independent clause—can stand as a complete sentence**	after our class meets at 9:00 in the morning **dependent clause**

Punctuating subordinate clauses

1. **When the dependent (subordinate) clause comes first, it is always followed by a comma.**

   Because the study sample is small**,** additional research is needed.

   If the blocks are too large **,** the stress cannot be reproduced.

   Before you start**,** make sure you have all the needed parts.

   Whereas a hoist can only lift and lower**,** a crane can move loads in horizontal and vertical planes.

2. **When the dependent (subordinate) clause comes second, a comma is not used—unless a contrast or concession subordinator is used, in which case the comma is optional.**

   Additional research is needed *because* the study sample is small. **[no comma]**

   The stress cannot be reproduced *if* the blocks are too large. **[no comma]**

   Make sure you have all the needed parts *before* you start.. **[no comma]**

   A crane can move loads in horizontal and vertical planes *whereas* a hoist can only lift and lower. **[comma optional because contrast subordinator (whereas) is used]**

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EXERCISES

Goals of this exercise:

1. To get you into the habit of using subordinators.
2. To make sure you understand that subordinators can appear at the beginning OR in the middle of clauses.
3. To make sure you understand how to punctuate subordinators depending on their positions in clauses.

If you are a strong writer, these exercises may seem too easy for you. If this is the case, you should be able to finish in less than 10 minutes. However, make sure that you follow the punctuation rules correctly and truly understand them.

Combine the following pairs of sentences using *subordinators.* Make the underlined sentence the subordinate, or dependent, clause. The logical relationship is given in brackets.

EXAMPLE:
Introduction and conclusion sections contextualize and frame the research. [**While]** Methods and results sections describe the study.

SOLUTION:
Introduction and conclusion sections contextualize and frame the research **while** methods and results sections describe the study.

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******* NOTE *******

These exercises introduce you to a variety of ways to structure sentences. In order to complete the exercises correctly, you must attach the subordinator to the underlined phrase. Be sure to punctuate correctly!

1. Copper is used for electric wiring. **[Because]**
   It is highly conductive.

2. Copper is highly conductive. **[Because]**
   It is used for electric wiring.

3. The differences are small. **[Although]**
   They point to areas that are important for user acceptance.

4. The problem of filtering out spam is complex **[Although]**
   Two new methods look promising

5. In laparoscopic surgery there is a monitor for viewing internal organs. **[While]**
   In open surgery the surgeon can look right at the organs.

6. Some students prefer assignments that are strictly focused on technical issues. **[While]**
   Others prefer to see the broader implications of their work.

7. Some students prefer assignments that are strictly focused on technical issues. **[Whereas]**
   Others prefer to see the broader implications of their work.

8. They participated in our study. **[After]**
   Subjects completed a questionnaire on their search habits.

9. Subjects participated in our study. **[After]**
   They completed a questionnaire on their search habits.

10. The filter makes a mistake. **[If]**
    The user simply re-categorizes the e-mail.

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11. Our query method will make scholarly research more efficient. **[If]**
    The market for Tablet PCs continues to grow.

12. Further research is needed in real-world settings
    The tests were only run in the laboratory. [**Since]**

13. The program was written in Java. **[Since]**
    It can run on all platforms.

14. Programming assignments involving games motivate some students. **[Although]**
    They are not a top priority for most engineering students.

15. The results confirm our hypotheses.
    There were some anomalies in data collection. **[Even though]**

Presenting Bad News: Joining Sentences to Show Concession

We use the contrast subordinators *although, though, even though, while, whereas* to show contrast. But they do more than contrast: they **de-emphasize** the points they are attached to and show **concession**. Concessive subordinators are very useful for presenting "bad news": they concede that a problem or shortcoming or flaw exists while de-emphasizing this problem.

Emphasizing the good news

Concessive subordinators are particularly useful in emphasizing a study or test's good points while still acknowledging mistakes or flaws. For instance, we might write:

Although the study's design has some flaws,	the results are promising
problem conceded	**good point emphasized**
Although the tests were done in a lab,	the findings should be applicable to the real world.
problem conceded	**good point emphasized**

These sentences use the subordinator ***although*** to concede some points, but still leave the reader on a high note—the promising nature of the studies.

Emphasizing the bad news

Sometimes, however, you want to emphasize the problems. This is especially important when you want to warn readers about potential safety issues. In this situation, you should attach the good point to the concessive subordinator and put the problem in the main clause.

Although the findings are promising,	the tests were done in a lab and may not be applicable to "real use" situations.
good point conceded	**problem emphasized**

This sentence, in contrast to the examples above, ends on a negative point.

No emphasis/Equal emphasis

If you want to stress the good and bad news equally, use one of the contrast coordinators, *but* or *yet* to join the two clauses.

The results are promising, **but** the design has some flaws.

This sentence stresses neither the results nor the flaws. The two clauses are given equal emphasis. Note that a comma precedes the coordinator.

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Summary of contrast and concession words

Word Type	Contrast	Concession
Subordinators	Although Even though Though Whereas* While	Although Even though Though While
Coordinators	But, yet	

*Note that *whereas* generally works better for emphasizing contrasts than for emphasizing concessions.

Subordinators: Join two clauses and *de-emphasize* the clause they are attached to.

Coordinators: Join two clauses and give *equal* emphasis to the ideas they join.

Punctuation:

If the subordinator appears in the first clause, use a comma:

Although the study's design has some flaws, the results are promising.

If a subordinator appears in the second clause, do not use a comma. (exception: an optional comma may be used before the contrast/concession subordinators *although, even though, though, while, whereas*):

The study's design has some flaws even though the results are promising.

If a coordinator—such as *but, yet*—connects two independent clauses (complete sentences), a comma should be placed before the coordinator:

The study's design has some flaws, but the results are promising.

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Exercises

In the following exercises, use subordinators to join the sentences to show contrast while emphasizing one point over another.

EXAMPLE:

There were some anomalies in the data collection.
The results confirm our hypotheses.

a. Combine and emphasize the positive results.

While there were some anomalies in the data collection, the results confirm our hypotheses.

Explanation: by placing the anomalies in the subordinate clause, they are de-emphasized while the advantages of the results are emphasized.

b. Combine and emphasize the anomalies in data collection.

Although the results confirm our hypotheses, there were some anomalies in the data collection.

Explanation: The subordinate clause de-emphasizes the results.

c. Combine and give equal emphasis.

The results confirm our hypotheses, but there were some anomalies in the data collection.

Explanation: The coordinator "but" gives equal emphasis to the two clauses.

1.
The virus was non-destructive.
The virus opened a backdoor to the computer system.

a. *Combine and emphasize the "good news".*

b. *Combine and emphasize the "bad news".*

c. *Combine and give equal emphasis.*

2.
Some alternative side glazings could increase head injuries.
These injuries do not appear to be critical.
a. *Combine and emphasize the "good news".*

b. *Combine and emphasize the "bad news".*

c. *Combine and give equal emphasis.*

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3.
The results of this study will not eliminate these incidents
We hope to reduce the frequency of these incidents.

a. *Combine and emphasize the "good news".*

b. *Combine and emphasize the "bad news".*

c. *Combine and give equal emphasis.*

4.
Students were less adept than professional software engineers in identifying human issues.
They were equally adept in identifying technical issues.

a. *Combine and emphasize the "good news" for students.*

b. *Combine and emphasize the "bad news" for students.*

c. *Combine and give equal emphasis.*

5.
The new materials reduced injuries.
They shattered under impact.

a. *Combine and emphasize the "good news" for the new materials.*

b. *Combine and emphasize the "bad news" for the new materials.*

c. *Combine and give equal emphasis.*

6.
Workers liked the new interface.
The time it took to complete routine tasks did not improve.

a. *Combine and emphasize the "good news".*

b. *Combine and emphasize the "bad news".*

c. *Combine and give equal emphasis.*

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7.
All 12 participants had difficulty with the tasks.
They were all ultimately successful.

a. *Combine and emphasize the "good news".*

b. *Combine and emphasize the "bad news".*

c. *Combine and give equal emphasis.*

8.
SMTP protocol is still a good form of authentication.
It sends user information across the Internet.

a. *Combine and emphasize the "good news".*

b. *Combine and emphasize the "bad news".*

c. *Combine and give equal emphasis.*

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Coordinators, Subordinators, and Transitions

The English language has three basic types of linguistic patterns for connecting main ideas: coordinators, subordinators and transitions. The table below summarizes the purposes and differences among these connectors.

Connector type	***Examples***	***Structure***	***Where they connect***	***Emphasis***	***Example***
Coordinators	for and nor but or yet so	One sentence	Middle of sentence	Give equal emphasis to two closely connected clauses.	The results are promising but additional research is needed.
Subordinators	because since although while if until when	One sentence	Beginning or Middle of sentence	De-emphasize the clause they are attached to.	While the results are promising, additional research is needed. The results are promising, although additional research is needed.
Transitions	moreover for example however in addition in general therefore thus	Two sentences	Near Beginning of second sentence	"Hand off" topic from one main idea to the next.	The results are promising. However, additional research is needed.

While the sentences in the *Examples* column above all have basically the same meaning, they are slightly different in emphasis. Coordinators and subordinators both keep ideas closely related, within a single sentence. Subordinators, in addition, allow you to place emphasis on one clause or the other and show a tighter linkage between ideas than coordinators.

Transitions, unlike coordinators and subordinators, connect two separate sentences. The word *transition* literally means *passing from one subject to another*. A transition, therefore, means that the main topic of a passage has shifted: the thought expressed in the first sentence has completed, and the topic focus is moving on to the next main idea. In most cases, a sentence beginning with a transition will be followed up with additional information on the same topic.

Because transitions help "hand off" the topic focus, transitions can be powerful devices for connecting paragraphs. A transition phrase such as *however* or *in addition* at the beginning of a paragraph indicates both that the topic has shifted and how the topic focus of the new paragraph is related to the previous paragraph.

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For discussion:
Discuss how the emphasis changes in each set of groups below depending on whether the clauses are connected with a coordinator, subordinator or transition.

1a. There were some anomalies in the data collection, but the results confirm our hypotheses.

1b. Although there were some anomalies in the data collection, the results confirm our hypotheses.

1c. There were some anomalies in the data collection. However, the results confirm our hypotheses.

2a. Some energy is lost inside the machine in overcoming friction, so the efficiency of a practical machine can never reach 100%.

2b. Because some energy is lost inside the machine in overcoming friction, the efficiency of a practical machine can never reach 100%.

2c. Some energy is lost inside the machine in overcoming friction. Therefore, the efficiency of a practical machine can never reach 100%.

Note that the "transition" passages above (1c, 2c) suggest that the writer will continue the thought begun in the second sentence. In other words, we would expect the writer of 1c to continue discussing the results in a follow-up sentence. Similarly, we might expect the writer of 2c to continue discussing machine efficiency in the next sentence. Thus, transitions (with the exception of transitions showing conclusion) imply that the author is going to elaborate upon or continue to discuss the thought introduced in the new sentence.

Connecting with transitions

Transitions *must* be placed in the first clause of a sentence. However, they need not be the first word of the sentence. The following variations all work well for connecting ideas:

In general, these findings suggest….
These findings in general suggest….

Moreover figure 2 shows….
Figure 2 moreover shows….

Therefore, most of the steel should be concentrated on the flanges.
Most of the steel should therefore be concentrated on the flanges.

Transitions *cannot* be used to connect two independent clauses in a single sentence. Instead, transitions must appear in the first clause of the sentence:

 The results suggest the new system improves speed. Moreover, technicians prefer the new system.

 The results suggest the new system improves speed, moreover technicians prefer the new system.

 WINACE has a high efficiency rating. Therefore, it should be the default compressor.

 WINACE has a high efficiency rating, therefore it should be the default compressor.

 My teacher explained the exercise in great detail. However, he managed to confuse everybody.

 My teacher explained the exercise in great detail, however he managed to confuse everybody.

Transitions, thus, connect two distinct sentences. A transition cannot connect two ideas in the same sentence.

Note: The errors above are called comma splices because they incorrectly use a comma to connect (or splice together) two complete sentences.

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Common Coordinators, Subordinators, and Transitions used in Technical Writing

The table below shows common coordinators, subordinators, and transitions that are used to express certain relationships between ideas. This list is far from complete.

Relationship	***Coordinator*** *(equal emphasis)*	***Subordinator*** *(de-emphasizes the clause it is attached to)*	***Transition*** *(hands off the topic to the next sentence)*
Addition Add or build on ideas.	and		Moreover In addition Also Furthermore
Cause/Effect Show that one ideas is a cause, effect or consequence of another.	so	because since	Therefore Thus As a result As a consequence
Contrast Contrast ideas or concede points.	but yet	although even though whereas while	However
Time Show how ideas are related in time.		before after when while as	First Afterwards Finally Meanwhile At the same time

******REMEMBER******

Subordinators and coordinators connect clauses <u>within</u> a single sentence.

Transitions connect ideas <u>between</u> two sentences or paragraphs.

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Exercises

In the following exercises, use coordinators, subordinators, and transitions as needed to join the sentences.

EXAMPLE:

[show cause/consequence]
The program was written in Java.
It can run on all platforms.

a. Combine in one sentence and give equal emphasis.

The program was written in Java, so it can run on all platforms.

Explanation: by using the coordinator *so,* we give both clauses equal emphasis.

b. Combine in one sentence and emphasize the platform-independence of the program.

Because the program was written in Java, it can run on all platforms.

Explanation: by using the subordinator *because*, we de-emphasize the programming language (Java) and emphasize that it can run on all platforms.

c. Hand off the topic from one sentence to the next.

The program was written in Java. Therefore, it can run on all platforms.

Explanation: The transitional phrase *therefore* connects two distinct sentences and switches the topic focus to the platforms.

1. [Addition]
The new firearms improved soldiers' accuracy by 10%.
They increased soldiers' speeds by 5%.

a. Combine in one sentence and give equal emphasis.

b. Hand off the topic from one sentence to the next.

2. [Contrast/concession]
The spam filter works.
It produces a lot of false positives.

a. Combine in one sentence and give equal emphasis.

b. Combine in one sentence and emphasize the false positives.

c. Hand off the topic from one sentence to the next.

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3. [Cause/effect]
A precise measurement is unattainable.
Some tolerances must be allowed.

a. Combine in one sentence and give equal emphasis.

b. Combine in one sentence and emphasize the tolerances.

c. Hand off the topic from one sentence to the next.

4. [Addition]
The emerging X3D specifications will make 3D web browsing cost-effective.
New advances in graphic cards will make 3D worlds more compelling to users.

a. Combine in one sentence and give equal emphasis.

b. Hand off the topic from one sentence to the next.

5. [contrast/concession]
3D web browsers are gaining in popularity.
The 3D web has not become a significant force in the marketplace.

a. Combine in one sentence and give equal emphasis.

b. Hand off the topic from one sentence to the next.

6. [cause/effect]
The IM introduces noise to the signal.
It reduces the overall signal coverage area.

a. Combine in one sentence and emphasize the signal coverage area.

b. Hand off the topic from one sentence to the next.

Transitions and Subordinators in Discussing Data

Connecting words of all types—coordinators, subordinators, and transitions—are crucial for discussing data and explaining what data means. Of these connecting words, transitions are the most flexible and the most frequently used.

There are many types of transitional phrases, and each type suggests a different relationship between the ideas you are connecting. Some transitions suggest that you are building, or accumulating upon, an idea you have already established. Other transitions suggest that your new idea contrasts with what has come before.

Here is a list of some common transitional phrases and the relationships they imply between ideas:

Relationship Category	***Transitional Phrases***
Accumulation	also, in addition, again, once again, further, furthermore, moreover
Similarity	similarly, likewise
Contrast	however, by contrast, on the other hand, unfortunately, unlike
Exception	still, nevertheless, nonetheless, in spite of, despite, in any case
Consequence	consequently, thus, therefore, hence, accordingly, as a result
Example or Evidence	for example, for instance, as a case in point, to illustrate
Generality	overall, in general, generally, on average
Emphasis	in fact, indeed
Sequence, Time or Order	first, second, third, previously, simultaneously, subsequently, next, finally, at the same time
Summary or Conclusion	therefore, to sum up, in summary, finally, to conclude, in conclusion, as shown, thus

This list is far from complete. Many, many words and phrases can be used as transitional devices to connect main ideas across sentences and paragraphs. Different words and phrases—even within the same relationship category—have slightly different meanings and connotations. Thus, transitions within the same relationship category are not completely interchangeable. Make sure that you understand the exact meaning of any transitions you use before you use them.

EXERCISES:

Each exercise below presents a table or figure followed by a very choppy and disconnected paragraph interpreting the data. Your job is to rewrite this paragraph using subordinators and transitions to connect the ideas. To help you out, the sentences have been grouped into units and various types of connectors have been suggested.

Each letter below represents a unit of short sentences that should all be combined into one sentence using the suggested connectors. You may rearrange the order of the short sentences and delete unnecessary words. Refer to the list of transitions on the previous page and the list of subordinators from previous exercises to complete the exercises. (Note: Since part of the goal of this exercise is to get you to use more complex sentence types, you should not use coordinators: and, but, yet, for, so).

EXAMPLE

Table 1: Compressor efficiency scores for text files

Compressor	Efficiency score
LZOP	1
PAR	1
PKZIP	1
JAR	.99
WINACE	.98
WINZIP	.97
STUFFIT	.90
DEEPFREEZE	.91
HUFFMANCE	.91
OPAQUE	.71
BLINK	.58

Table 2: Compressor efficiency scores for .exe files

Compressor	Efficiency score
LZOP	1
BLINK	.98
OPAQUE	.95
PKZIP	.73
WINZIP	.73
DEEPFREEZE	.72
STUFFIT	.70
SUPERPACK	.69
PAR	.66
JAR	.64
WINACE	.58

Tables 1 and 2 indicate that some of the most common compressors are very efficient for text files. These compressors are less effective at compressing exe files. WINACE has an efficiency rate of 0.98 for text files. It has an efficiency rate of only 0.58 for executable files. WINZIP has a high efficiency score for compressing text files. It has a much lower score for compressing .exe files. These findings show the following. One compressor may be more convenient to use than another. This depends on the type of file.

a. *[Subordinator emphasizing the bad news]*
Tables 1 and 2 indicate that some of the most common compressors are very efficient for text files.
These compressors are less effective at compressing exe files.

b. *[Transition showing example]*
[Subordinator emphasizing the bad news]
WINACE has an efficiency rate of 0.98 for text files.
It has an efficiency rate of only 0.58 for executable files.

c. *[Transition showing similarity]*
[Subordinator emphasizing the bad news]
WINZIP has a high efficiency score for compressing text files.
It has a much lower score for compressing .exe files.

d. *[Transition showing conclusion]*
These findings show the following.
One compressor may be more convenient to use than another.
This depends on the type of file.

Answer:
Tables 1 and 2 indicate that <u>while</u> some of the most common compressors are very efficient for text files, they are less effective at compressing exe files. <u>For example</u>, <u>although</u> WINACE has an efficiency rate of 0.98 for text files, it has an efficiency rate of only 0.58 for executable files. <u>Similarly</u>, <u>while</u> WINZIP has a high efficiency score for compressing text files, it has a much lower score for compressing .exe files. These findings <u>thus</u> show that one compressor may be more convenient to use than another depending on the type of file.

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1.

