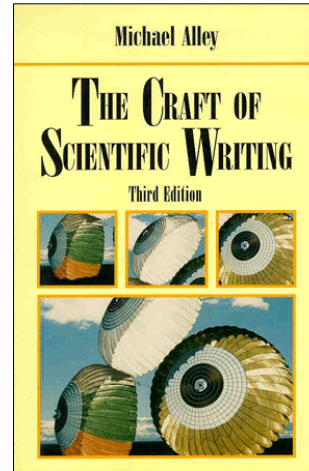


# The Craft of Scientific Writing: A Workshop on Documenting Research

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## You should begin the writing process by analyzing your constraints

purpose

audience

occasion

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**STIFFNESS EVALUATION AND VIBRATION IN A TRACTOR GEAR**

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**ABSTRACT**  
The problem of gear noise is widely known, but rarely studied in the past. However, in order to design quieter and more precise gears because of new regulations, it is necessary to know first and the degree of non-linear dependence. One of the most important theories and some degrees in transmission error that make the problem a dynamic or even the motion surface, and contact components, the contact law within a mesh. However, the correct understanding of gear vibration remains incomplete, even though there is general agreement about the nature of the phenomena. Variations are due to several natural versus stochastic, frequency, or cyclic fluctuations in drive torque, gear mesh transmission error, local component tolerances and deformations in the contact zone, thermal expansion.

The concept of a vibration system made of two gears is generally overlooked, but is linked by the mesh teeth stiffness. In the contact zone, this model can describe the dynamic linear response, i.e. the resonant frequency of the system. However, more complete phenomena such as geometric instabilities can be an important source of noise.

In the case of gear vibration problems in the mesh of an individual wheel, an investigation through the use of generative techniques, a suitable software has been developed to generate the gear profiles in order to evaluate global mesh deformations in finite element analysis.

**INTRODUCTION**  
In the analysis of gear dynamics several engineering topics are generally considered: gears, the profile-face generation, kinematics, gear tooth, shaft and support elasticity, force and contact dynamics, etc.

In the past several approaches have been proposed for gear modeling. An interesting literature overview can be found in [1], where the methods used to model gear dynamics were classified by considering the variation of single dynamic factor, mesh compliance, gear dynamics, forced mesh dynamics and mesh stiffness.

Recent years were marked by Andriano and Valtan [2], which began problems were investigated by Lee and Kim [3], the flexibility of shaft using a methodology of beam elements was modeled by Lee et al. [5]. Choi and Hwang [6] proposed a linear approximation for a pair of gear, gear and compared the material behavior with phenomena. Park et al. [7] studied the nonlinear dynamic response of a gear pair gear using a non-linear approach and two single degree of freedom models. Amabili and Brusa [8] obtained a continuous closed form solution for one constant speed and compared the results curves, stable and unstable regions, by means of the Hill infinite determinant.



An error of process is not using one's writing time effectively

Getting in the Mood



AIP Niels Bohr Library

Writing the First Draft



Revising, Revising, Revising

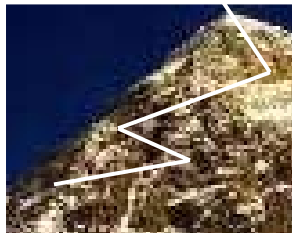


Finishing

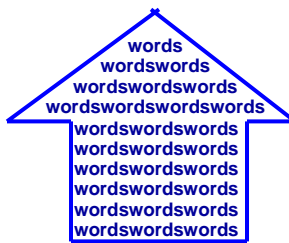


3

This workshop focuses on avoiding critical errors of style: structure, language, and illustration



