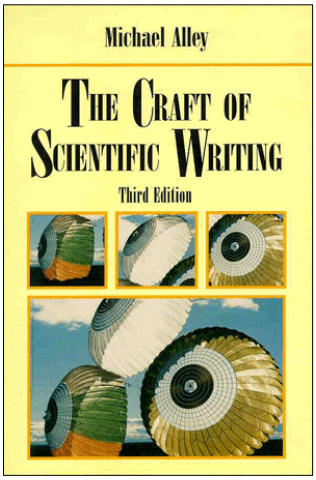
The Craft of Scientific Writing:

A Workshop on Documenting Research

Michael Alley
College of Engineering
Penn State



You should begin the writing process by analyzing your constraints

audience

purpose


Proceedings of IMECE04
2004 ASME International Mechanical Engineering Congress and Exposition
November 13-20, 2004, Anaheim, California USA

IMECE2004-59492

STIFFNESS EVALUATION AND VIBRATION IN A TRACTOR GEAR

G. BONORI
Dipartimento di Ingegneria Meccanica e Civile,
Università di Modena e Reggio Emilia, I-41100
Modena, Italy
bonori.giorgio@unimore.it

A.O. ANDRISANO
Dipartimento di Ingegneria Meccanica e Civile,
Università di Modena e Reggio Emilia, I-41100
Modena, Italy
andrisano.angelo@unimore.it

F. PELLICANO
Dipartimento di Ingegneria
Meccanica e Civile, Università di
Modena e Reggio Emilia, I-41100
Modena, Italy
francesco.pellicano@unimore.it

IMPLEMENTATION

ABSTRACT

The problem of gear noise in vehicle has been extensively studied in the past, however, recently the issue without this problem grew because of great investments in the drive regarding noise level and the increase of transmitted power/mass. One of the most important vibration and noise sources in transmission error that excites the gearbox as a dynamic system, the gearbox surfaces, and connected components; the external box radiates noise. However, the current understanding of gear vibration remains incomplete, even though there is general agreement about the nature of the phenomenon. Vibrations are due to several sources: torsion resonance, impulsive or cyclic fluctuations in drive torque, gear mesh transmission error, load component vibration response and fluctuations in the output torque demand.

The concept of a vibrating system made of two gears is generally modeled through two wheels linked by the teeth mesh stiffness. In its simple form, this model can simulate the classical linear resonance, i.e. the resonant frequency of the system. However, more complex phenomena such as parametric instabilities can be an important source of noise.

In the present paper vibration problems in the gears of an industrial vehicle are investigated through the use of perturbation techniques. A suitable software has been developed to generate the gear profiles in order to evaluate global mesh stiffness using finite element analysis.

INTRODUCTION

In the analysis of gear dynamics several engineering topics are generally considered: geometric profile/surface generation, kinematics, gear tooth, shaft and support elasticity, linear and nonlinear dynamical interactions.

In the past several approaches have been proposed for gear modeling. An interesting literature overview can be found in [1], where the mathematical models used in gear dynamics were classified by considering the evolution of simple dynamic factor, tooth compliance, gear dynamics, paired meter dynamics and torsion vibration.

Helical gears were studied by Andersson and Vedmar [2], teeth impact problems were investigated by Yea and Sun [3], the flexibility of shafts using a multi-degrees of freedom model was analyzed by Lin et al. [4,5]. Cai and Hayashi [6] proposed a linear approximation for a pair of spur gears and compared the analytical solution with the numerically calculated result by the nonlinear equation; they found that linear models are able to capture the main dynamic phenomena. Parker et al. [7] studied the nonlinear dynamic response of a spur gear pair using a semi-analytical approach and two single degrees of freedom models. Amabili and Rivola [8] obtained a continuous closed form solution for any rotational speed and computed the transition curves, stable and unstable regions, by means of the Hill infinite determinant.