Table 1: Average download speeds

Task	***Firefox 2.0***	***Internet Explorer 7.0***
Time to start up from cold	11.64 s	7.80 s
Render benchmark CSS page	1.71 s	2.13 s
Download benchmark HTML page w/ multiple images	2.03 s	2.47 s
Download benchmark Javascript	22.01 s	36.35 s
Perform function in benchmark Javascript	11.18 s	18.34 s

Table 1shows that Firefox 2.0 is faster than Internet explorer 7.0. Firefox 2.0 is faster in performing many common tasks. The more complex the task, the greater the advantage Firefox has over IE. IE downloaded a benchmark JavaScript in 36.35s. Firefox downloaded the same script in 22.01s. Firefox was faster than IE in performing a JavaScript function. Firefox was nearly 60% faster. Firefox had slower startup times than IE. IE started in 7.80 seconds. Firefox started in 11.64 seconds. These findings suggest that Firefox is a faster web browser for most tasks. Firefox does take longer to start up than IE.

a. Table 1shows that Firefox 2.0 is faster than Internet explorer 7.0.
Firefox 2.0 is faster in performing many common tasks.

b. *[Transition showing generality]*
The more complex the task, the greater the advantage Firefox has over IE.

c. *[Transition showing example]*
[Subordinator emphasizing the benefits of Firefox]
IE downloaded a benchmark JavaScript in 36.35s.
Firefox downloaded the same script in 22.01s.

d. *[Transition showing similarity]*
Firefox was faster than IE in performing a JavaScript function.
Firefox was nearly 60% faster.

e. *[Transition showing contrast]*
Firefox had slower startup times than IE.

f. *[Subordinator emphasizing the bad news for Firefox]*
IE started in 7.80 seconds.
Firefox started in 11.64 seconds.

g. *[Transition showing generality]*
[Subordinator emphasizing the benefits of Firefox]
These findings suggest that Firefox is a faster web browser for most tasks.
Firefox does take longer to start up than IE.

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2.

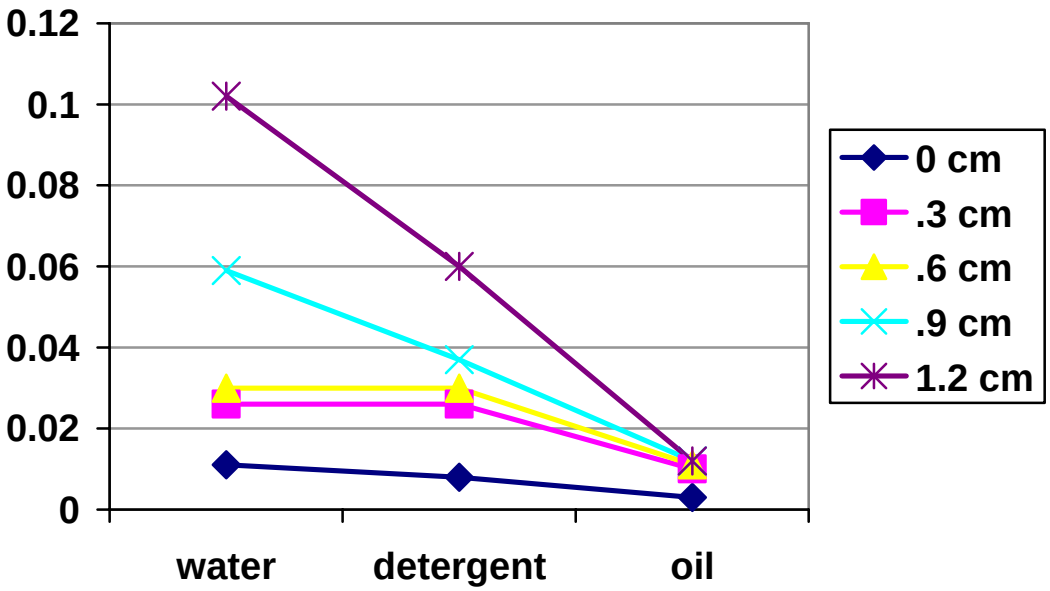

Figure 1: Effects of shoe sole tread width on COF for different contaminated floor surfaces.

Note: A high COF (coefficient of friction) is good because it means people will be less likely to slip.

Figure 1 shows that large groove treads increase COF on wet and detergent floors. Groove treads of 0cm had COFs of about .01 for wet floors. Groove treads of 1.2cm had COFs of over .10 for wet floors. COFs for floors covered with detergent had higher COFs for large tread widths. Tread width did not make as much difference on the oily floor. There was a slight increase in COF between 0cm and .3cm on the oily floor. Additional increases in tread width had negligible effects on COF. These findings indicate that large tread widths can increase safety on wet and detergent covered floors. Large tread widths will have little effect on oil-covered floors.

a. *[Transition showing generality]*
Figure 1 shows that large groove treads increase COF on wet and detergent floors.

b. *[Subordinator emphasizing the good news for large tread widths]*
Groove treads of 0cm had COFs of about .01 for wet floors.
Groove treads of 1.2cm had COFs of over .10 for wet floors.

c. *[Transition showing similarity]*
COFs for floors covered with detergent had higher COFs for large tread widths.

d. *[Transition showing contrast]*
Tread width did not make as much difference on the oily floor.

e. *[Subordinator emphasizing the bad news for tread width]*
There was a slight increase in COF between 0cm and .3cm on the oily floor.
Additional increases in tread width had negligible effects on COF.

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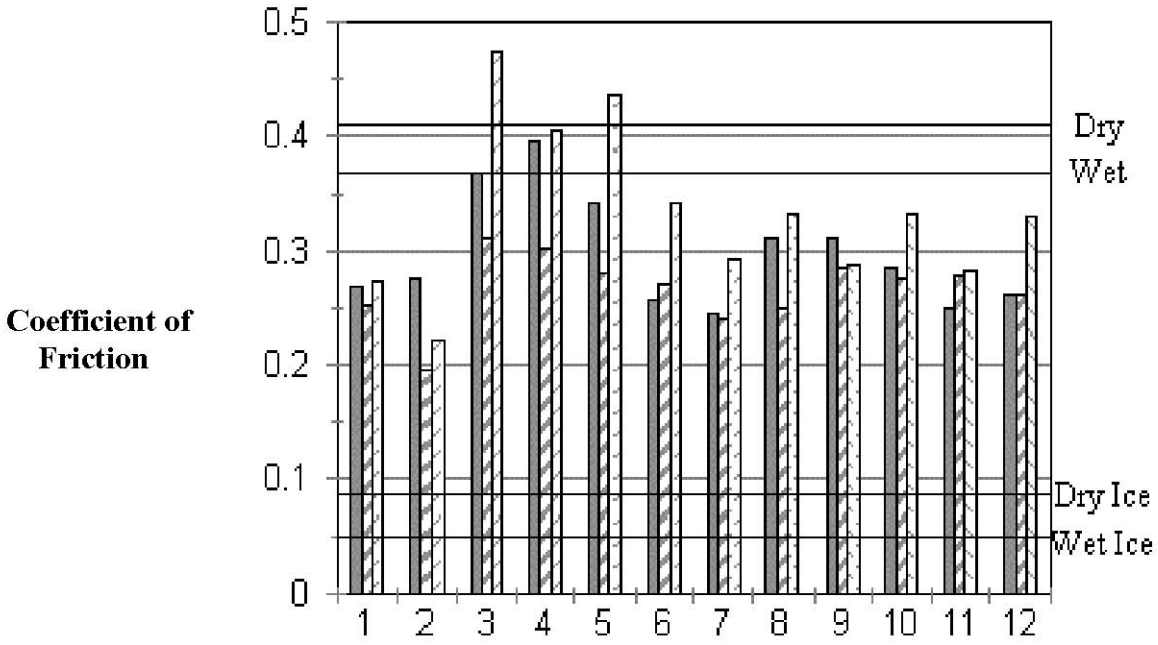
f. *[Transition showing conclusion]*
[Subordinator emphasizing the good news for tread width]
These findings indicate that large tread widths can increase safety on wet and detergent covered floors. Large tread widths will have little effect on oil-covered floors.

3.



LEGEND
Solid Grey..... Liquid
Hatch.....Slurry
Light Grey…Solid

1	Magnesium Chloride	7.	FreezGard 0 and TEA
2	LiquiDow	8.	Ice Stop
3	Calcium Magnesium Acetate	9.	Ice Stop 2000
4	Sodium Chloride	10.	MCP De-Icer
5	LiquiDow Armor	11.	FreezGard 0
6	FreezGard 0 and Shield LS	12.	FreezGard 0 and Ice Ban

Figure 2: Comparative COF results of de-icer chemicals in liquid, slurry, and solid chemical states.

Note: A high COF (coefficient of friction) is good because it means vehicles will be less likely to skid.

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Figure 2 shows that chemicals with additives performed better. They performed better than their pure chemical counterparts. $MgCl_2$ produced a co-efficient of friction of .25 during its slurry stage. Ice Stop 2000, an additive based on $MgCl_2$. produced a COF value of .33. The liquid COF of LiquiDow during its slurry stage was approximately .275. The liquid COF of LiquiDow Armor was .342. The COF of LiquiDow remained very low. It remained low even after LiquiDow had dehydrated and dried. The COF of LiquiDow Armor increased dramatically. The COF increased when LiquiDow Armor was dry. This data suggests the following. De-icing chemicals with additives should be used. They should be used because they increase friction, particularly in their slurry and dry states.

a. *[Transition showing generality]*
Figure 2 shows that chemicals with additives performed better.
They performed better than their pure chemical counterparts.

b. *[Transition showing example]*
[Subordinator emphasizing the good news for the additive]
$MgCl_2$ produced a co-efficient of friction of .25 during its slurry stage.
Ice Stop 2000, an additive based on $MgCl_2$. produced a COF value of .33.

c. *[Transition showing similarity]*
[Subordinator emphasizing the good news for the LiquiDow Armor]
The liquid COF of LiquiDow during its slurry stage was approximately .275.
The liquid COF of LiquiDow Armor was .342.

e. *[Transition showing accumulation]*
The COF of LiquiDow remained very low.
It remained low even after LiquiDow had dehydrated and dried.

f. *[Transition showing contrast]*
The COF of LiquiDow Armor increased dramatically.
The COF increased when LiquiDow Armor was dry.

g. *[Transition showing conclusion]*
This data suggests the following.
De-icing chemicals with additives should be used.
They should be used because they increase friction, particularly in their slurry and dry states.

--

Reporting Data: Overview

Figure 1: Accident caused by inaccurate bridge/vehicle clearance information

The accurate and straightforward communication of data is central to technical work. The exercises in this unit on *Reporting Data* all aim to teach you to communicate what data means.

One of the biggest differences between engineers who are considered good communicators and those who are considered poor communicators is ability not only to collect and analyze data but also to say what it means. One senior engineer described writing in his organization as "taking the goobledygook of numbers and turning it into some kind of sense."

When you write about data, your focus should not be on the calculations you preformed, the statistical tests you ran, or even the numbers themselves—instead, your focus should be on the "bottom line." Your goal should be to explain what the data means for the people who will have to make decisions and take actions based upon these numbers.

Before we start discussing specific strategies for communicating the "bottom line," let's take a minute to look at an example. On the following pages you will read about a feasibility study performed by a state Department of Transportation (DOT). Two different versions of the results of this study are presented below.

Your Task: Read these results sections and answer the following questions:

1. Which version, A or B, do you think does a better job of emphasizing the "bottom line"? In other words, which version does a better job of explaining what the study's findings mean for people who will have to make decisions? Why?

2. What specific organizational strategies or wordings does the better version use in order to make the "bottom line" easy to understand?

--

Background

Overhead clearance measurements for bridges are inspected every two years. These manual inspections allow the transportation department to update clearance information in order to account for any changes in vertical clearance that might occur due to shifts in the terrain, compression of the bridge structure, or changes to the pavement surface. The current process for conducting these inspections requires shutting down traffic lanes, which is time-intensive and difficult, particularly on Interstates. The purpose of the following report is to analyze whether a digital photolog sensor, mounted upon a van, can produce sufficiently accurate automated readings. Table 1 below contains the data captured during field tests with the vans containing photolog sensors.

Table 1: Difference between manual and automated measurements (in feet) for vertical clearances captured at 50, 100, and 500 HZ sampling rates

Route	*Bridge #*	*Last Manual Inspection*	*Paint condition of bridge*	*Speed of van*	*Δ 50 Hz*	*Δ 100 Hz*	*Δ 500 Hz*
I-91 NB	West Street (3162)	2/9/99	Poor	50	1.57	0.48	0.37
I-91 NB	Rte 160 (3164)	9/27/95	Average	50	3.09	0.79	0.11
I-91 NB	Gilbert Ave. (3031)	6/6/97	New	50	3.71	0.07	0.34
I-91 NB	Orchard Street (3025)	3/19/93	Average	50	3.15	0.54	0.50
Rte 99 NB	I-91 (1448 & 1449)	4/13/99	Average	35	0.04	0.09	0.05
I-91 SB	Orchard Street (3025)	3/19/93	Average	50	2.01	0.17	0.37
I-91 SB	Gilbert Ave. (3031)	6/6/97	Average	50	2.11	0.20	0.12
I-91 SB	Rte 160 (3163)	9/27/95	Average	50	3.38	0.23	0.14
				AVG ALL BRIDGES	2.38	0.32	0.25
				AVG FOR BRIDGES INSPECTED IN LAST 5 YEARS	2.32	0.31	0.19

VERSION A

The differences (Delta) between the average clearances that were measured by the device and by bridge inspectors diminish as the sensor-sampling rate increases. This is demonstrated by the average delta calculated for 50, 100, and 500 Hz that are 2.38, 0.32, and 0.25, respectively. The difference is also not biased above or below the measured values.

The improved results with a 500 Hz. sampling rate appears to minimize the thermal noise concern that was mentioned by the manufacturer with rates above 100 Hz.

The average Delta is 0.19 ft (2.3 in.) for information collected @ 500 Hz within the last five years.

The condition of the paint on the bridge did not appear to influence the accuracy of the measurement. This is illustrated in the results for the first and third bridges where the paint condition was poor and new respectively, yet delta was the same.

The measurements made at the slowest vehicle speed at bridges 1448 and 1449, had the greatest accuracy regardless of the sensor sampling rate. This may foretell a need for slower vehicle speeds at bridges with minimal clearances where very accurate measurements are required.

--

VERSION B

Table 1 shows that the photolog device produces accurate overhead clearance readings when operated at a 500 Hz sampling rate. The average difference (delta) between the photolog measurements at 500 Hz and the manual inspection is 0.25 feet, which meets the DOT's guidelines for clearance accuracy. Moreover, this delta improves to 0.19 feet if the analysis is narrowed to only include bridges that have been inspected in the last five years. In addition, the accuracy of the readings does not appear to be negatively affected by the paint condition of the bridge, as evidenced by the similar deltas obtained from bridges with new and poor paint conditions. These findings thus indicate that the photolog sensor at 500 Hz is well-suited to the measurement of vertical highway clearances.

Unfortunately, the 500 Hz sampling rate produces uncomfortable levels of thermal noise. However, running the sensor at lower rates, while eliminating the noise problem, also reduces accuracy. Table 1 shows that as the sensor-sampling rate decreases so does the accuracy of the measurements. While measurements taken at a 500 Hz sampling rate had an acceptable delta, the measurements taken at 100 and 50 Hz sampling rates had unacceptable deltas of 0.32 and 2.38, respectively.

The problem of inaccurate measurements at low sampling rates might, however, be resolved by running the van at a lower speed. Row five of Table 1 shows that the readings taken when the van was moving at 35 mph were among the most accurate readings, regardless of sampling rate. Thus, accuracy did not seem to decrease with sampling rate when the van was running at 35 mph. Additional research is needed to further test the finding that slower vehicle speeds can increase accuracy.

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Reporting Data I: "Digesting" simple data

In one study comparing successful and unsuccessful engineering reports, engineers and managers frequently referred to "digested" vs. "undigested" data. The good engineering communicators were those who "digested" their findings and explained what the data means. These engineers not only reported technical information but helped their readers understand the significance of the data.

When you are writing a progress report, executive summary, or any other document that will be read by managers, executives or non-technical personnel you must "digest" your data by

- Stating the most important findings in plain language.
- Drawing readers' attention to the numbers or data points that support the main finding.
- Discussing conclusions or recommendations that follow logically from the data.

This chapter teaches you a three-part formula useful for "digesting" simple, fairly straightforward data for your readers:

1. Refer to the table or figure and state the most important finding.
2. Support this finding by emphasizing high and low points in the data.
3. State the bottom line: explain what this information means to your readers.

Occasionally, for very simple data, you may feel like you are repeating the same assertions. However, it is far better to be to err on the side of stating your conclusion too strongly than to risk that you have not stated it clearly enough.

Step 1: Refer to the Data and State the most important finding

The most efficient way to refer to data in your writing is to begin sentences with the name or number of the figure or table you are discussing and tell readers what that figure or table *shows, demonstrates, illustrates,* or *suggests* as in the following examples:

Noun referencing data	***Verb***	***Finding***
Figure 1	indicates	that the O-rings fail to maintain contact at low temperatures.
Table 2	demonstrates	that the hydrostatic needle was less stable than the conventional needle.
Figure 4	suggests	that ejection mitigation glazing may reduce fatalities in roll-over crashes at speeds of 30 mph or more.

The Findings that you report in this first sentence should be summaries of the main trend illustrated in the table or figure. This sentence should be a factual representation of the data in the table or figure and should avoid making inferences or recommendations. In other words, report here the most important trend in your data but do not refer in this first sentence to knowledge or information that does not come directly from the data.

--

WARNING

Avoid wordy phrases such as "As you can see from figure 1" or "Looking at figure 4 you can clearly see." These phrases are wordy sound unprofessional. Be efficient.

Incorrect: As you can see from figure 5…. **Correct: Figure 5 shows that….**

Incorrect: Looking at Table 3.2, you can see that… **Correct: Table 3.2 illustrates that…**

Do not use the verb *proves* to explain your findings. Engineers, like scientists, almost never use *proves*. This is because experimental tests are rarely rigorous enough, extensive enough, or accurate enough to claim *proof* for anything. Instead, engineers use a range of verbs that range from low confidence to high confidence in the findings (see Figure 1)

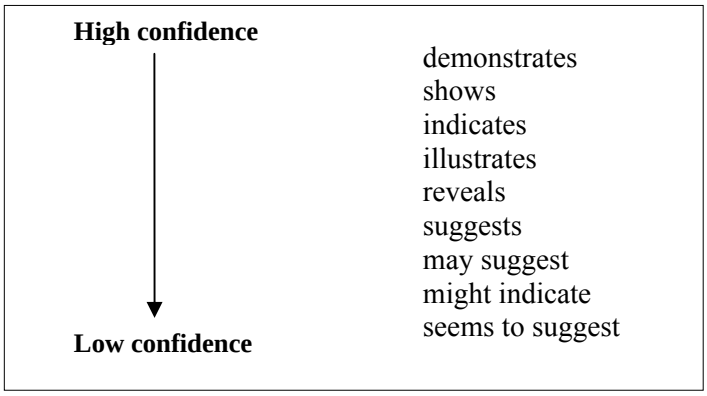

Figure 2: Common verbs used to refer to tables, figures, and other data

WARNING

Avoid using the verb *proves*. Instead, use the verbs in Figure 1 above.

Incorrect: Table 4.1 proves that… **Correct: Table 4.1 indicates that…**

--

Step 2: Emphasize high and low points in the data

You can efficiently compare data points by using subordinators showing contrast. The subordinators *while, although* and *whereas* all work to contrast two items while simultaneously emphasizing one point over another. These subordinators are therefore powerful tools for "digesting" data by efficiently comparing data points.