Structure



Language

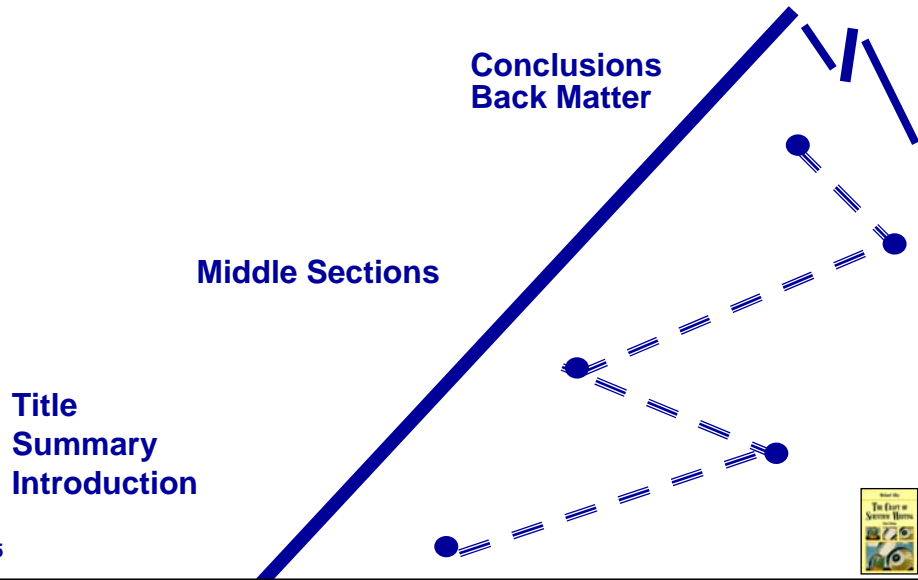


Illustration

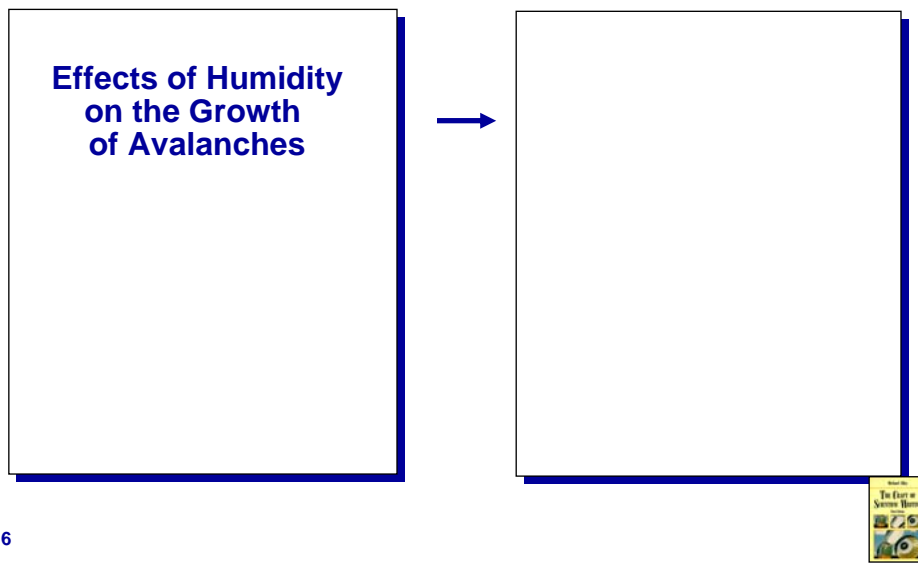


4

**One critical error is not properly organizing the document**



**A strong title orients readers to your area of work**



**A strong title also separates your work from everyone else's work**

**Studies on the  
Electrodeposition  
of Lead on Copper**



7



**A strong title also presents details  
in an understandable form**

**10 MWe Solar Thermal  
Central Receiver  
Barstow Power Pilot Plant  
Conversion Study**



8



**One common way to begin a document or section is to restate the title**

**New Chemical Process for  
Eliminating Nitrogen Oxides  
from Engine Exhausts**

**Sandia National  
Laboratories**

**This paper presents a new method for eliminating nitrogen oxides from the exhausts of engines and furnaces.**

9



**Another way, often used with unfamiliar topics, is to start with background information**

**Design of  
Steam Generators for  
the Downhole Portion  
of Oil Wells**

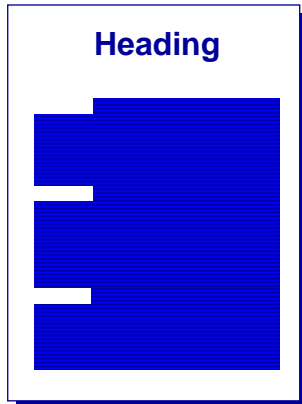
**Sandia National  
Laboratories**

**More than half of the oil in a reservoir is too viscous to pump out with conventional methods. By heating these oils with steam and decreasing their viscosity, we can recover billions of gallons. For oils below 800 meters, the steam produced on the surface loses too much energy in transit to heat the oil. We are developing a downhole steam generator to apply hot steam directly.**

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## Avoid abrupt beginnings to documents or sections



*Experiment.* The specimens were thin-walled tubes of 304L stainless steel...