1 Copyright © 2004 by ASME

occasion

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

Getting in the Mood

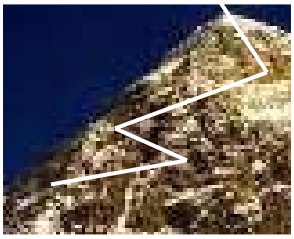
Writing the First Draft

Revising, Revising, Revising

Finishing

3

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



Structure

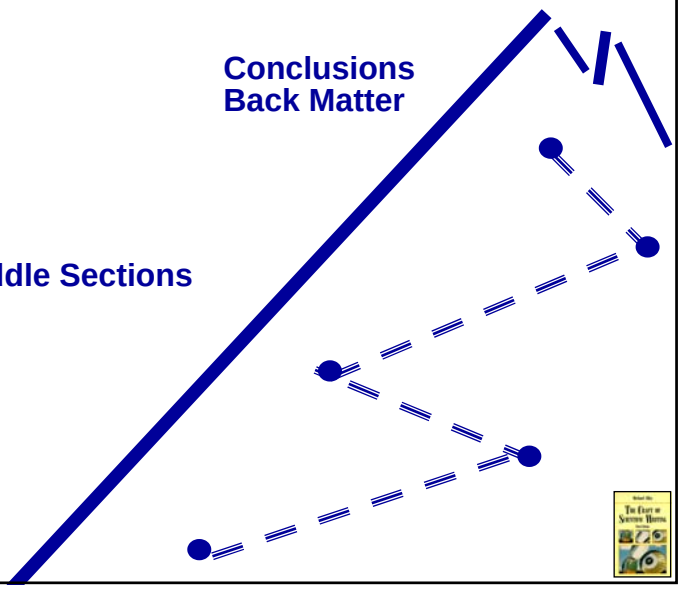
words
wordswords
wordswordswords
wordswordswordswords
wordswordswords
wordswordswords
wordswordswords
wordswordswords
wordswordswords
wordswordswords

Language

Illustration

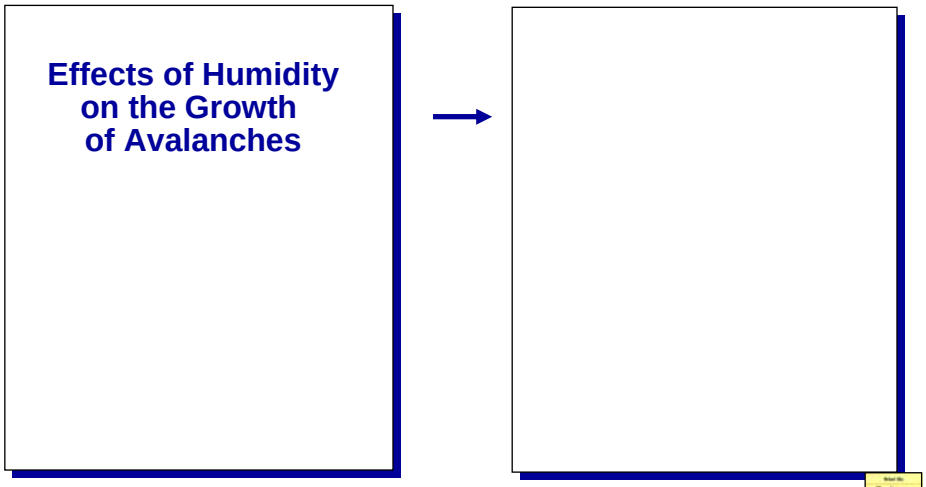
4

One critical error is not properly organizing the document



5

A strong title orients readers to your area of work



6

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

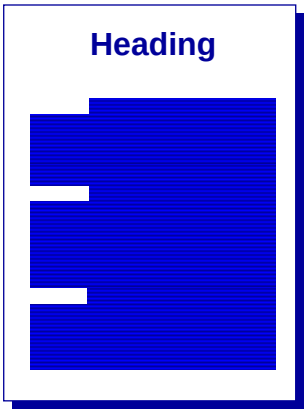
Design of Steam Generators for the Downhole Portion of Oil Wells

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.

10

Avoid abrupt beginnings to documents or sections



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

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

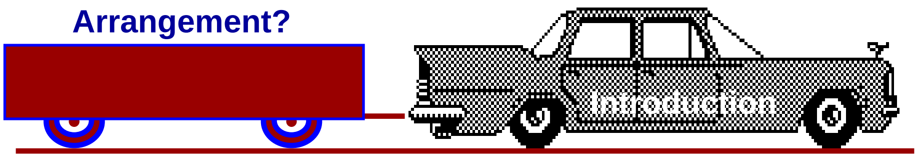
A document's introduction prepares readers for the discussion

Topic?