As discussed in the earlier chapter *Joining sentences with subordinators*, a subordinator such as *while, although* or *whereas* signals a complex sentence that has two parts. The first part is the main clause, which contains the data point you most want to emphasize. The second part is the dependent or secondary clause, which contains the point you want to receive less emphasis. The subordinator is attached to the secondary clause as in the following examples:

While the O-ring maintained contact at 100F, **secondary clause – deemphasized**	it lost and failed to reestablish contact at 50F. **main clause – emphasized**
Although the ejection-mitigation glazing had no effect at low speed accidents, **secondary clause – deemphasized**	it reduced fatalities by 20% at speeds of 30 mph and by 30% at speeds of 40 mph or higher. **main clause – emphasized**
Whereas other chemicals re-hydrated within 5 minutes, **secondary clause – deemphasized**	the solid sodium chloride would not re-hydrate. **main clause – emphasized**

It is also possible to switch the order of the main and secondary clause:

The conventional needle performed well at all rotation speeds. **main clause – emphasized**	while the hydrostatic needle was unreliable at high rotations. **secondary clause – deemphasized**
The ejection-mitigation glazing reduced fatalities by 20% or more at speeds above 30 mph **main clause – emphasized**	although it had no effect at low speed collisions **secondary clause – deemphasized**

--

Step 3: State the bottom line: Connect the data to what your reader wants to know.

Engineers are often very reluctant to come out and make a recommendation or conclusion because they fear being wrong. While this is a logical fear, managers, supervisors, and other non-technical personnel want to know what actions they should take based upon your data. As the person who has collected and analyzed the data, you are in the best position to say what it means. History is full of incidents where managers did not take crucial actions because engineers—while knowing about significant safety problems—were reluctant to take a stand.

When writing a recommendation, you should ask yourself—**who is my main reader and what does this reader most want to know?** For instance, if you have been asked to compare two or more types of chemicals, computer systems, hardware, or other products, the chances are that your reader wants a recommendation of which one to use. If you've been asked to evaluate the safety of a product, your reader almost certainly wants you to come out and say whether or not the product is safe.

To introduce the bottom line

1. Begin with a noun referencing your ***findings, data,*** or ***results***
2. Use a transition showing result, such as ***therefore, thus, consequently,*** or ***as a consequence*** to signal that your recommendations naturally follow from your analysis of the data
3. Use one of the "common verbs used to refer to data" in Figure 1
4. State the "bottom line": explain what the data means in terms of your readers' main concerns or goals.

Noun referencing data	***Transition showing result***	***Verb referencing data***	***Bottom line***
These findings	therefore	suggest	that the O-ring seal should not be used because it is unreliable at low temperatures
These tests	thus	suggest	that conventional needles are more reliable than hydrostatic needles.
Our computer models	thus	indicate	that further research should be conducted on ejection mitigation glazings
This data	therefore	indicates	that de-icing chemicals with additives will increase friction and prevent accidents.

--

Connecting to Readers' Goals: Direct vs. Indirect Recommendation

When you state the bottom line and connect the data to what your reader wants to know, you often end up recommending a line of action for your readers. You can recommend this line of action directly—by saying what ***should*** be done—or you can do it indirectly, by implying what will happen if a course of action is taken.

The following table illustrates the difference between *Direct* and *Indirect* recommendations:

Direct	***Indirect***
The O-ring seals should not be used because they are unreliable at low temperatures and compromise safety.	The O-ring seals are not reliable and could compromise safety at temperatures under 40 degrees F.
We should implement the new procedure as soon as possible.	The new procedure will reduce construction time by 40% with little cost in overhead.
The Highway Board should purchase digital photolog sensors.	Digital photolog sensors will produce accurate measurements in far less time than manual inspections.

Note how the recommendations in the "Direct" column sound much more forceful than those in the "Indirect" column. Managers and executives often do not like to be told what to do. Thus, in general, you should avoid using direct recommendations unless

(a) you have been specifically asked to provide a direct recommendation or
(b) safety is at stake or
(c) you have considered and reported on all of the factors necessary for an informed decision.

Thus, the first example in the table above should be stated as a direct recommendation: since the O-ring seal presents a safety threat, you should be as explicit as possible in warning readers about this threat. However, the second and third examples should probably use the indirect style since there are other factors—such as the exact cost, supplier information, and possibly other information that might affect the decision—that have not been explicitly considered in the analysis.

******NOTE******

The direct style of recommendation—i.e., we *should* or *should not* do X—should only be used in cases when safety is an issue, when you have specifically been asked to provide a recommendation, or when you feel confident that you have considered all factors necessary to make an informed decision.

--

EXERCISES USING SIMPLE DATA

Take the tables and figures that appear below and "digest" the data using the three-part strategy described above. Note that the data that appears below has been greatly simplified in order to help you become accustomed to the three-part strategy. Future exercises will introduce you to variations on this three-part format that will help you discuss more complex data.

EXAMPLE

A.

Table A: Introductory Computer Science students' responses to a questionnaire asking if they would prefer programming projects that emphasize real-world programming applications or projects that contain technical details only.

Preference	Percent Responding
Technical Details only	10%
Technical Details + Real World Application	62%
No Preference	28%

What does the person reading this data most likely want to know?
The person reading this is most likely a professor who wants to know what type of projects to assign.

Digested Data:

Table A suggests that most computer science students prefer projects that include real world contexts as well as technical details.

Step 1: Refer to table and main finding

While 10% of the students surveyed preferred projects limited to bare-bones technical details and 28% had no preference, over 60% preferred projects that mentioned real world contexts.

Step 2: Emphasize data points

This survey data thus suggests that instructors could motivate the most students by using assignments that emphasize real-world contexts in addition to technical details.

Step 3: State bottom line: connect to readers' goal of knowing what types of assignments to give.

--

1.

Table 1: Typing speeds for eight professional data entry clerks working on 15", 17"and 19" computer monitors

Monitor Size	Average typing speed (and standard deviations) in words per minute
15"	80.0 (8.5)
17"	80.9 (8.6)
19"	84.1 (11.3)

What does the person reading this data most likely want to know?

Present this data in digested form:

2.

Table 2: Return rates for questionnaires printed on 100 white paper vs. 100 questionnaires printed on colored paper

Paper Color	Percent of questionnaires returned
White	28%
Yellow	30%
Blue	31%
Pale Pink	31%
Electric Pink	35%

What does the person reading this data most likely want to know?

Present this data in digested form:

3.

Table 3: Truck accidents per vehicle miles for three different interstate highways

Interstate	Accidents per 100,000 vehicle miles
I-53	1.94
I-55	1.98
I-62	3.19

What does the person reading this data most likely want to know?

Present this data in digested form:

--

4.

Table 4: Coefficient of Friction (COF) for three types of surface. (Note: a high COF is good as it means people will be less likely to slip on this type of surface).

Surface	***COF***
Vinyl	1.02
Steel	.06
Terrazzo	.08

What does the person reading this data most likely want to know?

Present this data in digested form:

5.

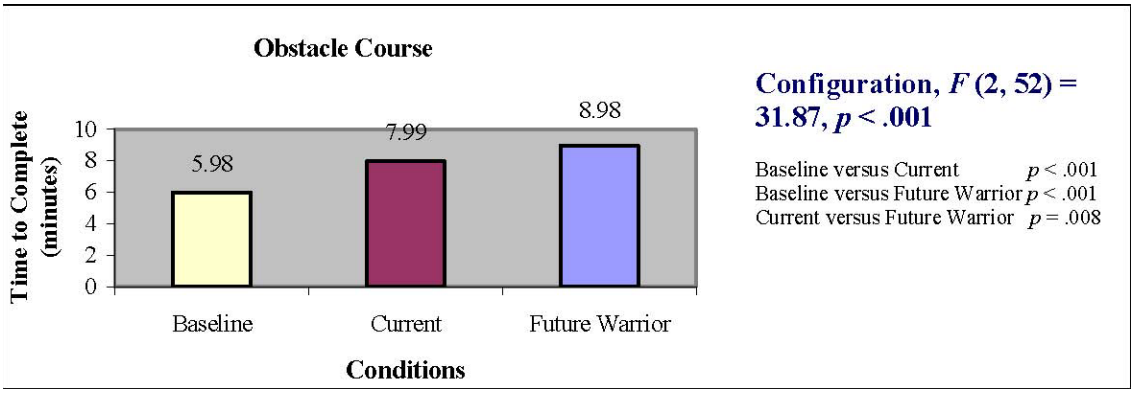

Figure 1: Average time for soldiers to complete obstacle course wearing baseline (no chemical protected clothing), current, and proposed "future warrior" protective gear.

What does the person reading this data most likely want to know?

Present this data in digested form:

--

Reporting Data II: Digesting Multiple Data Points

We are now going to introduce you to a slight variation in your "formula" for digesting data. Oftentimes, you are going to have multiple trends in your data that you want to point out to users. When your data has multiple findings or conclusions you can draw, your first step is to distinguish *main trends* from *secondary trends*.

Let's begin by looking at some data that has multiple trends:

Table X: Average number of errors and time to assemble machine part for two different sets of instructions.

Instruction set	***Average time to complete assembly (in seconds)***	***Average number of assembly errors***
Instruction set A	224 s	0.37
Instruction set B	197 s	0.18

Table X displays two separate trends:
(1) time to complete assembly decreased with instruction set B
(2) assembly errors decreased with instruction set B

Both of these findings are good news for Instruction set B. But which of these two trends should you emphasize when reporting your results? In other words, which of these two trends is your *main trend*?

There are two questions to ask yourself when deciding which trend you should select as your main trend:
1. Which trend has the strongest support from the data?
2. Which trend is most important to my readers?

In the case of Table X, the trend for reduction in errors has stronger support from the data than the trend for time to complete assembly: errors were cut by over 50% for instruction set B while time was reduced by a much smaller percentage (about 15%). Thus, the error trend has the stronger support from the data.

Moreover, the main reader of this document most likely wants to know which set of instructions will improve productivity on the assembly room floor. Since correct assembly is generally more important than quick assembly, the reader is probably more concerned about reducing errors than reducing assembly time. Thus, the error trend is also the most important to readers.

Our new formula for interpreting data with multiple trends thus looks as follows:
1. Refer to the table or figure and state the *main trend*.
2. Support the main trend by contrasting high and low data points.
3. Use a transition showing accumulation and state the *secondary trend*.
4. Support the secondary trend by contrasting high and low data points.
5. State the bottom line: Connect the data to what your reader wants to know.

--

Common transitions showing accumulation include

Moreover **In addition** **Additionally** **Furthermore**
Similarly **Likewise** **Also** **More importantly**

So the "digested" version of Table X would look as follows:

Table X suggests that Instruction set B reduced the number of assembly errors.	Step 1: Refer to Table and main finding
While workers made an average of .37 assembly errors per person with instruction set A, they averaged only .18 errors with instruction set B.	Step 2: Contrast high and low data points of main trend
Moreover, Instruction set B also reduced assembly time.	Step 3: Use transition showing accumulation to state secondary trend.
Whereas workers using Instruction set A completed assembly in an average of 224s, workers using Instruction set B completed assembly in an average of 197s.	Step 4: Contrast high and low data points of secondary trend.
This data thus suggests that instruction set B may improve assembly production.	Step 5: State bottom line

--

EXERCISES:

Digest the sample data in the tables below using the 5-part formula described above.

EXAMPLE

B. Indirect Recommendation

Table Y: Coefficient of Friction (COF) for three types of surface. (Note: a high COF is good as it means people will be less likely to slip on this type of surface).

Surface	*COF when surface is dry*	*COF when covered with oily contaminant*
Vinyl	.13	.03
Steel	.06	.02
Terrazzo	.08	.02

What does the person reading this data most likely want to know?

The person reading this is most likely responsible for purchasing or recommending a flooring surface for a building or factory and wants to know what surface is safest.

What is the main trend in this data? Why?

The main trend is the high COF of vinyl when surface is dry because this trend has the strongest data to support it.

Digested Data:

Table Y shows that vinyl has a higher COF than steel and terrazzo.	Step 1: Refer to Table and main finding
While dry steel had a COF of .06 and dry terrazzo a COF of .08, dry vinyl had a COF of .13.	Step 2: Contrast high and low data points of main trend
In addition, vinyl also had a slightly higher COF than other surfaces when covered with oil.	Step 3: Use transition showing accumulation to state secondary trend.
Vinyl's COF when covered with an oily contaminant was .03 whereas terrazzo and steel both have a COF of only .02.	Step 4: Contrast high and low data points of secondary trend.
This data thus suggests that vinyl surfaces will reduce slippage on both dry and oily factory floors.	Step 5: State bottom line: connect to reader's goal of knowing which surface is safest.

--

1.

Table 1: Mean target hit percentage and time to first shot by military equipment configuration.

Equipment configuration	*Hit Percentage*	*Mean time to first shot (in seconds)*
Current	.77	3.71
Proposed	.82	3.69

What does the person reading this data most likely want to know?

What is the main trend you want to emphasize? Why?

Present this data in digested form:

2.

Table 2: Users' responses to two different shopping websites.

Performance Measure	*Original Interface*	*Revised Interface*
Users able to complete purchase successfully	68%	95%
Average number of severe errors per user	0.95	0.15
Average satisfaction with website on a 5-point scale (1= very unsatisfied; 5 = very satisfied)	2.75	4.10

What does the person reading this data most likely want to know?

What is the main trend you want to emphasize? Why?

Present this data in digested form:

3.

Table 3: Introductory Computer Science students' responses to a questionnaire asking if they would prefer programming assignments that are based upon video games.

Preference	**Females (n=45)**	**Males (n=230)**	**All students (n=275)**
Prefer assignments based on video games	7% (n=3)	30% (n=69)	26% (n=72)
Prefer assignments NOT based on video games	33% (n=15)	9% (n=20)	13% (n=35)
No Preference	60% (n=27)	61% (n=141)	61% (n=168)

What does the person reading this data most likely want to know?

What is the main trend you want to emphasize? Why?

Present this data in digested form:

--

Reporting Data III: Digesting data with exceptions

The data that you worked with in the previous chapters were manipulated so that you could report relatively straightforward, uncomplicated results. However, most of the time you are going to work with data that cannot be summarized so neatly. Oftentimes, you will have data that does not fit—or even contradicts—the main trend you are reporting.

Let's begin by looking at the example we used in the last chapter—only this time we are going to use values that report contradictory trends.

Table X: Average number of errors and time to assemble machine part for two different sets of instructions.

Instruction set	***Average time to complete assembly (in seconds)***	***Average number of assembly errors***
Instruction set A	224 s	0.37
Instruction set B	292 s	0.18

Note that while this data shows that Instruction set B reduced assembly errors, it actually *increased* assembly time. Thus, while Instruction set B improved performance on one measure (errors) it depressed performance on another measure (time).

Just as in the last chapter, we need to decide which of these trends (error or time) is our *main trend*. Since correct assembly (fewer errors) is more important than speed of assembly (less time), we will focus on reduced errors as our main trend. The increase in assembly time thus becomes the *exception to the main trend*.

Here is the formula we will use to report exceptions to main trends:

Our new formula for interpreting data with multiple trends thus looks as follows:

1. Refer to the table or figure and state the *main trend*.
2. Support the main trend by contrasting high and low data points.
3. Use the transition *however* and then state the *exception*.
4. Provide a reason to explain this exception.
5. State an overall bottom line that also concedes to the exception.

--

So, the "digested" version of Table X would look as follows:

Table X suggests that Instruction set B reduced the number of assembly errors.	Step 1: Refer to table and main finding
While workers made an average of .37 assembly errors per person with instruction set A, they averaged only .18 errors with instruction set B.	Step 2: Contrast high and low data points of main trend
However, Instruction set B increased assembly time.	Step 3: Use *however* to state exception.
This increase may be due to the increased effort and complexity involved in actually assembling the part correctly.	Step 4: Provide reason to explain exception.
This data overall suggests that instruction set B may improve assembly production even though assembly times will increase.	Step 5: State overall bottom line that concedes to exception.

Steps 1-3 should be fairly clear, so let's begin by analyzing Step 4 in some detail.

Step 4. Provide a reason to explain the exception

After you point out the exception and the data supporting it, try to provide a plausible reason that might explain this exception. If you cannot think of a reason, state that you do not understand and that more research is needed.

There are two parts to providing this reason:

1. Use the *old/new strategy* (also known as the given/new or inchworm strategy) to begin the sentence.

   The old/new strategy basically involves beginning sentences with information the reader already knows (in other words, old information) and introducing new information toward the end of the sentence. Thus, your sentences should move like inchworms with the beginning repeating a little bit of information from the previous sentence while the end of the sentence takes a small step forward.

   The old/new strategy is one of the main ways you can improve your writing's coherence and make your writing easier for readers to understand.

   Common phrases for introducing old information when discussing data include:

This inconsistency	**This finding**	**This low value**
This difference	**This trend**	**This high value**
This increase	**This result**	**This unexpected finding**
This decrease	**This anomaly**	

--

2. Use the phrase ***due to*** or ***caused by*** to introduce your reason.

Examples:

Old information	**Reason**
This poor performance	is due to the expansion of the rubber seals at high temperatures
This inconsistency	may be due to problems with the measurement instruments.
The low COF value for Dow Liquid Armor	is caused by the presence of additives in this version of the solution.

Step 5: State an overall bottom line that concedes to the exception

You still want to end your "digested" paragraph with a statement that connects the data to what the reader most wants to know. However, since your bottom line is not entirely clear, you should also make sure that this last sentence includes a clause that concedes to the exception. You may want to refer back to the chapter on *Presenting Bad News: Joining Sentences to Show Concession*.

> Recall from *Presenting Bad News: Joining Sentences to Show Concession* that the subordinators *although, even though, though,* and *while* can be used to introduce concessions. These words all de-emphasize the clause they are attached to.

Your revised "formula" for stating the bottom line now looks as follows:

Noun referencing data	***Transition showing generality***	***Verb referencing data***	***Bottom Line***	***Concession***
These findings	overall	suggest that	the new equipment will improve accuracy	although speed will be reduced slightly.
These tests	generally	suggest that	conventional needles may be more reliable than hydrostatic needles	even though hydrostatic needles do perform slightly better at extremely high rotations.
Our computer models	overall	suggest that	ejection mitigation glazings can reduce fatalities	despite a slightly higher risk for head and neck injury.

--

EXERCISES:

EXAMPLE

Reason for exception: Pastel colors are becoming commonplace in office correspondence.

Table Y: Return rates for questionnaires printed on 100 white paper vs. 100 questionnaires printed on colored paper

Paper Color	**Percent of questionnaires returned**
White	28%
Yellow	27%
Light Green	28%
Pale Pink	28%
Electric Pink	33%

Data presented in digested form:

Table X suggests that questionnaires distributed on very bright paper might have higher return rates than those printed on white paper.

Step 1: Refer to table and main finding

While 28% of questionnaires printed on white paper were returned, 33% of electric pink questionnaires were returned.

Step 2: Emphasize data points using subordinator showing contrast.

However, the higher response rates do not seem to be true for pastel colors such as yellow, light green, and pale pink.

Step 3: Use *however* to introduce exception.

The relatively poor performance of pastel colors may be due to these colors becoming so common in general office correspondence.

Step 4: Use *old/new contract* and *due to* to introduce a reason explaining the exception.

These findings overall suggest that questionnaires printed on vibrant colors are more likely to be returned, although this is not the case for pastel colors.

Step 5: Use *old/new contract*, *overall* and concession subordinator to state bottom line that concedes to exception.

--

1. Reason for exception: The proposed configuration is slightly heavier than the current.

Table 1: Mean target hit percentage and time to first shot by military equipment configuration.