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## Although several names exist for summaries, essentially two approaches exist

This paper describes a new inertial navigation system for mapping oil and gas wells. In this paper, we will compare the mapping accuracy and speed for this new system against the accuracy and speed for conventional systems.

*Descriptive*

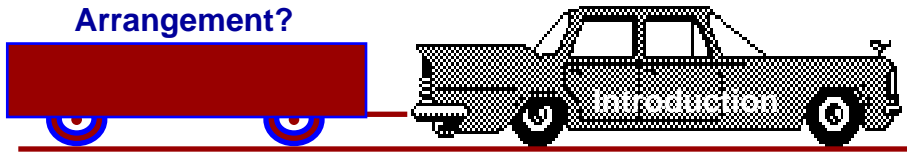
This paper describes a new inertial navigation system that will increase the mapping accuracy of oil wells by a factor of ten. The new system uses three-axis navigation that protects sensors from high-spin rates. The system also processes its information by Kalman filtering (a statistical sampling technique) in an on-site computer. Test results show the three-dimensional location accuracy is within 0.1 meters for every 100 meters of well depth, an accuracy ten times greater than conventional systems.

*Informative*



# A document's introduction prepares readers for the discussion

Topic?  
Importance?  
Background?  
Arrangement?



# The organization of a document is reflected in the headings, subheadings, and paragraphs

## Chapter 1 Introduction

The main purpose of this chapter is to introduce the topic of magnetorheological (MR) dampers to the reader. First presented is an overview of the development through various MR fluid media. Lastly, the project objectives and the approach taken to evaluate different MR damper designs are discussed.

### 1.1 An Overview of Magneto-Rheological Dampers

In recent years, considerable work has been conducted on the use of MR fluids. For instance, the Lord Corporation has been developing MR fluid and magnetorheological MR fluid star dampers for a number of years now. These star dampers are similar to the typical hydraulic star dampers that are widely employed on many large commercial roads. Lord Corporation's most star dampers are arguably the most successful commercial MR dampers in use. In addition to their star dampers, other commercial MR dampers will be available in the future. Control Systems, for instance, has announced that its MR damper suspension system will be available in some 2000 Cadillac models. MR dampers are, of course, however, in various applications. Recently, the military has shown interest in using MR dampers to control gas ascent on level gas meters and field activity. Another area of study has been magnetorheological MR dampers in the construction of buildings during earthquakes. This interest in commercial interest is largely due to the success of various projects and through the efforts of Lord Corporation, which is a leader in the field of MR dampers.

Magneto-Rheological MR fluid is composed of oil and varying percentages of iron particles that have been mixed with a non-conductive material. When subjected to an MR fluid becomes a solid body. When exposed to a magnetic field, the iron particles form a dispersed structure of fluid that increases the magnetic flux loss. The condition of the

particles can be visualized as a large number of microscopic spherical beads that are randomly distributed in the fluid. One can picture this as being something from the magnetic particles in the oil, and particularly in the case of magnetorheological particles. In this analogy, the spherical beads represent iron particles and the magnetic field represents a magnetic flux loss. One can picture many of these things of beads placed closely together such that the beads of a magnetic field. One might also think of the iron particles as being made up of four separate flux lines and so on a source of fluid flow.

MR fluid can be used in many different ways, all of which can be applied to MR damper design depending on the design's intended use. These media of operation are referred to as squeeze mode, valve mode, and shear mode. A damper that uses squeeze mode has a thin film between two plates of MR fluid that is sandwiched between magnetorheological plates as shown in Figure 1. An MR fluid damper in valve mode is shown in Figure 2. The thin layer of MR fluid in valve mode is sandwiched between two magnetorheological plates. Shear mode, see Figure 3 is used primarily for dampers that are used to produce large forces and for clutches and brakes. The shear mode of MR damper operation, valve mode, see Figure 4, is the most widespread of the three modes. An MR damper in valve mode is valve mode where the MR fluid is used to impede the flow of MR fluid from one reservoir to another. This is the concept of a magnetorheological MR damper design, all of the damper designs previously listed are covered with operation in the valve mode.