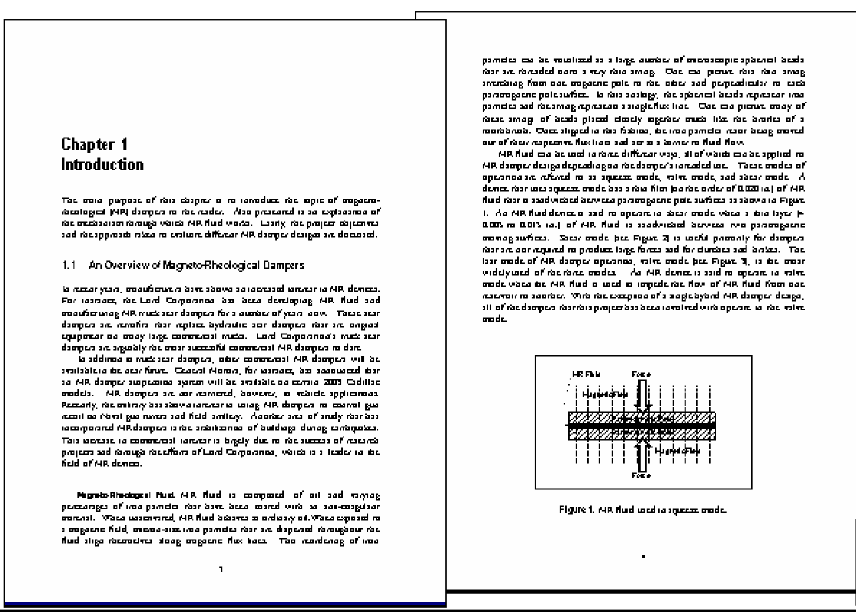
Importance?

Background?

Arrangement?



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



Chapter 1
Introduction

1.1 An Overview of Magneto-Rheological Dampers

Figure 1. MR fluid used in squeeze mode.

The headings and subheadings reveal the overall strategy of the document

Contents

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…

. . . . .

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

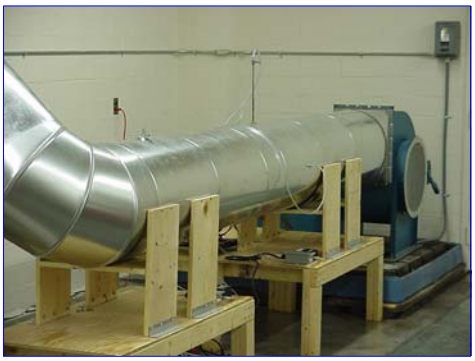
Procedures for Experiment

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?

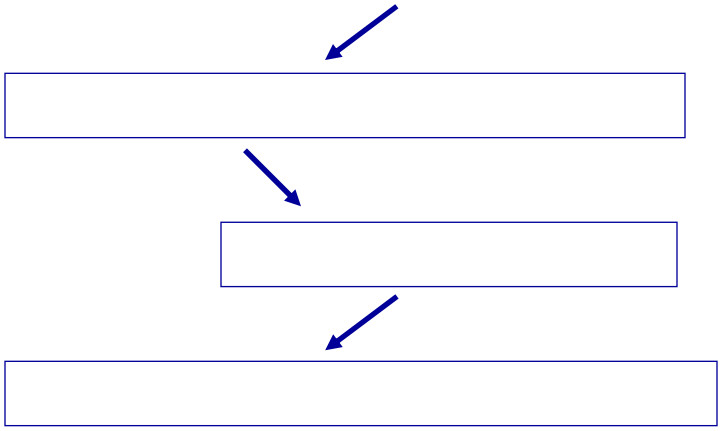
↓

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



19

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

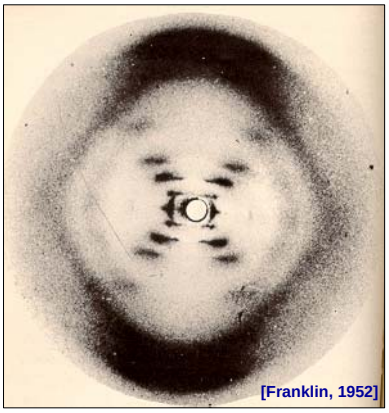
Conclusions

Analysis of Results

Future Perspective

20

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


[Franklin, 1952]