Equipment configuration	*Hit Percentage*	*Mean time to first shot (in seconds)*
Current	.77	3.71
Proposed	.82	3.75

What does the person reading this data most likely want to know?
What is the main trend you want to emphasize? Why?
Present this data in digested form:

2. Reason for exception: Users complained about the color scheme of the revised interface.

Table 2: Error rates and user satisfaction of original and revised shopping interfaces

	Original Interface	Revised Interface
Users able to complete purchase successfully	80%	95%
Average number of errors per user	0.25	0.19
Average satisfaction with interface on a 5-point scale (1=unsatisfied; 5 = very satisfied)	4.10	3.90

What does the person reading this data most likely want to know?
What is the main trend you want to emphasize? Why?
Present this data in digested form:

3. Reason for Exception: Filter A uses a scripting language rather than a compiled programming language.

Table 2: Percentage of junk mails correctly filtered

Filter	**Percentage of junk emails correctly filtered (out of 5000)**	**Run time (in seconds)**
Spam Filter A	**88%**	**240s**
Spam Filter B	**63%**	**161s**

What does the person reading this data most likely want to know?
What is the main trend you want to emphasize? Why?
Present this data in digested form:

--

4. Reason for exception: The head injuries occurred because the dummy hit its head on the roof—and not the safety-glazed windows.

Note: Failure to retain an occupant in the vehicle greatly increases the potential for fatalities
Note: HIC values of 300 and below are non-critical. Values above 300 are critical.

Table 4: Ejection and Head Injury Criteria (HIC) values produced during roll-over simulations with a dummy for different types of window glass.

Type of Glass	***Dummy Retained in Vehicle***	***Head Injury Criteria (HIC) Value Sustained by Dummy***
Open window	No	78
Standard tempered glass	No	134
Safety-glazed glass	Yes	279

What does the person reading this data most likely want to know?

What is the main trend you want to emphasize? Why?

Present this data in digested form:

--

Reporting Data IV: Emphasizing Differences

Often when you are digesting data you will want to focus readers' attention on the amount or degree of difference between certain conditions or configurations. This chapter introduces you to some slight changes in our formula for digesting data that draw readers' attention to the exact degree of difference.

Let's begin by taking a look at a particular example.

Table X: Change in traffic volume after converting Elm St. from two-way to one-way traffic flow.

Traffic Direction	***Average vehicles per hour between 4pm and 6pm***
Two-way installation	652
One-way installation	902

The first step under our formula for digesting data would say something like

(a)Original formula – step 1
Table X shows that traffic flow on Elm street increased after it was converted to a one way installation.

However, if we want to emphasize the amount of difference, we might say

(b) Revised formula – step 1
Table X shows that traffic flow on Elm street increased by 38% after it was converted to a one way installation.

Phrasing (a) above states a trend; phrasing (b) emphasizes the exact *amount of difference*. Phrasing (b) is particularly effective if you think this amount of difference will impress readers. In the case of Table X, 38% is a large increase; therefore, it makes sense to emphasize it.

Other cases might not be so clear cut. For instance, look at the two variations for "digesting" table Y.

Table Y: Typing speeds for eight data entry clerks working on 15", 17"and 19" computer monitors.

Monitor Size	**Average typing speed (and standard deviations) in words per minute**
15"	80.0 (8.5)
17"	80.9 (8.6)
19"	84.1 (11.3)

(a) Original formula—step 1
Table X shows that clerks using 19" monitor produced the highest typing speeds.

(b)Revised formula—step 1
Table X shows that clerks using the 19" monitors had typing speeds that were 5% faster than those using the 15" monitors.

--

In this case, 5% is not a particularly big difference. Some readers might be tempted to ignore findings this small. In this case, version A is probably more effective. However, version B could also be effective if the writer were to follow up this analysis of the table with some additional data illustrating why 5% is in fact a noteworthy difference.

> The average clerk processes 7680 records per year. A 5% increase across all eight clerks would mean an additional 3072 records processed per year, roughly the equivalent that would be expected from hiring another half-time clerk.

This new formula obviously requires you to do some additional math in order to transform the raw data from the table into a percentage that expresses the amount of change. In this case, 38% was obtained by dividing 902/652 = 1.38. This means that 902 is 138% of 652, or in other words, that 902 represents a 38% increase over 652.

NOTE

Expressing data as percentages is considered basic math. If you need a review, you can go to
http://www.purplemath.com/modules/percntof.htm
http://www.mathsteacher.com.au/year7/ch10_percentage/05_quan/quan.htm
or try going to Google and search for *converting percentages*.

SAMPLE PROBLEMS:

These problems are for those who want to make sure that they understand the math required in these exercises. The answers and explanations to these problems appear at the end of this section:

1. X = 20 seconds; Y = 25 seconds

   (a) Y is ____% slower than X.
   (b) X is ____% faster than Y.

2. X = 4.2 cm; Y = 6.2 cm

   (a) Y is ___ % larger than X.
   (b) X is ___% smaller than Y.

3. Memory used by X = 24 MB
   Memory used by Y = 86 MB

   (a) Y uses ___% more memory than X
   (b) X uses ___% less memory than Y.

4. Before upgrade, # of crashes caused by ntdll= 56/wk
   After upgrade, # of crashes caused by ntdll= 42/wk

   After the upgrade, ntdll crashes decreased by ___%.

5. Before 9/11 average airport wait time = 48 minutes
   After 9/11 average airport wait time = 81 minutes

   After 9/11, airport wait times increased by ___ %.

6. Before change = 2.8 accidents per million vehicles
   After change = 1.4 accidents per million vehicles

   After the change, accidents decreased by ____%.

--

Two formulas for emphasizing difference: Differences between groups vs. Before/After changes

Differences between groups

If you are trying to focus your reader's attention on the amount of difference between two or more groups, you should use the formula below:

Name of group 1	***verb***	***number***	***comparison***	***Name of group Y***
The COF of vinyl	is	68%	higher than	the COF of steel.
The Firefox browser	uses	24%	less memory than	Internet Explorer
The new motor	is	twice	as fast as	the old one

Between-groups comparisons should generally name both of the groups you are comparing.

Incorrect: The new equipment is 15% lighter.
Correct: The new equipment is 15% lighter than the old equipment

Before/After changes

If you are trying to focus your reader's attention on the amount of change that occurred after some event, you should use one of the following verbs that emphasize change:

increased **decreased**
improved **reduced**

Use the following formula to emphasize before/after changes:

After	***describe change***	***Noun***	***verb expressing change + by***	***Number/ proportion***
After	the new policy was implemented,	productivity	increased by	20%
After	installation of the new walk signals,	pedestrian accidents	were reduced by	68%
After	the catalytic converter was installed,	emissions	decreased by	one third

--

Precision of comparisons

Figures 1 below shows that phrasings that emphasize difference can vary in how precise they are.

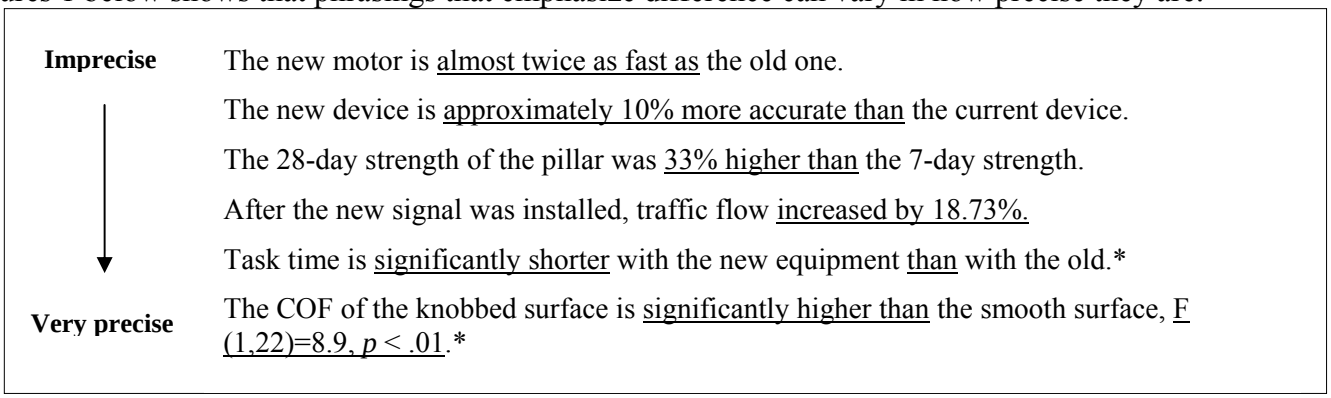

Figure 3: Emphasizing DIFFERENCES between groups of data

In general, the more technical your reader, the more precise you should be in describing your data. Managers may often respond better to rounded numbers than exact figures, but engineers and technical personnel will want to see precise numbers.

NOTE

* The word ***significant*** has a specialized meaning when applied to numbers. Significant means that data has been analyzed using statistical tests and been found to be significant at the level of $p < .05$ or better. If you have not run statistical tests or do not have a significant *p* value, do not use the word significant.

--

ANSWERS TO SAMPLE PROBLEMS

1. X = 20 seconds; Y = 25 seconds

(a) Y is 25% slower than X.

Divide the value of Y by the value of X: 25/20 = 1.25
Y is 125% of X, or since 125%-100% = 25%, 25% slower than X

(b) X is 20% faster than Y.

Divide the value of X by the value of Y: 20/25 = .8
X is 80% of Y; since 100%-80%=20%, X is 20% faster than Y

2. X = 4.2 cm; Y = 6.2 cm

(a) Y is 47.6% larger than X.

Divide the value of Y by the value of X: 6.2/4.2 = 1.476
Y is 147.6% of X, or since 147.6%-100% = 47.6%, 47.6% larger than X

(b) X is 32.3% smaller than Y.

Divide the value of X by the value of Y: 4.2/6.2 = .677
X is 32.3% of Y; since 100%-67.6%=32.3%, X is 32.3% smaller than Y

3. Memory used by X = 24 MB
Memory used by Y = 86 MB

(a) Y uses 258% more memory than X

Divide the value of Y by the value of X: 86/24 = 3.58
Y is 358% of X, or since 358%-100% = 258%, 258% more than X

(b) X uses 72% less memory than Y

Divide the value of X by the value of Y: 24/86 = .28
X is 72% of Y; since 100%-28%=72%, X is 72% less than Y

4. Before upgrade, # of crashes caused by ntdll= 56/wk
After upgrade, # of crashes caused by ntdll= 42/wk

After the upgrade, ntdll crashes decreased by 25%

Divide the *AFTER* value by the *BEFORE* value: 42/56 = .75
The *AFTER* value is 25% of the *BEFORE* value; since 100%-75%=25%, crashes decreased by 25%

5. Before 9/11 average airport wait time = 48 minutes
After 9/11 average airport wait time = 81 minutes

After 9/11, airport wait times increased by 69 %.

Divide the *AFTER* value by the *BEFORE* value: 81/48 = 1.69
The *AFTER* value is 169% of the *BEFORE* value, or since 169%-100%=69%, wait times increased by 69%

6. Before change = 2.8 accidents per million vehicles
After change = 1.4 accidents per million vehicles

After the change, accidents decreased by 50%.

Divide the *AFTER* value by the *BEFORE* value: 1.4/2.8 = .50
The *AFTER* value is 50% of the *BEFORE* value, since 100%-50%=50%, accidents decreased by 50%

--

EXERCISES:

For each exercise, digest just the first sentence of the data to emphasize the amount of difference.

EXAMPLE

Table X: Average start up times of three browsers on a slow machine

Browser	Average startup time
Firefox	12.0 s
Internet Explorer	7.7 s
Opera	5.0 s

Provide an initial sentence emphasizing the benefits of Opera for a non-technical audience:
Table X shows that the startup time of Opera is almost 60% faster than Firefox and 35% faster than IE.

Note: since the audience is non-technical, we use rounded figures rather than exact numbers.

1.

Table 1: Emissions output for two different fuels

Fuel Type	Vehicle emissions
Fuel A	3.61
Fuel B	2.47

Provide an initial sentence emphasizing the benefits of Fuel B for a technical audience:

2.

Table 2: Acceleration times for Mazda Miata and Pontiac Solstice

Car	*Time to accelerate from 0-60 mph*
Mazda Miata	6.7s
Pontiac Solstice	7.2s

Provide an initial sentence emphasizing the benefits of the Miata for a general, non-technical audience:

--

3. Emphasize the benefits of the upgrade for a technical audience.

Note: A benchmark is a program that performs the same operations on different devices, measures execution time and compares the results. This is probably the only method to compare performance objectively. The output of the Spb benchmark test is an index that measures overall performance.

Table 3: Effects of an OS upgrade on performance of a Compaq iPaq

OS	**Performance index on Spb benchmark test**
Windows Pocket PC 2002	828.06
Windows Pocket PC 2003	953.18

Provide an initial sentence emphasizing the benefits of the upgrade for a technical audience:

4.

Table 4: Hours per week average engineering student spends studying outside of class.

Year	***Average hours studying per week***
2000	26.4
2006	23.9

Provide an initial sentence emphasizing the poor study habits of today's students for a general, non-technical audience:

5.

Table 5: Memory usage of three browsers with no pages loaded

Browser	**Memory usage**
Firefox	42 MB
Internet Explorer	24 MB
Opera	53 MB

Provide an initial sentence emphasizing the disadvantage of Opera for a general, non-technical audience:

--

Reporting Data V: Condensing Data

Often when you are discussing large, complex tables of data, you will need to condense your numbers by summarizing across multiple data cells in order to present the data in digested form. Such summarization is particularly important when you are writing for non-technical audiences. For example, look at table X below

Table X: Mean target hit percentage and time to first shot by military equipment configuration and target distance

Equipment configuration	Range (in meters)	Hit Percentage	Mean time to first shot (in seconds)
Current config.	50-90	.78	3.74
	90-140	.40	4.26
	140+	.39	4.35
Proposed config	50-90	.80	3.72
	90-140	.48	4.18
	140+	.42	4.31

The person reading this table most likely wants to know whether the current configuration or the proposed configuration is better. However, there is so much data here that it is difficult to compare the two configurations easily. We could report separate results for each firing range, but that would quickly mushroom into a string of numbers that non-technical readers would find off-putting or confusing.

Probably the best way to compare these two configurations is to calculate averages for the hit percentage and mean times of each configuration. These averages can then be compared against one another. Thus, our calculations would look as follows:

Current Config – Hit Percentage	Current Config – Mean Time	Proposed Config - Hit Percentage	Proposed Config - Mean Time
.78	3.74	.80	3.72
.40	4.26	.48	4.18
.39	4.35	.42	4.31
+	+	+	+
1.57	12.35	1.70	12.21
1.57/3 = .52 Average hit percentage	12.35/3 = 4.12 Average mean time	1.70/3 = .57 Average hit percentage	12.21/3 = 4.07 Average mean time

Now that we have condensed the results for each target range into a single average, we are now ready to calculate the amount of difference for our two variables:

Difference in hit percentage
Proposed hit percentage/ current hit percentage = .57/.52 = 1.096, or 109.6%.
109.6%-100% = 9.6%
The hit percentage for the proposed configuration is 9.6% higher than for the current configuration.

Difference in time to first shot

--

Proposed mean time/ current mean time = 4.07/4.12 = .987 or 98.7%.
100%-98.7% = 1.3%
The proposed configuration is 1.3% faster than the current configuration

So, here's how we would digest this data:

> Table X indicates that, on average, the hit percentage is 9.6% higher for the proposed configuration than for the current configuration. Moreover, the mean times to first shot decreased slightly (by an average of 1.3%) when soldiers were using the proposed configuration. These findings suggest that the proposed configuration has some advantages over the current configuration.

The phrase *on average*

When you are condensing data as we have done above, you should be sure to let your readers know that you are comparing averages by including a phrase such as on average or averaged across. Here are various ways of communicating that you are comparing averages:

> On average, X is 5% more than Y.
> Averaged across all three conditions, X is 5% more than Y.
> The value of X, averaged over six months, is 5% more than Y.
> The average value of X is 5% more than Y.

--

EXERCISES:

EXAMPLE

Table Y: Energy usage per day in kilowatt hours before and after using insulating paint

Month	2004—before insulating paint	2005—after insulating paint
May	59	54
June	77	62
July	89	74
August	112	96
Sept.	116	112

Digest this data to emphasize the benefits of insulating paint.

After using insulating paint, average energy usage dropped by over 12%.

How we arrived at the 10% figure:

1. Add up all of the values in the column for 2004: 453
2. Divide this number by the total number of months: 453/5 = 90.6
3. Add up all of the values in the column for 2005: 398
4. Divide this number by the total number of months: 398/5 = 79.6
5. Compare the two averages:
    a. Divide the *AFTER* value by the *BEFORE* value: 79.6/90.6 = 87.9%
    b. The *AFTER* value is 87.9% of the *BEFORE* value
    c. Or since 100%-87.9%=12.1%, energy usage dropped by 12.1%

--

1. **Table 1: Student complaints about parking by month**

Month	*# of complaints about parking*
August	72
September	84
October	68
November	60
December	51
January*	22
February	18
March	11
April	12

* On January 1, a new parking garage was opened.

Digest this data to emphasize the change in parking after new garage was opened on January 1.

2.

Table 2: Average reading times and comprehension scores for a textbook passage printed using different fonts.

Font set		*Average time to read passage*
Standard Fonts	Times New Roman	234 s
	Verdana	238s
	Arial	245 s
Non-standard fonts	Comic Sans MS	289 s
	Goudy Stout	301 s
	Curlz MT	401 s

Digest this data to emphasize the benefits of Standard fonts for a non-technical audience.

3.

Table 3: Energy usage (in kilowatthours per year) and cost of different refrigerator models

Refrigerator type	*Model*	*Energy use in kwh/year*	*Estimated Annual Energy cost*
Refrigerators with a top freezer	Kenmore 6021	292	$25
	Kenmore 7041	364	$32
	Sunfrost 231A	401	$38
Refrigerators with side-by-side freezer	Kenmore 5630	582	$48
	Whirlpool 1211	605	$50

Digest this data to emphasize the benefits of a top freezer.

--

Statistical Information as a Modifier

The same technical report is often read by multiple types of readers. Some of the readers will be very technical and will want to know exact results of measurements, calculations, and statistical tests. Other readers will be managers, clients, and users who just want the "big picture" and will trust you to make sure all of the numbers are correct.

To balance the needs of these two audiences, technical writers often move detailed numerical and statistical information to the ends of sentences or to parentheses in the middle of sentences. This placement provides detail for those technical readers who want to check all of your calculations, but also presents the information in such a way that non-technical readers can easily skip over information they don't need.

Thus, when writing complex technical analyses, we often place detailed numerical information in a modifying clause at the end of a sentence. There are several ways to connect this technical information to the main clause of the sentence:

- Connect with a preposition such as *at, with, from, to*
- Connect with a *–ing* verb such as *representing, accounting, indicating*
- Connect with *which*
- Connect with a comma followed by numerical details. This last variation is most frequently used when reporting statistical information.

Connect with preposition

Some of the most common compressors, like WINZIP and WINACE, are among the most efficient, **main clause**	with efficiency scores equal to 0.96 and 0.98, respectively. **technical details**
The number of hours the average engineering student studied declined 3%, **main clause**	from 24.2 to 23.5 hrs/wk. **technical details**

Connect with *–ing* verb

9,012 drivers were found to be in violation, **main clause**	accounting for about 3.8% of the total. **technical details**
The number of hours the average engineering student studied decreased from 24.2 to 23.5 hrs/wk **main clause**	representing a 3% decline. **technical details**

Connect with *which*

9,012 drivers were found to be in violation, **main clause**	which accounts for about 3.8% of the total. **technical details**
The number of hours the average engineering student studied decreased from 24.2 to 23.5 hrs/wk **main clause**	which represents a 3% decline. **technical details**

--

Connect with comma—used with statistical information*

This analysis revealed a significant main effect for configuration,	Wilks' $\lambda = .42$; $F(2,10) = 6.92$; $p = .013$
main clause	**technical details**
The COF of the knobbed surface is significantly higher than the smooth surface,	$F(1,22)=8.9$, $p < .01$.
main clause	**technical details**

* **NOTE:** The word *significantly* has a special meaning when used in reporting data. *Significant* means that the data has been analzed using statistical tests and been found to be significant at the level of $p < .05$ or better. If you have not run statistical tests or do not have a significant *p* value, do not use this word.