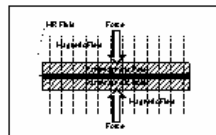


Figure 1. MR fluid used in squeeze mode.



## The headings and subheadings reveal the overall strategy of the document

Contents	
Abstract .....	ii
Acknowledgments .....	iii
Nomenclature .....	vi
List of Figures .....	viii
List of Tables .....	x
1 Introduction .....	1
2 Literature Review .....	7
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2.2 Effect of Temperature Gradients on Secondary Flows .....	13
3 Theoretical Analysis of Secondary Flows .....	18
3.1 Theoretical Development of Classical Secondary Flow .....	24
3.2 Effects of Compression and Viscosity on Classical Secondary Flow .....	29
3.3 Methods of Predicting Secondary Losses at the Endwall .....	32
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4.1 Computational Domain .....	38
4.2 Meshing Procedures .....	44
4.3 Numerical Simulation Techniques .....	49

15



## A common mistake with section transitions is to begin sections abruptly

### ~~Calculation of Fan Performance~~

~~Calculations of Volume Flow Rate. Here we used dynamic measurements. Each of the values for dynamic pressure used to find the flow rate was an average of five dynamic...~~

~~.....~~

16



**In research writing, one common section is the literature review**

**Purpose:**

- (1)
- (2)
- (3)
- (4)

**Structure:**

**Organization:**  
**Depth:**

**In organizing a section, think about the purpose of that section**

**Procedures for Experiment**

The goal of the experiment was to evaluate the effectiveness of inlet guide vanes at reducing the electrical power required by the fan. To evaluate the effectiveness of these vanes, we measured....

**What were goals?**

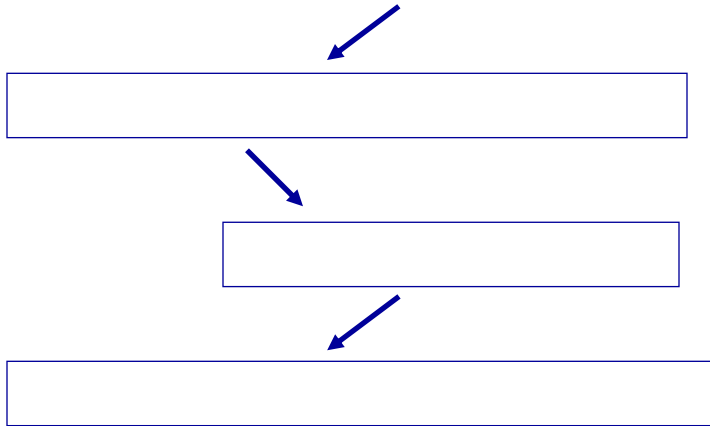


**What was measured?**



## To be persuasive in research writing, you need to present assertions in a methodical fashion

This research estimates the coolant leakage flows between the downstream stationary vanes and rotating blades in a gas turbine engine

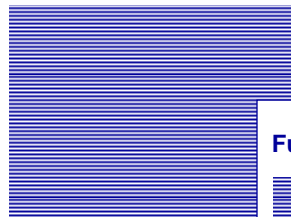


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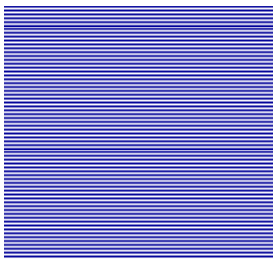
## In a strong ending, you analyze results and give a future perspective