James Watson surreptitiously looked at Rosalind Franklin's work


[Luzzati, 1950]

Watson did not give enough credit to Franklin

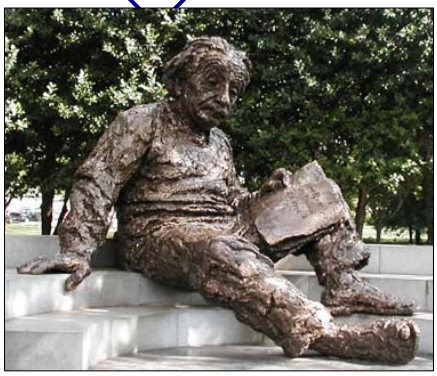
A writing error of language is making the writing needlessly complex

Content: Ideas

Style and Form: Writing

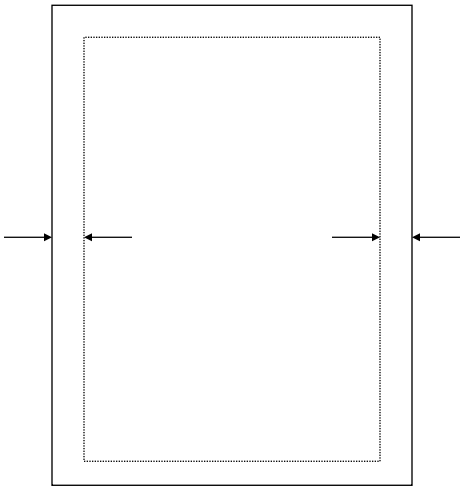
Inherent complexity:
Reynolds number
turbulent eddies
ρv^2

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.

Words have both denotations and connotations

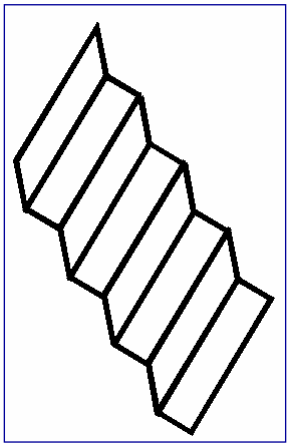
Negative	Neutral	Positive
←	inexpensive	→
←	unusual	→
←	simple	→
←	clear	
←	sufficient	

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.

Not having commas after introductory phrases or clauses often causes ambiguities

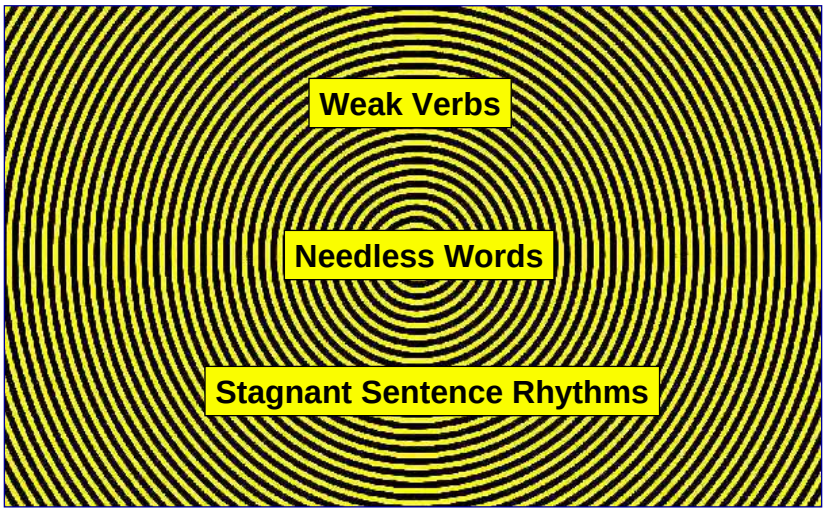
As light hydrocarbons evaporate the oil vapor pressure falls.