A second way to push technical information out of the spotlight where it won't interfere too much with non-technical readers is to place this information in parentheses, as in the following examples:

> A regression model (with an R^2 of 0.91) was established to describe and predict the relationship between the COF and the tread groove width
>
> Analyses of main effects on time to first shot revealed a significant effect of configuration (F (2, 22) = 29.87, $p < 0.001$), weapon sight (F (1, 11) = 8.27, $p < 0.015$), range (F (2, 22) = 78.01, $p < 0.001$), and angles (F (3, 33) = 40.17, $p < 0.001$).

In these cases, statistical tests and information have been moved to parentheses where readers can skip them.

--

EXERCISES:

Combine the following sentence kernels into a single sentence.

1.

Coal ranked second as a primary energy source in 2004.
Coal accounts for 25.6 percent of world primary energy production.

2.

The number of inspectors responding that voice dictation would be "very beneficial" outweighed those responding that it would be "somewhat beneficial."
The number responding that it would be "very beneficial" was 71.4%
The number responding that it would be "somewhat beneficial" was 28.6%.

3. The COF was significantly higher for the larger tread widths.
The statistical test was $F\ (2,18) = 12.42$, $\underline{p} < .001$.

4.

Pacific mountain states have the highest per person accident rates.
These rates are 29.5 accidents per 100,000 people.

5.

The 7 day-strength of the concrete cylinder was 5931.17 and the 28-day strength was 6593.73 psi.
This represents an increase of 68%.

6. The most efficient compressors for text files are BIX, PKZIP, and XPA.
These compressors all have a TE score equal to one.

7. Nuclear electric power generation increased significantly between 1994 and 2004.
Nuclear electric power generation rose from 2.1 trillion kilowatthours to 2.6 trillion kilowatthours.
This is a 23.2-percent increase.

8.

The emissions output of the traditional fuel was three times as high as the alkylate blend.
This difference is statistically significant.
The statistical test is $F(2,19) = 6.92$, $p < .05$.

--

Reporting Data: Review

THE BASIC FORMULA

Our basic formula for digesting data has up to five parts, depending on the type of data. The first and last statements are the most important because these state what the data actually means. These "bottom" line statements act as a kind of "sandwich" for the supporting details and are always present.

1. **Refer to the data and state the main trend**
2. **Support this statement with data**
3. **Note any additional trends and support them with data**
4. **Note any exceptions and provide reasons**
5. **State the bottom line.**

VARIATIONS TO THE FORMULA

Depending on the complexity of your data, some of these steps can be modified or condensed. Here is an overview of various options you may exercise.

1. Refer to the data and state the main trend
2. Support this statement with data

If you are working with very simple data, you may sometimes combine steps 1 and 2 by emphasizing difference. If your data is complex or you have run statistical tests, then keep these separate statements.

3. Note any additional trends
a. state the trend
b. support this trend with data

Again, if your data is simple, you can consider combining 3a and 3b. If your data is complex or you have run statistical tests, keep these separate sentences.

4. Note any exceptions
a. state the exception
b. *Optional:* support exception with data
c. explain exception (*may be skipped*)

If you want to call your reader's attention to the importance of an exception or drawback, then support it with data.

If the reason for your exception is obvious to your reader, you may skip step c.

5. State the bottom line.

If your data has an exception, your "bottom line" should concede this potential problem with your findings.

If your reader asks you to make a direct recommendation, use a should statement.

--

Now, let's go through the basic formula and its variations step by step.

Step 1: Refer to the data and state the main trend

Refer to data	***Verb***	***Main trend***
Figure 1	indicates	that the O-rings fail to maintain contact at low temperatures.
Table 2	demonstrates	that the COF of vinyl is 120% higher than the COF of steel.

Step 1 Checklist

- Do you begin by naming the table or figure?
- Do you use an appropriate verb (such as demonstrate, suggest, indicate, show)?
- Do you state the main finding without extrapolating on the data? (i.e., do you state that vinyl has a high COF vs. stating that the vinyl is safer than steel?)

Step 2: Support the main trend you emphasized in step 1 with data.

Subordinate (de-emphasized) clause	***Independent (emphasized) clause***	***Optional: emphasize difference***
While clerks typed 80 wpm on the 15" monitor,	they typed 84.1 wpm on the 19" monitor,	a 5% increase.

-- OR --

Independent (emphasized) clause	***Subordinate (de-emphasized) clause***	***Optional: emphasize difference***
Vinyl had a COF of 1.2	whereas steel had a COF of only .04,	a statistically significant difference, $p < .0001$.

Step 2 Checklist

- Did you attach the subordinate clause to the data you want to *de-emphasize,* leaving the data you want to emphasize in the independent (main) clause?
- Did you punctuate the subordinate clause correctly?
- If statistical tests have been run, do you include the test results at the end of the sentence?

--

Step 3: Note secondary trends.
If you have any additional trends that support your main finding, mention them here.

3a. State the trend
3b. Support the trend with data

State the trend		**Support the trend with data**		
Transition	***State trend***	***Subordinate (de-emphasized) clause***	***Independent (emphasized) clause***	***Optional: emphasize difference***
In addition,	users were more satisfied with the revised website.	While the old website received an average satisfaction rating of 3.2	the new site received an average rating of 4.5	a significant increase, t =3.1, $p < .05$

Step 3 Checklist

- Do you include a transition showing accumulation (such as in addition, additionally, moreover)?
- Do you state the secondary finding without extrapolating on the data? (i.e., do you state that vinyl has a high COF vs. stating that the vinyl is safer than steel?)
- Did you attach the subordinate clause to the data you want to *de-emphasize,* leaving the data you want to emphasize in the independent (main) clause?
- Did you punctuate the subordinate clause correctly?
- If statistical tests have been run, do you include the test results at the end of the sentence?

Variation: Combine Steps 3a and 3b to state the trend and data in one statement

If you think your audience will have little difficulty understanding the significance of your data, you can combine steps 3a and 3b into one sentence that emphasizes difference.

Standard Formula	***Variation: Combine trend and data***
In addition, the Miata had better acceleration than the Solstice at high speeds. While the Solstice took 6.3 seconds to accelerate from 60-80 mph, the Miata did so in only 5.4 seconds, 15% faster.	In addition, the Miata was able to accelerate from 60-80 mph in approximately 15% less time than the Solstice.

--

Step 4: Note any exceptions or drawbacks

An exception is any data that contradicts or does not support your main finding. For instance, you may find that a new product improves accuracy but increases task completion times. In this case, your main trend is that the product increases accuracy; the exception or drawback is that it slows down production. Your digested data needs to acknowledge and account for this drawback.

4a. state the exception or drawback
4b. *Optional:* support exception or drawback with data
4c. explain reason for exception or drawback (*may be skipped if obvious)*

Exception		**Reason**	
Transition	***State exception***	***Repeat "old" information***	***State Reason***
However,	the new spam filter takes longer to run than the old one.	This increase in time	is due to the programming language used for the new filter.

In general, your "default" should be to explain the reason for the exception or drawback. However, in some cases this reason is obvious or the drawback is so small that you don't really need to justify it. For instance, many people will immediately accept that a substantial improvement in performance will also involve a slight increase in cost. If this is the case with your readers, you may opt to skip step 4c.

Step 4 Checklist

- Do you begin with the transition *however*?
- Do you state the exception without extrapolating on the data? (i.e., do you state that vinyl has a high COF vs. stating that the vinyl is safer than steel?)
- Do you use the old/new contract to begin the second sentence with information your reader already knows?
- Do you use the phrases *due to*, *caused by*, or *because* to introduce your reason?

Variation: Support the exception or drawback with data

Most of the time, we do not want to call attention to drawbacks to our main findings. However, occasionally it is important to make sure the reader fully understands the consequences or extent of these exceptions or drawbacks. In these cases, we may add an extra step to support the exception with evidence.

However, SSRI anti-depressants slightly increase the likelihood that teens will commit suicide.	Step 3a: State the exception or drawback.
Teens who take SSRIs are 3.5% more likely than those on a placebo to attempt suicide.	Step 3b: Support the exception with data.
This increase in suicides may occur because the depressed person gains energy after taking the SSRI. This increase in energy may give a person who previously had suicidal thoughts the stamina to follow through on these thoughts.	Step 3c: Explain the reason for the exception.

--

Step 5: State the bottom line

We state the bottom line by referring to our data, making an indirect recommendation, and conceding any drawbacks to this recommendation (if applicable).

Transition	***Verb***	***Indirect recommendation***	***Drawback, if applicable***
This data therefore	indicates that	vinyl surfaces will reduce slips and falls.	
These findings overall	suggest that	SSRI antidepressants will help most teens,	although there may be a slightly elevated risk of suicide.

Step 5 Checklist

- Do you include an appropriate transition: *overall* or *in general* if your data has exceptions and *therefore* or *thus* for other cases?
- Do you use an appropriate verb to introduce your recommendation?
- Do you use the verb *will*, *may* or *might* to imply what you recommend?
- Do you use a concessive subordinator (*although*, *while* or *even though*) to concede any exceptions or drawbacks to your recommendation?

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EXERCISES

1. Digest Table 1 in a well-written paragraph that answers the question "which motor is the least noisy?"

Table 1: Noise output of two different truck motors

Motor Type	***Interior (driver's seat)***	***Exterior***
Fuel cell powered motor	39.2 dB(A)	53.5 dB(A)
Traditional Diesel motor	63.0 dB(A)	71.0 dB(A)

2. Digest Table 2 in a well-written paragraph that answers the question "are fog warning systems worth implementing?"

Notes:
- **High standard deviations in vehicle speeds are a major cause of accidents. Reducing the standard deviation in vehicle speed will lead to fewer accidents.**
- **The speed limit on the road was 50 mph.**

Table 2: Average speed and standard deviation of speed of vehicles under adverse weather conditions before and after a fog warning and education system was implemented.

Implementation	***Before implementation***	***After implementation***
Average vehicle speed	45.5 mph	48.0 mph
Standard deviations in vehicle speed	14.3 mph	7.1 mph

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3. Digest Figure 1 in a well-written paragraph that answers the question "which pavement type is safer?"

Note: A high COF is good as this means there is more traction and cars are less likely to have accidents.

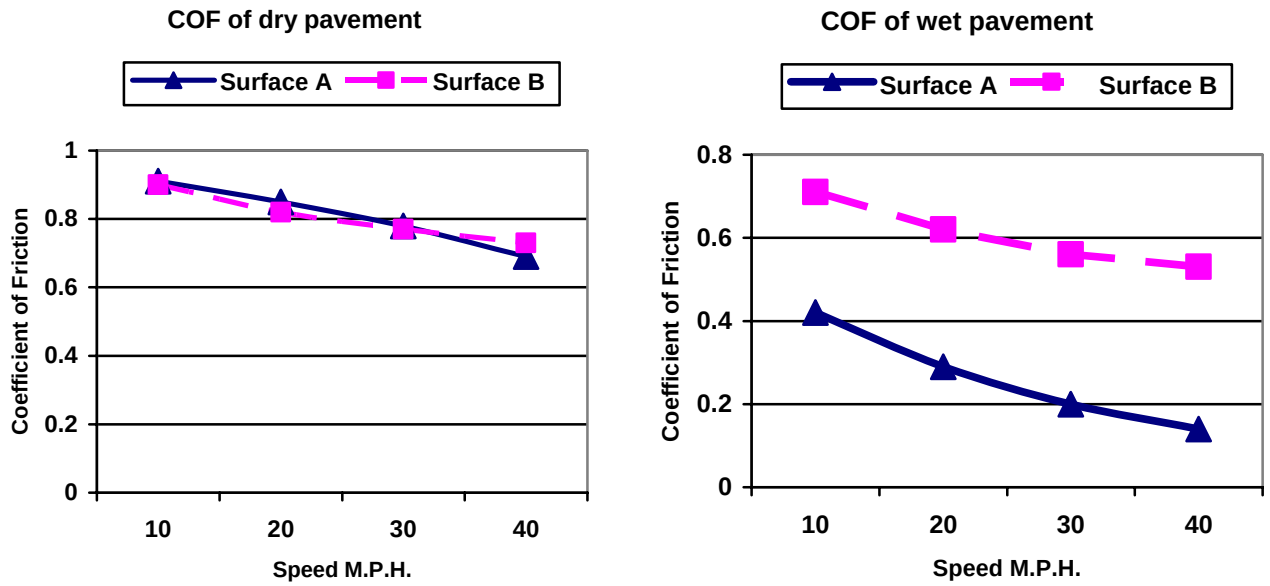

Figure 1: COF of two different pavement surfaces at different speeds in dry and wet conditions.

4**.** Digest the data in figure 2 in a well-written paragraph that answers the question "which fuel is best for the environment?" **Be sure to note the significance test in your paragraph.**

Note: The EUG2000 is a diesel fuel currently available while the SEGO fuel is an experimental alkylate blend for small motors. **The difference between the emissions for the EUG2000 and SEGO fuels with a catalyst is significant, *p* < *.01*.**

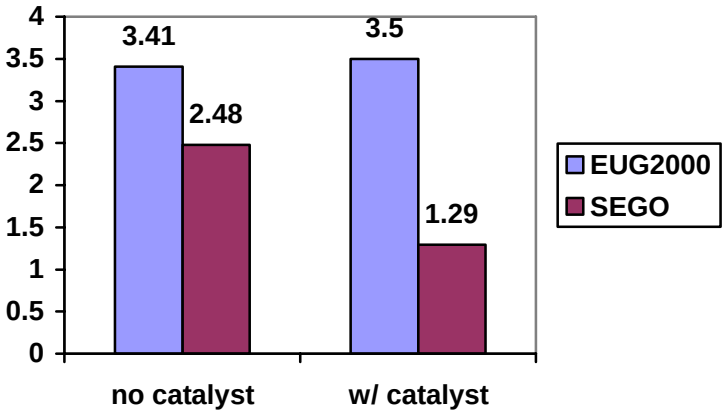

Figure 2: Emissions outputs for a diesel chainsaw motor with and without a catalyst for two different fuels.

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Reporting Data: The Challenger Disaster

The most frequent problem that managers have with written communication from engineers is that engineers fail to articulate the bottom line. In other words, engineers often neglect to stress the conclusions and recommendations that should follow from their data. Too often, engineering reports focus on the details of the tests performed—the equipment tested, the measurements taken, the statistical tools used—to such an extent that the meaning of the data becomes lost for all but the most technical people.

Engineers are in the best position to say what technical data means. When they fail to clearly state the conclusions that should be drawn from the data, disastrous consequences can follow. Dorothy Winsor's research on the *Challenger* space shuttle disaster, for instance, shows how communication problems between engineers and NASA officials led to the doomed space shuttle mission.

Because they are the most important part of a technical report, conclusions should be stated in clear language at both the beginning and the ending of the report. In other words, conclusions should not only be stated multiple times, but they should also appear in the two most prominent sections of the report—the beginning and the end.

- In long technical reports, conclusions should appear in the executive summary and in a separate section titled "Conclusions" or "Recommendations" at the end of the report.
- In short memos, conclusions should be stated in both the first and last paragraphs.
- To make them stand out, conclusions are often written as bulleted lists. In some exceptional cases, conclusions and recommendations are bolded to add emphasis.

In the information below, you will read about the causes Challenger disaster and then analyze a memo written by engineers to NASA officials. You will then rewrite this memo to emphasize the conclusions that NASA officials should have drawn from the engineering research.

All information about the Challenger disaster and communication comes from

D. Winsor, "Communication Failures contributing to the challenger accident: An example for technical communicators," *IEEE Transactions on Professional Communication*, vol. 31, pp. 101-107, 1988.

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Background on the *Challenger* disaster

On January 28, 1986 the *Challenger* space shuttle exploded 73 seconds after take-off. This disaster was highly remarkable because the *Challenger* contained the first and only civilian that has accompanied a NASA space mission—the schoolteacher Christa McAuliffe. The *Challenger* disaster put NASA into a public-relations crisis from which it has never recovered.

A task force found that the cause of the *Challenger* disaster was a faulty O-ring seal on the solid rocket boosters developed by the contractor Morton Thiokol International (MTI). Although engineers repeatedly warned management about the problems with the faulty O-ring seal, the disastrous space shuttle launch was allowed to proceed. In an appendix to the *Report of the Presidential Commission on the Space Shuttle Accident*¸ Commission member R.P. Feynman notes that mangers estimated a 1 in 100,000 probability estimate of flight failure and loss of life while engineers had estimated a 1 in 100 probability.

One MTI engineer, Roger Bosjoily, was a vocal critic of the rocket boosters. Bosjoily concluded one internal memo dated six months prior to the launch and addressed to the MTI vice-president of engineering by stating, "It is my honest and very real fear that if we do not take immediate action to dedicate a team to solve the problem with the field joint having the number one priority, then we stand in jeopardy of losing a flight along with all the launch pad facilities."

Bosjoily's alarming memo was never circulated outside of MTI. However, shortly thereafter, MTI did send a memo about the faulty O-ring seals to NASA officials. This second memo to NASA officials appears in the section below. When later queried about this memo, NASA officials replied:

> "I don't know if anybody at that time understood the joint well enough to realize that the data was crucial"
> "There were a whole lot of people who weren't smart enough to look behind the veil and say, 'Gee, I wonder what this means.'"
> "I didn't realize the data's significance"
> "It sounded like old news"

Below is a copy of the memo MTI submitted to NASA officials. See if you can figure out why NASA did not fully recognize the threat that the O-ring seal presented:

Note that on January 24, 1985, a year before the Challenger launched, a shuttle flight was launched at a temperature of 53 degrees F. It showed much greater O-ring erosion than any previous flight.

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Memo from Brian Russell, MTI Engineer to NASA's Jim Thomas

DATE: August 9, 1985
SUBJECT: Actions pertaining to SRM Field joint Secondary seal

Per your request, this letter contains the answers to the two questions you asked at the July Problem Review Board telecom:

1. *Question:* If the field joint secondary seal lifts off the metal mating surfaces during motor pressurization, how soon will it return to a position where contact is re-established?

   Answer: Bench test data indicated that the o-ring resiliency (its capability to follow the metal) is a function of temperature and the rate of case expansion. MTI measured the force of the O-ring against Instron platens, which simulated the nominal squeeze on the o-ring and approximated the case expansion distance and rate.

   At 100^{o}F the O-ring maintained contact. At 75^{o}F the O-ring lost contact for 2.4 seconds. At 50^{o}F the O-ring did not reestablish contact for ten minutes at which time the test was terminated.

   The conclusion is that the secondary sealing capability in the SRM field joint cannot be guaranteed.

2. *Question:* If the primary o-ring does not seal, will the secondary seal seat in sufficient time to prevent joint leakage?

   Answer: MTI has no reason to suspect that the primary seal would ever fail after pressure equilibrium is reached, i.e., after the ignition transient. If the primary o-ring were to fail from 0 to 170 milliseconds, there is a very high probability that the secondary o-ring would hold pressure since the case has not expanded appreciably at this point. If the primary seal were to fail from 170 to 330 milliseconds, the probability of the secondary seal holding is reduced. From 330 to 660 milliseconds the chance of the secondary seal holding is small. This is a direct result of the o-ring's slow response compared to the metal case segments as the joint rotates.

Please call me or Mr. Roger Boisjoly if you have additional questions concerning this issue.

EXERCISES:

1. Analyze the memo: List at least three things that this memo does wrong that resulted in the failure of NASA officials to recognize the extent of the O-ring failure problem.

2. What is the main trend in the *Answer* to *Question* #1? What is the bottom line? How might this bottom line have been better emphasized?