### Conclusions

#### Analysis of Results



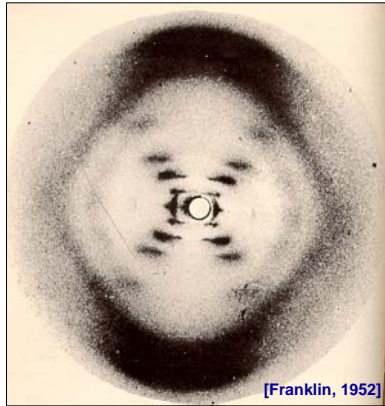
#### Future Perspective



20



**Failure to emphasize the contribution of others can cast a shadow on one's career**



James Watson surreptitiously looked at Rosalind Franklin's work



Watson did not give enough credit to Franklin



**A writing error of language is making the writing needlessly complex**

**Content:**  
Ideas

**Style and Form:**  
Writing

**Inherent complexity:**  
*Reynolds number*  
*turbulent eddies*  
 $\rho v^2$

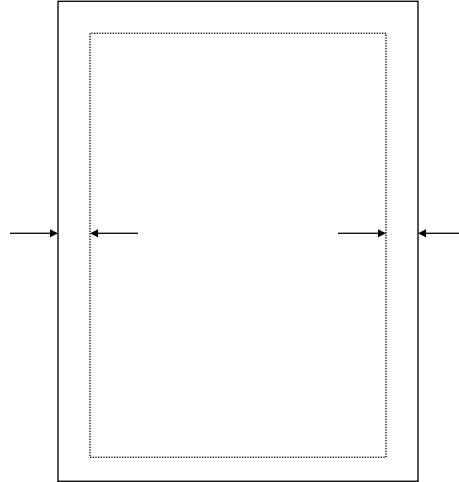
**Needless complexity:**



**Another writing error of language is communicating the wrong message**



**J. Edgar Hoover**  
Director of FBI , 1924–1972



**An ambiguity is a group of words that can have more than one meaning**

**The proposed schedule is discussed below for the next four years.**



## Word choice often causes ambiguities

We wanted to reduce the vibration of the fan at the exhaust as the exhaust ducting was cracking.



25



## Words have both denotations and connotations

Negative

Neutral

Positive



26



**Also causing ambiguities are pronouns, particularly the pronouns *it* and *this***

Although engineers realized the design flaws in the Titanic soon after its sinking in 1912, the reasons for the severe damage inflicted by the iceberg remained a mystery until its discovery in 1985.

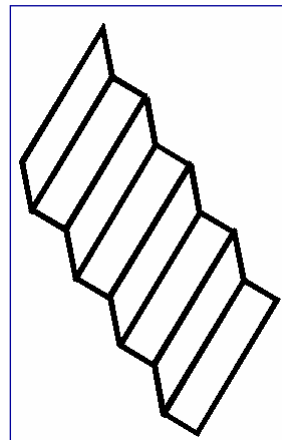


27



**Not having commas after introductory phrases or clauses often causes ambiguities**

As light hydrocarbons evaporate the oil vapor pressure falls.



28



**When commas are missing within lists, ambiguities often occur**

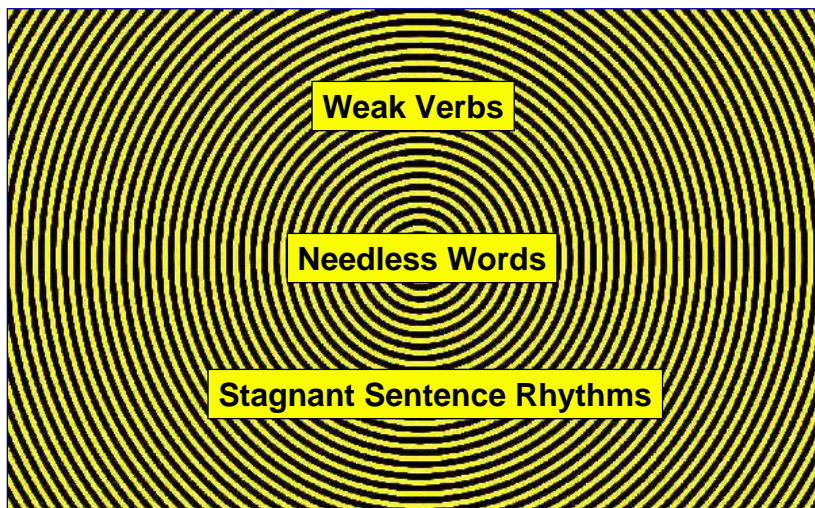
**We examined neat methanol and ethanol and methanol and ethanol with 10% water.**



29



**Another critical error of language is placing the audience in a hypnotic state**



30



## Placement of a verb affects its strength

In this study, the care given by a hospital and the medical outcomes of patients are compared. The effects of exogenous factors, such as the types of illnesses, are accounted for. Also, the opinions of both patients and physicians on the quality of health care are considered.