When commas are missing within lists, ambiguities often occur

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

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



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.

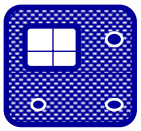
Needlessly passive verbs slow your writing

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

Active Voice	**Subject performs the action.**
Passive Voice	**Subject is acted upon.**

Problems can arise using the active voice with inanimate objects

Safe

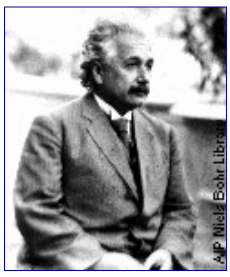


Dangerous

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.

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.

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

Sentence ← Manner of action

Subordinate action

Reason for action

Vary sentence openers to vary rhythm

subject-verb

prepositional phrase

adverb

dependent clause

More sophisticated sentence openers exist

infinitive phrase

gerundial phrase

dependent clause as subject

participial phrase

More sophisticated sentence openers exist

verb-subject

direct object

appositive

double clauses

Varying sentence openers enlivens the writing and allows connections

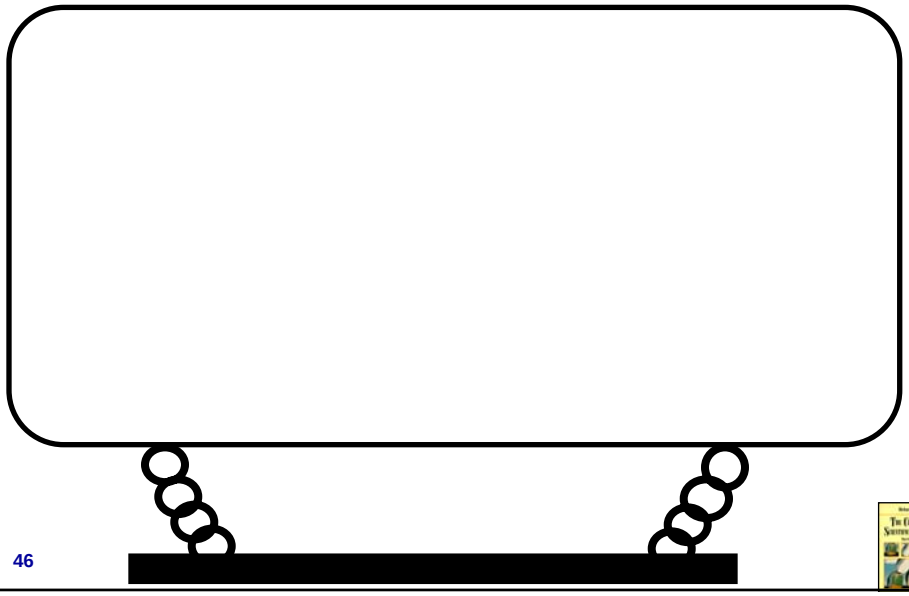
Mount St. Helens erupted on May 18, 1980. Its slope collapsing, the mountain emitted a cloud of hot rock and gas. In minutes, the cloud devastated more than 500 square kilometers of forests and lakes. Although the effects of the eruption were well documented, the origin is not well understood. Volcanic 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.

To make connections, use transitional phrases early in sentences

Continuation **Pause** **Reversal**

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

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



One critical error of illustrations is not choosing a persuasive image

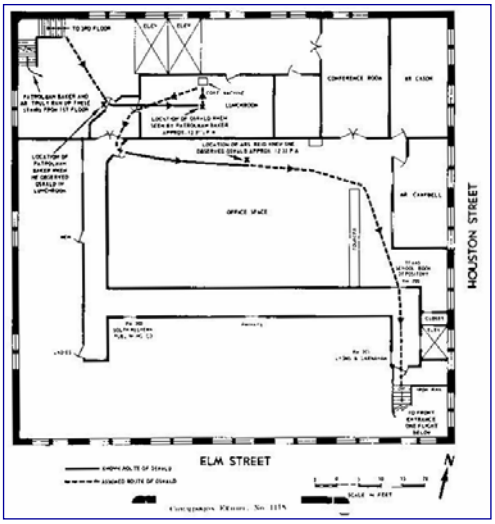


Figure 1. Alleged path of Oswald, after shooting of President Kennedy, through second floor of Texas Schoolbook Depository.