3. What is the main trend in the *Answer* to *Question* #2? What is the bottom line? How might this bottom line have been better emphasized?

4. Organize the data from *Answer 1* and *Answer 2* in two separate tables. What are the pros can cons of organizing the data in tables vs. describing the data in text as in the original memo?

Reporting Data: Graphics

First, go through the PowerPoint presentation entitled "Reporting Data: Graphics." Then work with a partner to analyze the problems with the following graphics. What would be a better way to display this information?

You can right-click on Figures 1 and 2 and Table 1 and directly modify these graphics to show how they could be better represented.

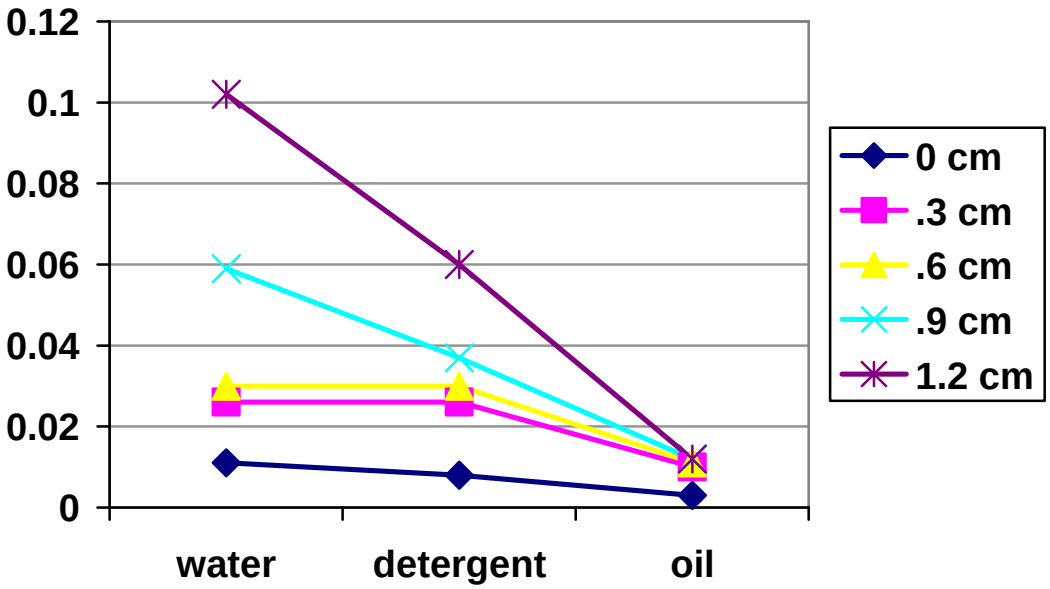

Figure 1: Effects of shoe sole tread width on COF for different contaminated floor surfaces.

Note: A high COF (coefficient of friction) is good because it means people will be less likely to slip.

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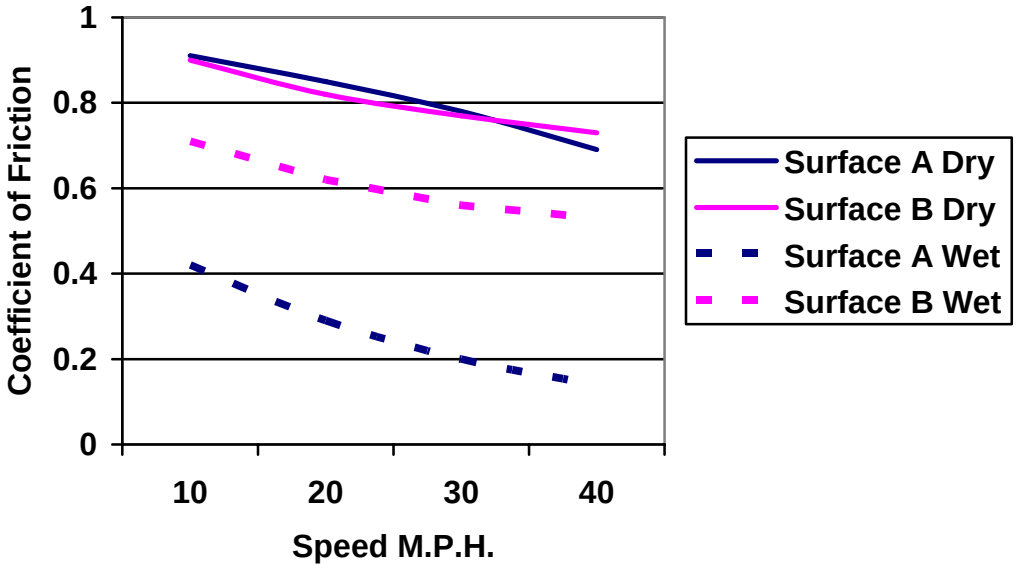

Figure 2: COF of two different pavement surfaces at different speeds in wet and dry conditions

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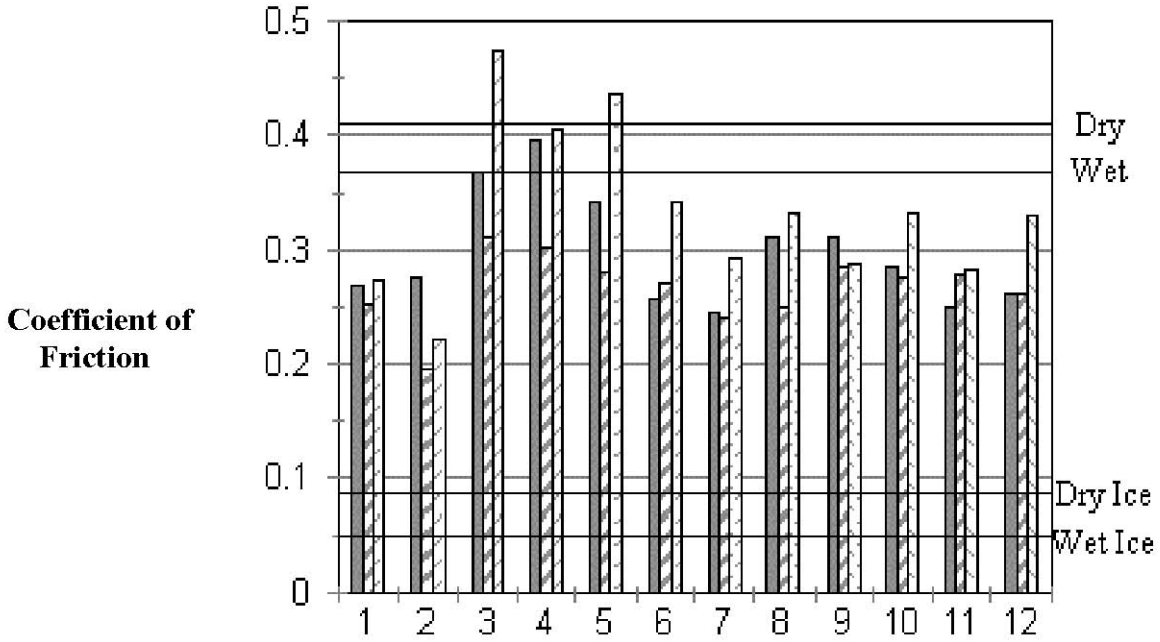

LEGEND
Solid Grey..... Liquid
Hatch.....Slurry
Light Grey…Solid

7	Magnesium Chloride	7. FreezGard 0 and TEA
8	LiquiDow	8. Ice Stop
9	Calcium Magnesium Acetate	9. Ice Stop 2000
10	Sodium Chloride	10. MCP De-Icer
11	LiquiDow Armor	11. FreezGard 0
12	FreezGard 0 and Shield LS	12. FreezGard 0 and Ice Ban

Figure 3: Comparative COF results of de-icer chemicals in liquid, slurry, and solid chemical states.

Note: A high COF (coefficient of friction) is good because it means vehicles will be less likely to skid

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Table 1: Average download speeds

Task	***Firefox 2.0***	***Internet Explorer 7.0***
Time to start up from cold	11.64 s	7.80 s
Render benchmark CSS page	1.71 s	2.13 s
Download benchmark HTML page w/ multiple images	2.03 s	2.47 s
Download benchmark Javascript	22.01 s	36.35 s
Perform function in benchmark Javascript	11.18 s	18.34 s

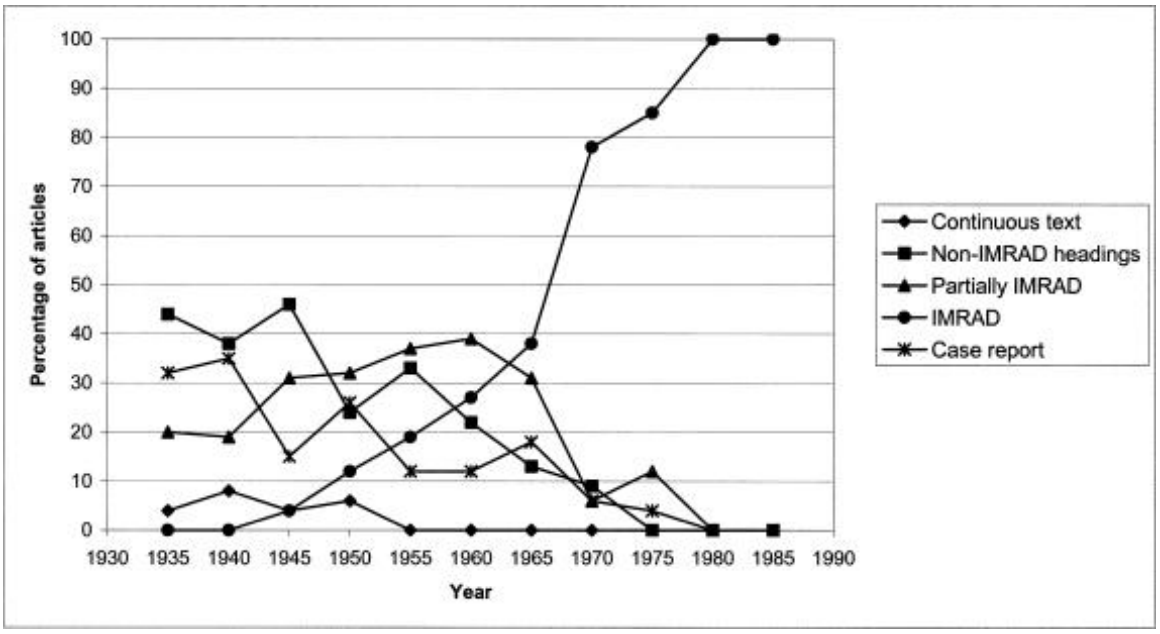

Figure 4: Types of articles published in British Medicine Journal from 1935 to 1985.

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Reporting Data Practice Exercise: Glove Use Among Nurses

You are working as an analyst for a hospital. The hospital administration is concerned with preventing hospital-acquired (or nosocomial) infections in patients. Nosocomial infections are new infections that patients pick up as a result of treatment in a hospital.

One way to prevent nosocomial infections is for hospital personnel to use disposable gloves. However, in practice many hospital personnel frequently neglect to wear gloves. This increases the likelihood that they will transmit infections from one patient to another.

One year ago, your hospital required all emergency room nurses to participate in an educational program designed to emphasize the importance of using gloves. Your hospital is now considering requiring this training for all hospital staff. However, before mandating this training, hospital administration wants to see if it was effective in increasing protective glove use.

Without their knowledge, all 23 members of the emergency department's nursing staff were observed during vascular access procedures. Each nurse was observed three times before the training, three times at approximately one month after the training, and three times at approximately six months after the training to see how often they wore gloves. Each procedure by a nurse was counted as a separate observation.

Table 1 on the next page shows the number of times each nurse was observed as wearing gloves (out of three observations) before, immediately after, and six months after the training. In addition, the data includes the experience level of each nurse. This data is also available in an EXCL file.

Exercise:

Take this data and "digest" it so that hospital administrators can understand what it means. Your "digested" data should include at least one effective table or figure that helps your reader quickly grasp whether or not the training was effective. Be sure to also analyze the data by years of experience to see if there are any differences in how effective the training was for experienced vs. inexperienced nurses.

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Table 1

Nurse	Years Experience	Before training	1 month after training	6 months after training
1	4 or more	1	3	2
2	under 4	2	3	3
3	under 4	3	3	3
4	4 or more	2	3	1
5	4 or more	1	2	0
6	under 4	0	2	2
7	4 or more	1	3	2
8	4 or more	3	3	2
9	under 4	3	3	3
10	4 or more	0	2	1
11	under 4	2	3	3
12	under 4	2	3	3
13	under 4	3	3	3
14	4 or more	0	3	1
15	4 or more	0	2	1
16	4 or more	1	3	2
17	under 4	2	3	3
18	4 or more	0	3	1
19	4 or more	1	3	2
20	under 4	2	3	3
21	under 4	1	3	3
22	under 4	2	3	3
23	4 or more	0	2	0

Note: Data story and scenario adapted from The Data and Story Library
http://lib.stat.cmu.edu/DASL/DataArchive.html
http://lib.stat.cmu.edu/DASL/Stories/GloveUseAmongNurses.html

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Organizing the Technical Report: The IMRAD format

Most scientific and technical disciplines follow a standard organization for reporting an experiment. Up until this point we have focused on reporting the results of experiments. Now we take a step back and look at the entire report as a whole.

A technical report usually has the following sections in the following order:

1. Title
2. Abstract or Executive Summary
3. Introduction
4. Methods
5. Results
6. Discussion or Recommendations
7. References

Sections 3-6 are typically known as the **IMRaD** format: **I**ntroduction, **M**ethods, **R**esults and **D**iscussion.

The sections of a technical report can vary greatly in length and detail depending on the length and level of formality of a report and whether it is written in an academic or workplace setting. Let's examine each of these sections in order.

Title

The title of a technical or scientific report should clearly and precisely state the main focus of the report. Your title should mention major variables tested.

Bad Title	***Good Title***
ME 441 Project	Strength of concrete cylinders after 7 and 28 days
Factors affecting friction	Effects of shoe tread width on the friction of three different surfaces

Abstract or Executive Summary

Both an abstract and an executive summary are essentially a report in miniature. They both summarize all of the major sections of the report. A well-written abstract or executive summary will **briefly cover** the purpose of the report (introduction), how the research was conducted (methods), what was found (results), and what it all means (discussion).

Abstracts are generally a single paragraph (medical abstracts, however, have their own format) and are primarily read by academic researchers who want to understand how the report's findings add to or challenge what they know about a topic.

Executive summaries are generally longer than abstracts and are primarily read by business or government executives who want to understand how the report's findings contribute to the organization's goals or actions. The length of an executive summary is generally proportionate to the length of the report: longer reports have longer exec summaries; shorter reports have shorter ones.

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Introduction (why are you writing this report?)

The Introduction section describes the purpose of the report. For academic reports, the introduction should contain citations to prior research on the topic and explain how the current study will add to or extend this research (in others, the intro explains what is *new* about the current research). For business reports, the introduction contains background information that non-technical readers will need to understand the report and why it is important.

The introduction can be a single sentence (this is often the case if the reader has specifically asked for the report and is familiar with the topic) or several pages. Generally, introduction sections move from explaining why the topic is important to explaining the specific research question that the report will answer.

Methods (what did you do?)

This section explains the details of how you collected data, what types of measurements you took, and how you analyzed the data. The methods section frequently uses subheadings so that readers can skim it quickly and come back to it when they have specific questions in mind. Thus, the methods section should be designed to enable skimming and jumping around. These reading strategies are best accommodated by subheadings, which allow the reader to quickly locate specific information. Common subheadings in a methods section include

Participants

State the number of people who participated, the criteria for selecting these participants, and relevant demographic information about the participants.

Research sample

If the research involved collecting things—such as water or rock samples—explain what was collected and the criteria for selecting these samples.

Procedures

Briefly describe the steps that you took in collecting your data.

Measurements

Describe what dependent variables—such as time, weight, coefficient of friction—were taken and how these measurements were obtained.

Analysis

Describe how the data was analyzed. Include any statistical procedures, formulas, or equations used for analyzing the data.

Use the subheadings that are most relevant to a particular study. Many other reports use subheadings that are not listed here. The goal of the methods section should be to help readers find the answers to specific questions in as short a time as possible.

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Results (what did you find?)

The results section presents the findings from your research. This and the executive summary/abstract are the most important parts of your report. You should use tables, figures, and words to "digest" your data and focus readers' attention on the most important trends and conclusions.

The reporting data exercises in these materials have trained you to write an effective results section.

Discussion (what does it mean?)

This last section of your report is the most variable. Although it is most common to refer to this section as the *Discussion*, some reports will label it as *Conclusion, Implications,* or *Recommendations*. Many reports will have *both* discussion sections and conclusion or recommendation sections.

In any case, the final section of your report is one of the most important. It should clearly connect your findings to your readers' goals, explaining the bottom line.

For academic reports, the discussion section begins by summarizing the main points of the results section—in other words this section begins by emphasizing the bottom line. Next, this section will generally explain how these findings support, contradict, or otherwise extend what the academic community knows about this topic. Citations are common. Next, the section acknowledges flaws or limitations in the current study and then suggests possible directions for future research.

In business settings, technical reports often end with a bulleted list of recommendations based upon your findings.

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A short IMRaD report—ACADEMIC FORMAT

Gender and Interruptions in the twenty-first century

Abstract
Early research in gender and discourse found that women are more likely to be interrupted than men. However, this research may now be outdated. This study examined 5 females and 11 male science and engineering professionals at bi-monthly meetings to see if gender inequities in conversation still exist. The results indicate that men were able to speak for longer periods of time and experienced significantly fewer interruptions than women. These findings suggest that there may still be hidden biases in the contemporary workplace.

Introduction
Research on gender and communication style in the 1970's and 1980's found that women are more likely to be interrupted than men in both professional and academic settings (Eakins & Eakins, 1978; West & Zimmerman, 1983) . As a consequence, women overall speak less on average than do men in these settings. In addition, some researchers have suggested that the ideas that women contribute to these conversations are more likely to be overlooked (Spender, 1982)

However, it has been some time since these initial research studies were done and the status of women in the workplace and academy has increased considerably since the 1980's, although women are still under-represented in upper management and in technology and engineering professions. The current study examines discussions in a research and development company to see if women today still seem to be more likely to be interrupted than men.

Method
Participants:
5 women and 11 men participated in this study. All participants were engineers or scientists at a major research and development company. Length of service at this company ranged from less than one to 12 years.

Observations
This group was observed twice at bi-annual development meetings. The first meeting was 75 minutes; the second was 62 minutes. These meetings were video-taped with two different cameras to ensure that all interactions were captured. The researcher then proceeded through the videotapes, noting each time a participant spoke, how long the participant spoke, and whether or not the participant was interrupted.

Results
Table 1 indicates that men spoke for much longer periods of time than women in the two meetings observed and were less likely than women to be interrupted. Whereas the average woman spoke for a total of almost 25-1/2 minutes during the meetings, the average man spoke for 33-1/2 minutes, t =13.05, $p < .001$. Moreover, women were much more likely to be interrupted than men. While the average man was interrupted an 5.4 times during the two meetings, the average woman experienced over 9 interruptions, t = 9.06, $\underline{p} < .01$. However, women were just as likely to speak up as men. This might indicate that women have plenty to say but have more difficulty saying it. These findings overall suggest that women may be cut off from speaking more frequently than their male peers in research development meetings.

Table 1: Average number of turns, total speaking time, and interruptions per participant

Gender	***Average number of turns***	***Average amount of time spoke***	***Average number of times interrupted***
Men	26.1	2010 s	5.4
Women	27.4	1528 s	9.7

Discussion:
This study suggests that while women attempted to speak as often as men, men were able to speak for longer periods of time and experienced significantly fewer interruptions. These findings are consistent with previous research conducted in earlier decades which found that women were more likely to be interrupted than men of equal rank in professional and academic settings (Eakins & Eakins; West & Zimmerman).