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## Needlessly passive verbs slow your writing

**Misconception: Scientific writing must be written in the passive voice.**

**Active Voice**

**Subject performs the action.**

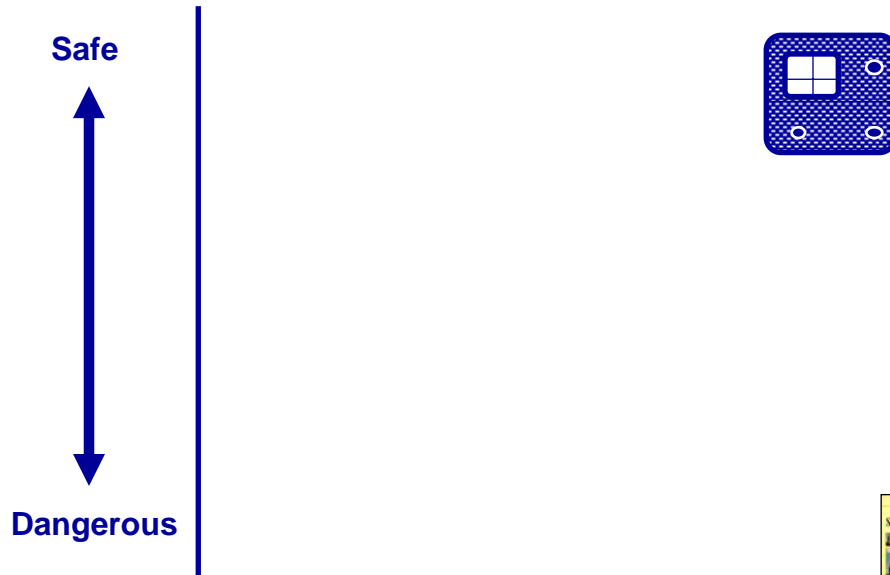
**Passive Voice**

**Subject is acted upon.**

32



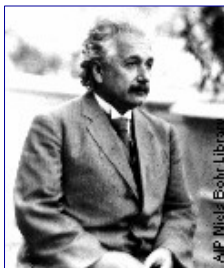
## Problems can arise using the active voice with inanimate objects



## Using the first person is fine as long as the emphasis remains on the work

**Misconception: In scientific writing, you cannot use the first person.**

### Users of the First Person



### Non-Users of the First Person

It was decided that...

It was assumed that...

It was realized then that...



## Avoiding the first person often convolutes sentences

In that an effort to identify a specific control circuit responsible for the failure of the gear box was unsuccessful, it was determined appropriate to resurvey the collector field for torque tube damage.



## Weak verbs hide the energy of your work

A new process for eliminating nitrogen oxides from diesel exhaust engines is presented. Flow tube experiments to test this process are discussed. The percentage decrease in nitrogen oxide emissions is revealed.



## **Tightening your writing can make it more energetic**

**Vibration measurements made in the course of the Titan flight test program were complicated by the presence of intense high-frequency excitation of the vehicle shell structure during the re-entry phase of the flight.**



37



## **Tightening your writing can make it more energetic**

**The objective of our work is to obtain experimental data that can be used in conjunction with a comprehensive chemical kinetics modeling study to generate a detailed understanding of the fundamental processes that lead to engine knock.**



38



**When sentence rhythms do not vary,  
even the most interesting subjects seem dull**

z  
z  
z

Mount St. Helens erupted on May 18, 1980. A cloud of hot rock and gas surged northward from its collapsing slope. The cloud devastated more than 500 square kilometers of forests and lakes. The effects of Mount St. Helens were well documented with geophysical instruments. The origin of the eruption is not well understood. Volcanic explosions are driven by a rapid expansion of steam. Some scientists believe the steam comes from groundwater heated by the magma. Other scientists believe the steam comes from water originally dissolved in the magma. We need to understand the source of steam in volcanic eruptions. We need to determine how much water the magma contains.