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

..., as shown in Figure 4.

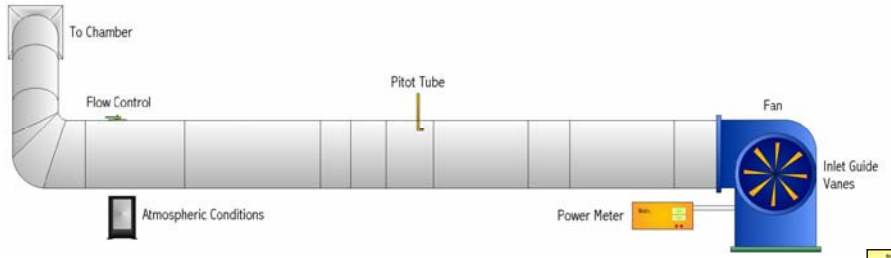
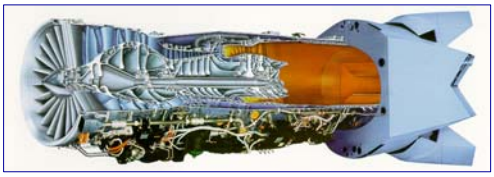
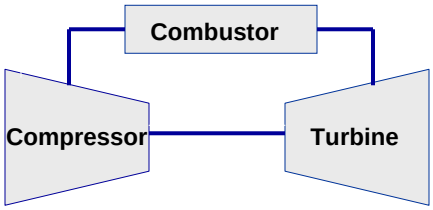


Figure 4. Title of figure [Raven, 2000]. Some formats allow you extra sentences to explain unusual details.

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





Readers have certain expectations for line graphs

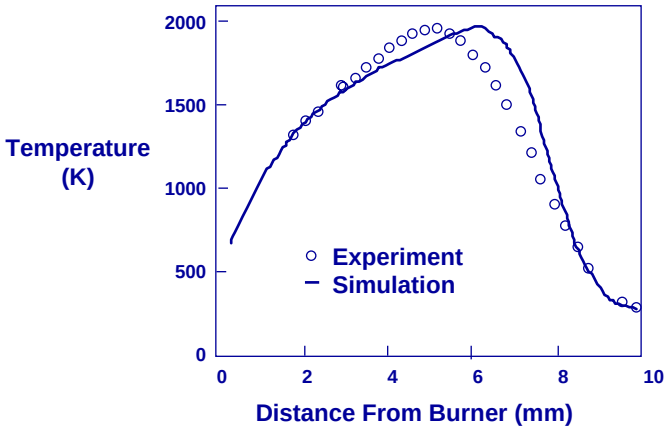
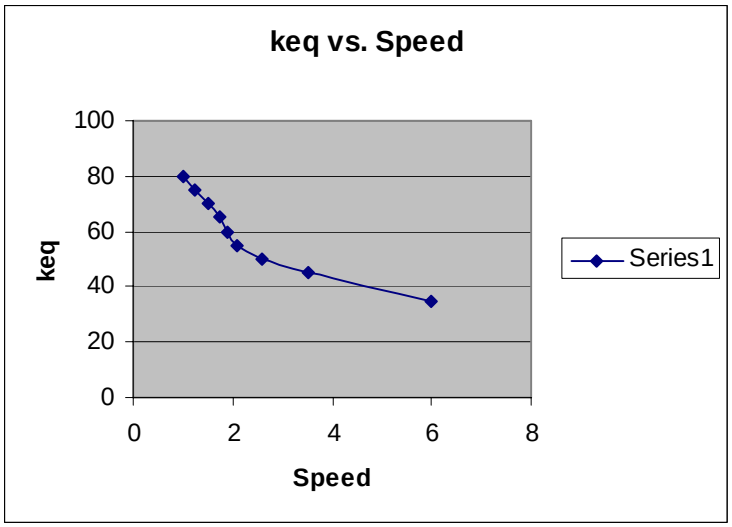


Figure 12. Computational and experimental temperatures for laminar diffusion flames [Sandia, 1987].

With graphs, you should challenge Excel's defaults



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

Michael Alley
College of Engineering
Penn State