This study, of course, is limited by its small size. Moreover, it took place in an engineering setting, a field that is still primarily male-dominated. Further research could continue these observations in fields where women have been more successful, such as biology and medicine.

References
Eakins, B. W., & Eakins,R. G. (1978). Sex differences in human communication. Boston: Houghton-Mifflin
Spender, D. (1984). Man made language. London: Routledge
West, C, & Zimmerman, D,H.(1983). Small insults: A study of interruptions in cross-sex conversations between unacquainted persons. In B. Thome, C. Kramarae, & N, Henley (Eds.), Language, gender and society (pp, 102-117), Rowley, MA: Newbury House Publishers

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A short IMRaD report—BUSINESS FORMAT

To: Clark Daniels, Vice President Human Resources
Todd Coleman, Vice President Research and Development

From: Tim Sanchez, Senior Manager, Human Resources
Subject: Support for complaints by female R&D researchers
Date: February 12, 2006

Executive Summary

Women researchers have complained that a "good old boy" culture in XYZ labs in which the ideas of female researchers are more likely to be dismissed than those of their male colleagues. To see if this bias does in fact exist, a communications researcher from a local university reviewed videotapes of two of R&D biannual development meetings. The researcher's observations support the women's complaints, finding that women spoke for shorter periods of time and were more likely to be interrupted than men. It is recommended that employees receive training to promote more productive brainstorming sessions.

Introduction

Management at XYZ Labs has been concerned for some time about the attrition of women researchers who have left XYZ to pursue careers at other laboratories. When asked, many of our current and former female researchers complained of a "good old boy" culture in the organization in which the input of female researchers is more likely to be rejected or ignored than that of their male colleagues. To see if this observation had any basis in fact, a communications researcher from a local university was asked to sit in on development meetings where researchers from all units meet to brainstorm ideas.

Method

Two of our R&D department's biannual development meetings were videotaped using the equipment and support from our media and public relations department. A total of 5 female and 11 male scientists and engineers attended these meetings. Length of service at this company ranged from less than one to 12 years.

After the communications researcher signed a confidentially agreement, he was given access to tapes. The researcher then proceeded through the videotapes, noting each time a participant spoke, how long the participant spoke, and whether or not the participant was interrupted.

Results

Table 1 indicates that our male employees spoke for much longer periods of time and were much less likely than their female colleagues to be interrupted. Whereas the average woman spoke for a total of almost 25-1/2 minutes during the meetings, the average man spoke for 33-1/2 minutes, a 32% difference. Moreover, women were much more likely to be interrupted than men. While the average man was interrupted 5.4 times during the two meetings, the average woman experienced over 9 interruptions, $t = 9.06$, $p < .01$. However, the female researchers were just as likely to speak up as men. These findings overall seem to support the complaint that female researchers are more likely to be ignored than their male colleagues.

Table 1: Average number of turns, total speaking time, and interruptions per participant

Gender	*Average number of turns*	*Average amount of time spoke*	*Average number of times interrupted*
Men	26.1	2010 s	5.4
Women	27.4	1528 s	9.7

Further analysis indicated that nearly 75% of the interruptions were initiated by just two male researchers, both of whom also spoke for long periods of time. While these two researchers interrupted both male and female colleagues, the women appeared more visibly frustrated by these interruptions.

Recommendations

This research lends some support to the complaint that female researchers have a difficult time getting their ideas across, particularly in the competitive environment of the bi-annual development meetings. The following steps are recommended:

1. The two male researchers who together contributed nearly 75% of all interruptions should be taken aside and made aware of the consequences of their behavior. There should be follow-up and support for these researchers to help them change their habits.
2. Female researchers should receive encouragement to be more assertive in talking over interruptions.
3. All employees should receive training in promoting more productive brainstorming sessions.
4. After these first three steps have been completed, future development meetings should be observed to see if these steps have made a difference in speech patterns.

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For Discussion:
Browse through several journals in your field and note their use of headings and subheadings. How does the information contained in each of the IMRaD sections change for different disciplines?

Exercises

Go back to Exercise 15: *Glove Use Among Nurses*. You should have already "digested" the data in this exercise. The tables and figures and text you created earlier should now become the *Results* section of your technical report. Now take the rest of the information provided in this exercise and present it in IMRaD format for an internal hospital memo. Be sure to use main headings for each of the IMRaD sections and subheadings for the methods section.

Introductions: Defining the Report's Purpose

The format of technical report introductions can vary a good bit. Some introductions can be pages long, with multiple subheadings that provide detailed background information or a history of the project. Others can be as short as a single paragraph or—if the reader is very familiar with the topic—even a single sentence.

ALL introductions, however, are similar in that they must define the purpose of the report. In other words, the introduction to a technical report must communicate to readers why the report is important and what they will learn from reading it.

Most introductions use four basic "moves" to summarize the purpose of the report:

1. Establish the importance of the topic (why is this important?)
2. Describe what is already known about the topic (what do we already know?)
3. Clarify what is not known (what do we want to know?)
4. Explain how your research will "fill in the blanks" about what we don't know (how are we going to find out?)

Here are some example introductions. Go through these and mark where each introduction uses each of the four "moves" above. What patterns do you see in how these moves are introduced or how they overlap with one another?

1.
Windows has recently released Windows Mobile 2003, a new upgrade to its Pocket PC operating system. Windows is telling users that the upgrade is essential. However, the upgrade is not cheap and many users have suffered in the past from upgrades that did little to improve the system. To see if the upgrade is really worth the cost and time to install, this report summarizes the differences between Windows Mobile 2002 and 2003 and compares the two operating systems on a number of benchmark tests.

2.

The National Highway Traffic Safety Administration (NHTSA) reports that a significant number of highway fatalities and injuries involve the partial or complete ejection of occupants through vehicle windows. New window designs, incorporating different glazing/frames, may be able to reduce the risk of ejections. However, questions have been raised about the high cost and practicability of glazing designs. Moreover, the safety benefits of glazing designs have never been demonstrated. This report discusses the development of analytical and research tools to evaluate the problem of ejection and provides data measuring potential benefits of safety glazing designs.

3.

Use of over-the-counter sympathomimetic amines, intended to augment physical performance in athletes or as a weight loss aid, is controversial, and there is little information on potential risks. Cardiovascular symptoms comprise almost one-half of the adverse events reported to the U.S. Food and Drug administration (FDA) (2) and range from cerebrovascular accidents to seizures and ventricular fibrillation (VF) (2). However, systematic data on the cardiovascular effects of ephedrine and, specifically, any potential arrhythmogenic effects are not available. This study examines the hypothesis that ephedrine supplements, used in doses recommended in over-the-counter preparations, increase the relative risk of ischemia-dependent ventricular arrhythmias in the presence of chronic ischemic heart disease.

4.

A technical working group meeting was sponsored by the Snow and Ice Cooperative Pooled Fund Program (SICOP) of the American Association of State Highway and Transportation Officials (AASHTO) held on March 8th and 9,1999 in Minneapolis, Minnesota. At that time, the group reviewed approximately thirty (30) reported incidents in which roads reportedly became slippery after application of liquid chemicals, used in anti-icing operations. One reason for slippery road conditions after application of liquid anti-icing measures included the possibility that under certain conditions, the liquid chemicals could concentrate by evaporation, thus undergoing a crystallization phase change. At that time, it was hypothesized that crystals might give rise to a slick road surface which the committee referred to as “chemical slipperiness”. The purpose of this research was to determine if this hypothesized condition has any basis in fact.

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Methods: Helping Readers Jump Around

The methods section of your report is the section most likely to be skipped by non-technical readers. Even technical readers may not at first read all of this section. Instead, readers tend to skip over the methods section and then return to it only when they have questions about how you obtained your results. These readers usually have very specific questions in mind; thus, the methods section should be organized to help readers **find the information they want as quickly as possible**.

Use subheadings

The best way to help readers find the information they want is to include subheadings. Thus, readers who want to know how you selected the people who participated in your research will jump to the *Participants* section. Readers who want to know how you prepared materials for your research will jump to *Materials*. Readers who want to know what statistical tests you used will jump to *Analysis*. You may find that individual sections of your methods section only have two or three sentences. This is fine. The goal of the methods section should be to break the information up as much as possible so that readers can jump around.

Common subheadings in methods include:

Participants

If your research involved people, begin by saying how many people participated. Explain your criteria for selecting these participants (cancer patients, college students, college students enrolled in Biology 101, computer users). If relevant, give breakdowns by gender, age, or other factors.

Research sample

If your research involved collecting things—such as water or rock samples—explain what you collected and your criteria for selecting these samples.

Procedures

Briefly describe the steps that you took in collecting your data. The goal here is to answer any questions the reader might have about how you proceeded. For instance, if the order in which you collected data was important be sure to explain it here. If a step or procedure is obvious, you do not necessarily need to describe it—think about what your reader wants to know.

Materials

Include the exact technical specifications and quantities of any chemical or physical materials used. Explain the steps used to prepare the materials if relevant.

Equipment

Describe any special equipment you used for collecting or measuring your data and any special procedures you used if relevant.

Survey (or Interview) questions

If your research involved giving participants a survey or asking interview questions you should briefly describe the types of questions you asked in a separate section.

Observations

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If observations are important to your research project, you should describe what you observed and how you observed it. The goal of this section should be to show that your observations were as objective and unbiased as possible.

Measurements

Describe what dependent variables—such as time, weight, coefficient of friction—you measured to test your hypothesis. Be as specific as possible. For instance, if you used a survey to measure satisfaction, you should explain the scale (e.g. "Satisfaction with the website was measured on a 5-point Likert scale where 5 = strongly agree and 1 = strongly disagree").

Analysis

Describe how the data was analyzed. Include any statistical procedures, formulas, or equations used for analyzing the data.

Obviously, no one will report is likely to include all of the above headings and there may be other headings appropriate for other types of research studies. Use the subheadings that are most relevant to your study.

The goal of the methods section should be to help readers find the answers to specific questions in as short a time as possible. Thus, you should think about how readers might challenge your study and organize your methods section to help readers find the answers to their questions. For instance, if you are worried that readers might wonder if the order in which you collected data biased your results, include details about the order of data collection under *procedures*. If readers will wonder if the observations you made are biased, include details in the *observations* section that explain how you counted and recorded your observations.

Use Past Tense

Methods sections should be written in the past tense. They explain the details of what you did in the past—and not what you are currently doing or will do in the future.

Use Passive Voice

Because methods sections are meant to focus on the objects of study and procedures--in other words, *things* rather than *people*--methods sections are usually written in passive voice. Effective passive voice sentences begin with objects or procedures (nouns that are not people) and leave out the people performing the action. This phrasing makes the methods sound objective and emphasizes things and procedures.

Active Voice *emphasizes person*	**Passive voice without subject** *emphasizes thing or procedure*
I sampled the force plate data at a rate of 120 Hz.	The force plate data was sampled at a rate of 120 Hz.
We tested four contamination conditions.	Four contamination conditions were tested.
Researchers noted each disturbance of the force plate.	Each disturbance of the force plate was noted.

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EXERCISES

Work with a partner to revise the two methods sections below. Organize each section into appropriate subheadings and rearrange information as needed. Modify the language to phrase sentences in passive voice language that emphasizes procedures and the objects of study rather than the people doing the studying.

1. Wikipedia, the on-line encyclopedia, vs. Encyclopedia Britannica

This report compares the information accuracy of wikipedia and Britannica on science topics.

We chose fifty entries from the websites of Wikipedia and Encyclopaedia Britannica on subjects that represented a broad range of scientific disciplines. We only selected entries that were approximately the same length in both encyclopaedias. In a small number of cases some material, such as reference lists, was removed to bring the length of the entries closer together. We then stripped the entries of metadata and formatting to leave only raw text.

Our researchers then sent each pair of entries to a relevant expert for peer review. The reviewers were not told which article came from which encyclopaedia. We asked the reviewers to look for three types of inaccuracy: factual errors, critical omissions and misleading statements. 42 useable reviews were returned.

The reviews were then examined by our researchers who then estimated the total number of errors for each article. In doing so, we sometimes disregarded items that our reviewers had identified as errors or critical omissions. In particular, as we were interested in testing the entries from the point of view of 'typical encyclopaedia users', we felt that experts in the field might sometimes cite omissions as critical when in fact they probably weren't – at least for a general understanding of the topic. Likewise, the 'errors' identified sometimes strayed into merely being badly phrased – so we ignored these unless they significantly hindered understanding.

We chose reviewers in academic positions who have worked in a relevant field for a long time and are highly regarded by their peers as an expert in the topic in question. Reviewers were told that one entry in each pair was from Wikipedia and the other from Britannica, but they were not told which was which.

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2. Pattern-based spam filters vs. Baysean filters

This report compares two different types of spam filters. You can read the entire original report at: *http://lwn.net/Articles/9460/*

We took 3000 messages received at lwn@lwn.net - a little under two weeks worth. 295 of those messages were real mail and 2705 were spam.

Once the messages were sorted, we fed them all to SpamAssassin and to bogofilter. SpamAssassin is a pattern-based Spam filter that uses a detailed set of rules to detect spam. Bogofilter is a new Bayesian filter written by Eric Raymond. bogofilter is coded in C, while SpamAssassin is in Perl.

Bogofilter requires training, so we tested it twice on our set of 3000 messages: once after training with 15% of the 3000 messages, and once after being trained with the whole set. Then we ran both filters on a very different set of emails: 5000 recent postings from the linux-kernel list, only twelve of which were spam.

For each filter we recorded the number of emails correctly sorted, the number of false positives (legitimate emails falsely identified as spam), and the number of false negatives (spam falsely identified as legitimate).

For discussion:
After you have completed these exercises, compare your responses with those of another group or groups. What are the costs and benefits of your different approaches? Next, download the "Answers" file for this assignment and compare the sample responses there with those prepared by your groups. Which of the variations do you think will be the most reader-friendly for someone who wants to skip around and find specific answers to particular questions?

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Discussion: Explaining What it All Means

The discussion section is the most variable part of a technical report. In particular, academic discussion sections differ greatly from business discussions—which often use the heading *Recommendations* instead of or in addition to *Discussion*.

The final sections of all technical reports—whether they are called *Discussion*, *Recommendation, Implications,* or *Conclusion*—need to (1) summarize the most important findings of the study and (2) discuss where readers should go from here. Thus academic reports typically end by discussing future research that needs to be done whereas business reports end by listing what actions a company or organization should take as a result of this research.

Academic Discussions
While academic introduction sections start by citing prior research to create a space for the current study, academic discussion sections start by summarizing the current study and end by suggesting future research. Academic discussion sections have four basic moves.

1. Summarize what is most important in the current study.
2. Acknowledge any problems with the study methods.
3. Explain implications—what has changed in the state of knowledge in the field.
4. Suggest future research that could be done.

Business Recommendations
Technical reports in the workplace often end with a *Recommendations* section rather than a *Discussion* section. Typically, the recommendation section begins by summarizing the most important findings from the report and then provides a list of recommendations. This list can be simple or detailed, depending on the needs of the report.

There are two things to keep in mind when creating lists:

1. All items in the list should use parallel structure (see exercise 21 on parallel structure). This means that every item in the list should follow the same grammatical format: if the first item in the list begins with a present-tense verb, all items in the list should begin with a present-tense verb; if the first item is a complete sentence, all items in the list should be complete sentences.

2. If the list contains more than five items, it should use some sort of "chunking" or embedded structure. 5-7 is the approximate number of items that the average reader can contain in short term memory. Lists that contain more than five items—particularly if they are complicated items—tend to overwhelm readers and are difficult to follow.

SAMPLE RECOMMENDATION LISTS

From a report on improving ATM banking machines

Recommendations:

- Add an EMV smart card reader so users cannot forget their cards in the machine.
- Place a security camera in a highly visible location so users feel more secure
- Make deposit envelopes available at all times so users can complete paperwork while standing in line.
- Install a 10.4 VGA color display so users can interact with the display in poor light conditions.

From a report on estimating bridge replacements and repair

Our recommendations include

- Studying redundancy with nonlinear structural modeling to validate analysis predictions.
- Using probabilistic methods to determine and recommend loads that should be used.
- Conducting live traffic field tests to understand relationship between load-age and fatigue.

From a report on statewide emergency response systems

It is recommended that the Department of Transportation take the following actions to improve its Emergency Strategic Response Plan:

1. Improve coordination with all DOT partners
    a. Establish relationships with first responders at federal and state levels
    b. Define roles and responsibilities of all partners
    c. Develop tools and techniques to improve partner coordination

2. Enhance interagency communication
    a. Identify areas of ineffective communication
    b. Identify strategies for anticipating and offsetting communications issues

3. Develop detailed evacuation plan
    a. Identify and coordinate with destination locations
    b. Plan evacuation routes
    c. Determine where to preposition supplies
    d. Develop plans for en route emergency vehicles
        i. Medical
        ii. Police
        iii. Fire
        iv. Roadside service

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EXERCISES:

Identify the four "moves" found in academic discussion sections in the following excerpts. Draw brackets around the sentences that represent each move and label them 1,2,3,4.

EXAMPLE 1

Results from this study showed that those in the classical music condition performed better on the problem-solving task than those in the Punk music or No Music conditions, regardless of time constraints. Interestingly, participants in the Classical music condition performed better despite the fact that they contributed more off-task comments to one another than the No Music condition and about the same number of off-task comments as the Punk music group. Most of the off-task comments were personal in nature (i.e., emoticons, jokes). These results support research by Jensen (2001), which found that participants listening to classical music were more likely to disclose personal information than those listening to no music.

Those in the classical music condition appeared to be more involved in the task, leading to better scores on the problem-solving task and an increase in the use of hyper-personal communication. It is possible that classical music helped the participants relax creating an opportunity for them to not only succeed at the problem-solving task, but also have a more interactive communication experience. Future studies should examine the effects of different types of Classical music on computer-mediated tasks as well as other types of computer-based tasks, such as Web browsing and playing online games.

EXAMPLE 2

As a group, the CS students in this study were sensitive to changes in the rhetorical presentation of programming assignments. These students also strongly indicated, both in closed- and open-ended questions that assignments emphasizing real-world applications and users would increase their motivation and enjoyment of programming exercises. This finding is consistent with research that has found increases in student motivation and performance when writing assignments stress audiences outside of the classroom. Thus, by making small shifts in the wording of their assignments, CS instructors may be able to improve student satisfaction with their classes as well as better prepare students for the human-centered demands of the contemporary workplace.

Although this study did not provide evidence to suggest that such rhetorical changes could help attract and retain female computer science students, additional research on this topic is warranted. In particular, researchers and instructors should look at how such changes in rhetorical presentation can affect female students enrolled in introductory high school or college computer classes who may have been dissuaded from computing careers by cultural stereotypes.

This study, of course, only examined how students said they would react to particular assignment instructions and did not test actual reactions. It would be interesting to see how students responded if they actually completed these tasks and whether students who were routinely given assignments that ask them to consider real-world contexts would be any more adept at identifying and understanding human issues than students who did not receive such emphasis. If this is the case, then these students would enter the workplace much more prepared to deal with real-world problems than their counterparts in a more traditional CS curriculum.

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The Executive Summary or Academic Abstract

An executive summary or an academic abstract is a report, proposal or other document in miniature. The executive summary/abstract contains enough information for readers to become acquainted with a long document without actually reading it.

Executive summary vs. Abstract:

Both executive summaries and academic abstracts are documents in miniature. Executive summaries are used in business situations, are written for executives, and can be up to several pages for a long report. Abstracts are used in reporting academic research and are usually only a paragraph long.