**Varying sentence openers allows for more kinds  
of transitions between sentences**



- Topic of Sentence
- Time or place of action
- Manner of action
- Subordinate action
- Reason for action



## Vary sentence openers to vary rhythm

subject-verb

prepositional phrase

adverb

dependent clause

41



## More sophisticated sentence openers exist

infinitive phrase

gerundial phrase

dependent clause  
as subject

participial phrase

42



## More sophisticated sentence openers exist

verb-subject

direct object

appositive

double clauses

43



## Varying sentence openers enlivens the writing and allows connections

Mount St. Helens erupted on May 18, 1980. Its slope collapsing, the mountain emitted a cloud of hot rock and gas. In minutes, the cloud devastated more than 500 square kilometers of forests and lakes. Although the effects of the eruption were well documented, the origin is not well understood. Volcanic explosions are driven by a rapid expansion of steam. Recently, debate has arisen over the source for the steam. Is it groundwater heated by magma or water originally dissolved in the magma itself? To understand the source of steam in volcanic eruptions, we need to determine how much water the magma contains.

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**To make connections, use transitional phrases early in sentences**

**Continuation**

**Pause**

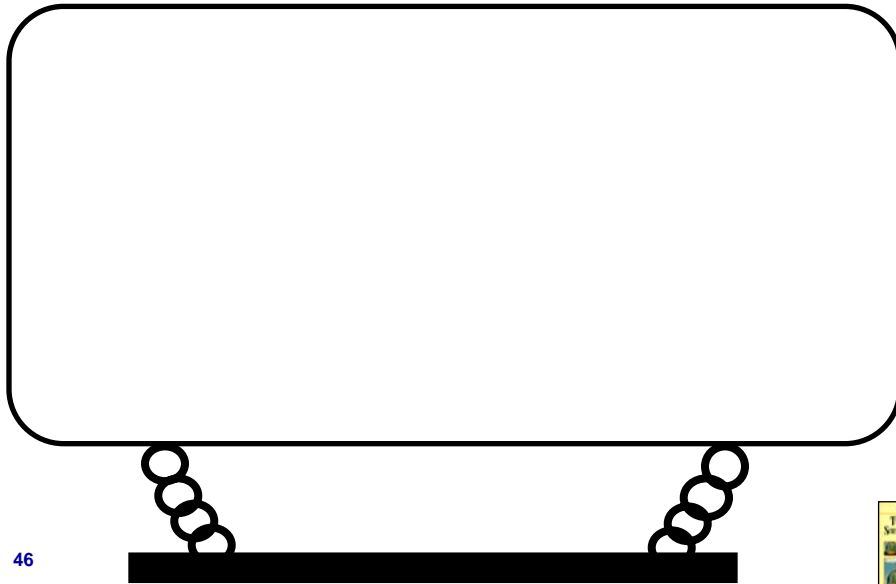
**Reversal**

~~This shows...  
This means...~~

45



**A fourth critical error is not anchoring your language in the familiar**



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One critical error of illustrations is not choosing a persuasive image

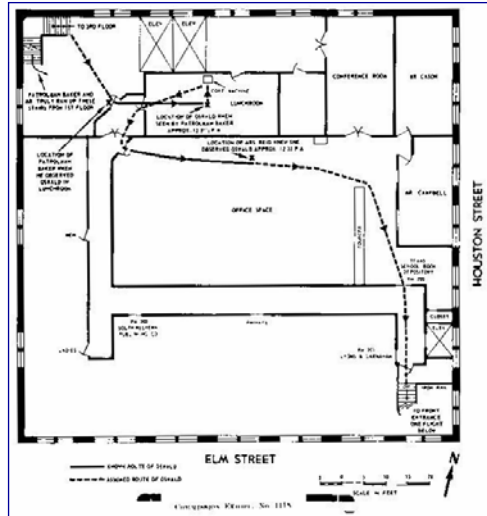


Figure 1. Alleged path of Oswald, after shooting of President Kennedy, through second floor of Texas Schoolbook Depository.



For clarity, you should introduce and explain illustrations in the text

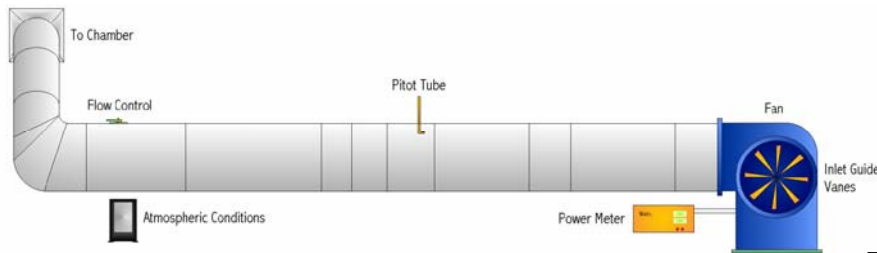
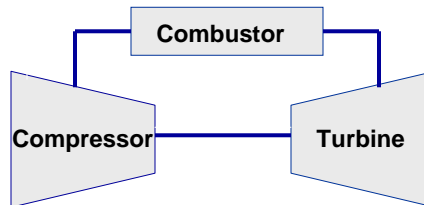
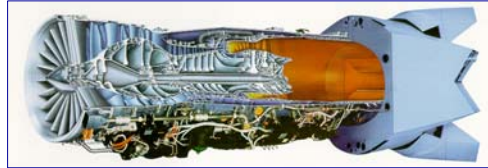


Figure 4. Title of figure [Raven, 2000]. Some formats allow you extra sentences to explain unusual details.



## When presenting images, you choose between photographs, drawings, and diagrams



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## Readers have certain expectations for line graphs

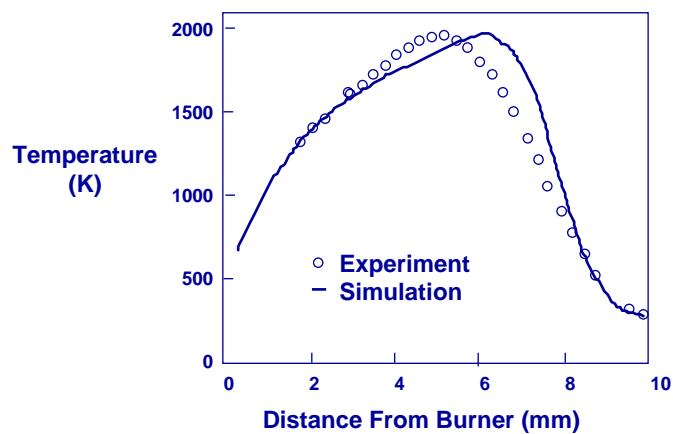
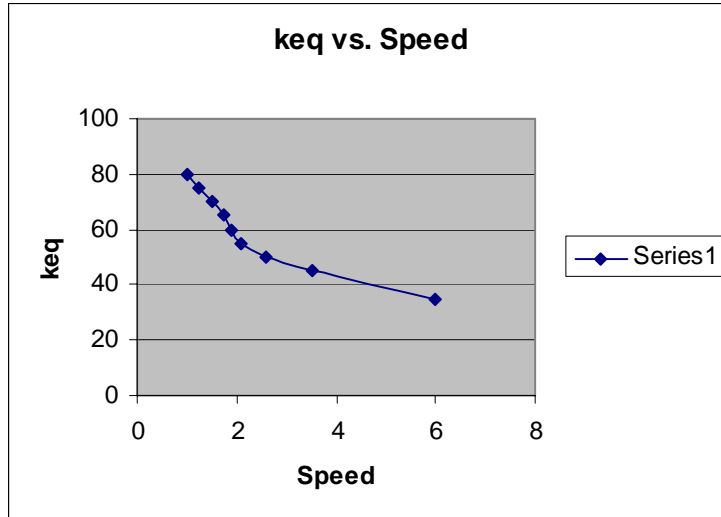


Figure 12. Computational and experimental temperatures for laminar diffusion flames [Sandia, 1987].

50



**With graphs, you should challenge Excel's defaults**



51

**In summary, writing is a craft upon which we should continually strive to improve**

**Michael Alley**  
College of Engineering  
Penn State