Abstracts:

Abstracts are used in academic settings and are usually only a paragraph long, although some academic journals allow longer abstracts. The most common academic abstract format has 1 sentence explaining the importance of the topic and the relevance of the research problem, 1-2 sentences summarizing the methods, 1-2 sentences describing the results, and 1 sentence summarizing the implications.

Executive Summaries:

The primary audience for an executive summary is executives: administrators, managers, and other non-technical personnel who will be reading your report to understand how your research fits into the organization's "big picture."

An executive summary is usually one page long, but can be shorter or longer as needed, depending on the length of the main report. It should appear immediately after the title so that it is the first part of the report that readers encounter. The executive summary should contain a brief non-technical overview of the purpose, main findings, and implications or recommendations of your report.

The executive summary is the most important part of a technical report because it may be the only section of the report that gets read in detail. If the executive summary emphasizes the wrong information, leaves important information out, or is poorly written, readers may miss or misunderstand the overall outcomes and implications of your report. In some companies, the executive summary is distributed independently of the report so that managers and other employees have an idea of what is going on across the company. Readers interested in more information can then request a copy of the full report.

An executive summary should answer the following questions:

1. **What is the purpose of the report? Why is it important? Why should this report matter to the reader?**

   A statement about the background and purpose of the report is always necessary—even if the person you are writing to specifically asked for a report on this topic. While you may have been working for days, weeks or months on this report, your reader has been doing other things. Managers will be overseeing multiple projects and cannot be expected to immediately recall the details or purpose of any one report without a brief reminder. Failing to provide such a reminder is arrogant because it assumes that your report is at the top of your reader's mind. Engineers often have reputations as bad writers because they fail to explain the purpose or importance of a report before they launch into details.

2. **Briefly, what did you do?**

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The executive summary should contain a brief statement about your methods—but keep it brief. Executives don't need to know all of the details—that's for other engineers and technicians who will find these details in the body of the report. Instead, keep it brief—explain that tests were conducted or simulations were run but don't go into the details of your measurement instruments or computer models. For short reports (under 10 pages), you can normally explain what you did in 1-2 sentences.

3. What did you find? What is the bottom line?

This is the most important part of the executive summary. The executive summary should describe the major trends in your data and answer the questions your reader most wants to know. For instance, if your readers want to know if a new material improves performance, make sure that your answer to this question is clearly emphasized in the executive summary.

4. What are the implications? How does this report fit into the bigger picture?

Your executive summary should clarify what should change as a result of your report. Explain what steps should be taken next or what changes should be made. If there are costs associated with your recommendations, describe them briefly here—remember, executive summaries are written for executives.

******NOTE******

In some organizations, executive summaries list specific recommendations—in fact recommendations may compose the majority of the executive summary—while in other organizations executive summaries simply refer readers to a separate section labeled *Recommendations*.

Before Continuing…..

Take a look at Table 1 below. What does this table tell you about writing a report for a managerial audience?

Table 1: How often managers read various report sections (source: Souther 1985)

Section of Report	**Percent of time managers read**
Executive summary or abstract	100%
Introduction	60%
Body (including results, methods)	15%
Conclusion (includes discussion, recommendations)	50%
Appendices	10%

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EXERCISES:

1. Executive summaries A, B, and C below were written by engineering students to describe small experiments they had conducted and analyzed. Read these summaries and answer the following questions.

   a. How well does each executive summary answer the following four key questions:
      1. What is the purpose of the report?
      2. What was done?
      3. What was learned?
      4. What is the bottom line?

   b. Rank these three summaries from best to worst. Explain your rankings.

2. Executive summaries D and E are two different versions of the same executive summary. Read these summaries and answer the following questions.

   a. How well does each executive summary answer the four key questions?

   b. Rank these summaries from best to worst. Explain your rankings.

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EXECUTIVE SUMMARY A

An experiment was conducted using 3 different types of popcorn and 3 different time settings. The quality and amount of popcorn was affected by the brand of popcorn. The three brands of popcorn were Store brand ($1.29), Jolly Time ($1.79), and Orville Redenbocker ($2.89). The popcorn was popped at 3 time settings of 2 minutes, 2.5 minutes, and 3 minutes. This study will help shoppers decide which type of popcorn they want to buy and the desired time settings to pop the popcorn.

This experiment was conducted using 3 factors: Type of popcorn, time setting, and the size of the bag. Minitab 14 was the statistical software that was used to summarize the results of the experiment. The following conclusions will be drawn from the experiment based on the Minitab output:

- The number of cups popped
- Which factor (brand, time, or bag size) is most significant for the amount of popcorn popped
- Which type of popcorn pops the most popcorn

EXECUTIVE SUMMARY B

This experiment tests the effect of choke type and gun selection on target accuracy. Three competent shooters of approximately equivalent marksmanship abilities tested three different choke types (full, modified, and improved) and two different guns (a Remington 11-87 semi-automatic and a Beretta 682 Gold E). With a confidence level of 95%, the gun selection ended up to be the only significant factor. The Beretta was found more accurate than the Remington possibly because the Beretta's weight is centered in the middle of the gun while the Remington is a little barrel-heavy. However, if the confidence level is lowered to 90%, choke type is also significant, with the improved choke more accurate than the modified or full. Thus, for target shooting, the most accurate combination would be the Beretta with an improved choke

EXECUTIVE SUMMARY C

The purpose of this report is to comprehensively describe an experiment conducted to identify the factors affecting the chemical reaction rate of a simulated virtual chemical reaction, and to describe the relationship between the reaction rate and these factors in a mathematical form.

The organization of this technical report is as follows: section one of the report gives a background about the problem under testing. It acts as a clear statement of the problem, which helps in understanding the problem nature, and in selecting the proper response variable, factors, and design technique. Section two describes the detailed design of the experiment, including the response variable, the factors to be included in the experiment, and the factor levels for each factor. It also describes the statistical approaches as well as statistical software that will be used. This section also describes how to conduct the experiment listing the expected equipment and their specification, and the number of observations to be taken. Section three describes how the actual experiment was conducted; listing test procedures followed, actual test equipment, and tabulated experimental data. Section four contains complete analysis for the resulting data using the statistical tools described in the design section. Output from statistical software, analysis of the resulting output, and analysis results are also explained in this section.

The last section of the report, section five, concludes the experiment and summarizes the results obtained. It also gives recommendations for future conduction of similar experiments.

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Executive Summary D
Ejection Mitigation Using Advanced Glazing

In response to the National Highway Traffic Safety Administration Authorization Act of 1991, the agency initiated research programs concerning motor vehicle rollover protection. As part of that research, the agency has conducted a crashworthiness research program to evaluate ways to reduce the number of fatalities due to ejection. The program was expanded from side impact ejections to include ejections from rollover, front, and rear impacts.

An average of 7,492 people are killed and 9,211 people are seriously injured each year in passenger cars, light trucks and vans because of partial or complete ejection through glazing. Of these, 4,557 fatalities are associated with vehicle rollovers. Advanced ejection-mitigating glazing at the right and left front side windows could save 1,313 lives and prevent 1,290 serious injuries per year. From an economic standpoint, the total cost per year to society will be between $563,463 and $931,827 per life saved, depending on the material selected by the manufacturers. This estimate is based on an estimated annual incremental cost of $768,000,000 ($48 per vehicle for front, side windows) if trilaminate glass-plastic-glass is used to $1,270,080,000 ($79 per vehicle for front side windows) if rigid plastic is used.

Computer simulations and component testing show that head injuries may increase with the use of some alternative side glazings. Some glazing have small increases in Head Injury Criteria (HIC) values over those produced by standard tempered glass. Other glazings have an HIC increase of 500 or more (as measured by the free-motion headform in 24 kmph impacts).

We recommend continuing research to further evaluate the safety potential of advanced glazing materials and to measure the performance characteristics of the prototype systems.

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Executive Summary E
Ejection Mitigation Using Advanced Glazing

In response to the National Highway Traffic Safety Administration Authorization Act of 1991, the agency initiated a crashworthiness research program to evaluate ways to reduce the number of fatalities due to ejection. Based on the safety need, the primary goal evaluated in this project has been the potential ability of advanced glazings to mitigate ejections through front side windows during vehicle rollovers.

Computer modeling and NASS accident reports were studied in order to understand how side ejections occur and to determine the opportunities that exist for advanced glazing systems to reduce these ejections. Objective component tests were designed and conducted to evaluate both the ejection mitigation and the potential for head injury during occupant glazing impacts.

This preliminary assessment is very encouraging. There are a variety of glazing materials that could reduce ejections without incurring significant occupant injury. While some alternative side glazings could increase head injuries, these injuries do not appear to be critical. Analyses indicate that advanced ejection-mitigating glazing at the right and left front side windows could save 1,313 lives and prevent 1,290 serious injuries per year.

The costs of ejection-mitigation glazings to the front side windows range between $48-79 per vehicle, depending on the material selected by the manufacturers. However, the safety benefits are quite high, which results in a reasonable cost per averted fatality. The total cost per year to society will be between $563,463 and $931,827 per life saved.

Because the preliminary results from this research project demonstrate that alternative glazing systems offer a significant safety potential, we recommend that the research outlined in this report be continued to more fully evaluate the safety implications of alternative glazing systems and to measure the performance characteristics of the prototype systems.

Using Active vs. Passive Voice

Active voice emphasizes people; passive voice emphasizes things. Use active voice when you are writing to managers and non-technical audiences. Use passive voice when you want to emphasize technical details rather than the people performing technical actions.

What is active voice?

Active voice sentences begin with the person or subject *completing* an action:

The dog	bit	the boy.
Actor	**action**	**recipient of action**
The technician	installed	the gear.
Actor	**action**	**recipient of action**

Active voice sentences emphasize people and their actions. Active voice is most appropriate for non-technical audiences.

What is passive voice?

Passive voice sentences begin with the person or object *receiving* the action:

The boy	was bitten	by the dog.
recipient of action	**action**	**actor**
The gear	was installed	by the technician.
recipient of action	**action**	**actor**

Passive voice sentences emphasize things and are often a good choice for technical readers. You can often recognize passive voice by the "to be" verb followed by a past tense verb. Not every phrase that fits this formula is a passive construction, but it is a good rule of thumb.

Passive voice so stresses the things or objects receiving the action that the people or subjects doing the action can be left out.

Active Voice *emphasizes person*	**Passive voice with person/subject** *emphasizes thing*	**Passive voice without subject** *emphasizes thing*
The technician installed the part.	The part was installed by the technician.	The part was installed.
Cheri called the meeting to order.	The meeting was called to order by Cheri.	The meeting was called to order.
The FAA grounded the planes.	The planes were grounded by the FAA.	The planes were grounded.

Passive voice constructions that include the person or subject doing the action (middle column) usually should be avoided because they are wordy. As a general rule of thumb, if the person or subject doing the action is important enough to be mentioned, the sentence should be written in the active voice.

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Avoid passive voice sentences that include the person/subject doing the action. You can often spot these wordy sentences because they follow this formula:

***to be* verb**
+
Past tense verb
+
by

When to use Active vs. Passive Voice

Use Active Voice for managers and non-technical Readers. Use Passive Voice for technical readers.
Most people prefer concise sentences that focus on people and actions. This people-focus helps non-technical readers visualize information because they can imagine a person or agent behind the actions. Thus, active voice is preferred for most writing situations involving non-technical readers.

However, technical readers and writers often have good reasons to emphasize objects, materials, processes, or concepts rather than people. Thus, when you are writing for technical readers, use passive voice to emphasize technical details rather than people.

Use Active Voice to assign credit or blame. Use Passive Voice to sound objective and impersonal.
Many writers like passive voice because, by removing people from sentences, it makes writing sound more impersonal and objective.

Use Passive Voice for Methods and Active Voice for Other Report Sections.
Methods sections of technical reports are usually written in passive voice because the methods section (which focuses on *what* was done) focuses on the processes, materials, and measurements receiving actions—and not the people doing the actions. Methods sections are primarily read by technical readers who are interested in the details of the experiment.

By contrast, active voice is most commonly found in report sections that will be read by non-technical readers. These report sections include the executive summary, the results, and the recommendation sections.

Use Active Voice to….
- Address non-technical readers
- Emphasize people
- Assign credit or blame
- Write executive summaries, results and recommendations

Use Passive Voice to….
- Address technical readers
- Emphasize things
- Appear objective
- Write methods

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EXERCISES ON PASSIVE VOICE

Rewrite the following active voice sentences to emphasize things rather than people.

EXAMPLE

A. The technician successfully installed the catalytic converter.
Rewrite to emphasize the converter: The catalytic converter was successfully installed.

B. We sampled the force plate data at a rate of 120 Hz.
Rewrite to emphasize the force plate: The force plate data was sampled at a rate of 120 Hz.

Rewrite to emphasize the sampling rate: A rate of 120 Hz was used to sample the force plate data.

1. Surgeons successfully performed a new experimental liver transplant operation.
Rewrite to emphasize the operation:

2. We tested BogoFilter twice.
Rewrite to emphasize BogoFilter:

3. The research team tested four contamination conditions in the experiment.
Rewrite to emphasize the contamination conditions:

4. Engineers buttressed each tower with two sets of cables, transferring the load into the ground.
Rewrite to emphasize the towers.

5. Researchers measured the COF between the sole materials and the floors using a Brungraber Mark II (BM II) slipmeter.

Rewrite to emphasize the COF:

Rewrite to emphasize the Brungraber Mark II (BM II) slipmeter:

6. I fed 5000 email messages to two different spam filters.
Rewrite to emphasize the messages:

Rewrite to emphasize the Spam filters:

EXERCISE SET II:

Use the following information to write sentences for technical or managerial audiences.

EXAMPLE

Object	***Verb***	***Subject***
House	Paint	Acme Inc.

Write for technical audience (emphasize things):
The house was painted.

Write for managerial audience (emphasize people):
Acme Inc. painted the house.

7.

Object	***Verb***	***Subject***
Operations	shut down	the FAA

Write for technical audience (emphasize things):

Write for managerial audience (emphasize people):

8.

Object	***Verb***	***Subject***
Detailed project plans	draw up	Public affairs

Write for technical audience (emphasize things):

Write for managerial audience (emphasize people):

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9.

Object	***Verb***	***Subject***
12 deicing chemicals	study	Snow response team

Write for technical audience (emphasize things):

Write for managerial audience (emphasize people):

10.

Object	***Verb***	***Subject***
Program	thoroughly test	Quality Assurance

Write for technical audience (emphasize things):

Write for managerial audience (emphasize people):

11.

Object	***Verb***	***Subject***
Coffee breaks	eliminated	John Smith

Write to avoid blame (emphasize things):

Write to assign credit/blame (emphasize people):

12.

Object	***Verb***	***Subject***
Adequate inspections	not conducted	Susan Smith, the floor manager

Write to avoid blame (emphasize things):

Write to assign credit/blame (emphasize people):

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Parallelism: Maintaining Consistency

Parallelism refers to the way that items in a series are worded. You want to use the same style of wording in a series of items--it makes it easier on the reader. Widely varied wording is distracting and potentially confusing to readers. Bulleted and numbered lists, report headings and subheadings, and series of verbs or nouns within a single sentence should always be parallel.

Items in a bulleted or numbered list

Items in a list should all have the same sentence structure. The following list does not have parallel structure. Can you see how to revise it?

1. Perform a synthesis of research on low-noise pavements
2. Collect baseline data for comparing pavement noise levels
3. Cost/Benefit ratios will be conducted
4. Prepare guidelines for best practices in reducing pavement noise

Items 1, 2, and 4 in this list all begin with verbs: perform, collect, prepare. However, item 3 begins with a noun: cost/benefit ratios. To make this list parallel, modify item three to begin with a verb: *Conduct cost/benefit ratios.*

Headings in a report

Report headings and subheadings should also always be parallel. The following list of headings does not have parallel structure. Can you see how to revise them?

Collecting groundwater samples
Soil sample handling
Analyzing samples

The first and last headings begin with *–ing* verbs: collecting, analyzing. However, the second heading begins with a noun: soil sample. To make these headings parallel, modify the second one to begin with a *–ing* verb: *Handling soil samples*.

Noun and verb phrases in a single sentence

Items and phrases in a single sentence should also be parallel. The following sentence does not have parallel structure. Can you see how to revise it?

> Beatrice called the meeting to discuss the sales figures from last month, describe the company's new incentive program, and introduced the new Sales manager.

This sentence has a series of three verb phrases. The first two verb phrases begin with infinitive verbs: discuss, describe. However, the last phrase begins with a past tense verb: introduced. To make this series parallel, change the last verb to the imperative form: *introduce the new Sales manager.*

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Let's look at another example of faulty parallelism within a series of items in a sentence. The following sentence does not have parallel structure. Can you see how to revise it?

> The dialysis process includes the removal of nitrogenous wastes and correcting electrolyte imbalances and fluid overloads.

The are two phrases in this series. The first begins with a noun: *the removal*. The second begins with a verb: *correcting*. You can revise this sentence in two ways:

(1) change the first phrase to a verb: *removing nitrogenous wastes*

Or

(2) change the second phrase to a noun: *the correction of electrolyte imbalances*

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EXERCISE SET 1:
Combine the following items into a single sentence that has parallel structure.

EXAMPLE:

Customers often call the showroom to inquire about pricing.
Customers often call the showroom asking what items are available.
Customers often call the showroom to place orders.

Option 1: Customers often call the showroom to inquire about pricing, ask what items are available, and place orders.

Option 2: Customers often call the showroom to inquire about pricing, availability, and ordering.

Combine the following items into a single sentence that has parallel structure.

1. He was a poor student because he waited until the last minute to study for the exam.
   He was a poor student because he completed his lab problems in a careless manner.
   He was a poor student because his motivation was low.

2. The problem of the greenhouse effect might be remedied by reducing the use of fossil fuel.
   The problem of the greenhouse effect might be remedied by reforesting on a large scale.
   The problem of the greenhouse effect might be remedied by the development of alternate energy sources, such as solar and nuclear fusion.

3. The company's quarterly meetings consisted of reviewing the previous meeting's minutes.
   The company's quarterly meetings consisted of hearing a financial report.
   The company's quarterly meetings consisted of the president's plans for future expansion.

4. Blackboard could be improved by adding a search function.
   Blackboard could be improved if a central login were provided.
   Blackboard could be improved with a more visible drop box interface.

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EXERCISE SET 2:
Combine the following items into a bulleted list that has parallel structure.

EXAMPLE:

We recommend that you combine features on the control panel page to limit the cluttering.
We recommend changing the label “control panel” to "instructor functions."
We recommend another button that returns to the main page.

Option 1:
We recommend the following:

- Combining features on the control panel page to limit the cluttering.
- Changing the label “control panel” to "instructor functions."
- Adding another button that returns to the main page.

Option 2:
Recommendations:

- Combine features on the control panel page to limit the cluttering.
- Change the label “control panel” to "instructor functions."
- Add another button that returns to the main page.

5.
I left my job because the pay was poor.
I left my job because of long hours.
I left my job because I found the work tedious
I left my job because the equipment was dangerous

6.
Let your doctor know if your child is not identifying shapes, colors, and familiar objects.
Let your doctor know if your child is not maintaining balance and coordination.
Let your doctor know if your child does not pay attention.
Let your doctor know if your child fails to follow directions.

7.
Needed improvements to the alarm clock include stabilizing the top unit.
The alarm clock needs to allow the user to listen to the CD when the alarm is set.
Needed improvements to the alarm clock include making the snooze button larger.
The alarm clock needs to prevent users from accidentally turning off the alarm.
A more intuitive method for operating the CD unit would improve this alarm.

8.
To comply with elevator safety recommendations we must perform monthly inspections.
To comply with elevator safety recommendations all work should be conducted in accordance with American Society of Mechanical Engineers (ASME) standards.
To comply with elevator safety recommendations we should evaluate the long-term performance of all installations.

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