

INSTRUCTOR'S GUIDE

WRITTEN COMMUNICATION MODULE

Charles L. Karr

Aerospace Engineering and Mechanics Department

College of Engineering

University Of Alabama

INTRODUCTION

The Instructor's Guide for the Written Communication Module will assist instructors as they insert a short module on written communication into a standard engineering course. Obviously, entire courses are taught on technical writing and written communications. Thus, this three-class module will focus on a very narrow aspect of written communication: the abstract or Executive Summary. Using this instructional module in a standard engineering course will provide the students with some instruction and experience in preparing an engineering abstract or Executive Summary.

The module provides instruction on effective written communication skill as it pertains to engineering abstracts and/or executive summaries, and provides students with an opportunity to practice the skills discussed (see Figure 1 for a listing of student activities). This follows the format for teaching skills suggested by Woods et al (1997), where a skill is introduced in a context-free environment and then bridged and extended into the discipline material. The module also provides for instruction followed by practice with evaluation and feedback – an approach considered essential in teaching a skill (Seat et al, 1999).

STUDENT ACTIVITIES

- **Write an Executive Summary for an article or technical report related to a scientific discipline, but one that is not too difficult for the student to understand. This initial exercise is completed with no instruction from the instructor.**
- **Refine their initial executive summaries after having received instruction on the requisite components and form of an Executive Summary.**
- **Write an Executive Summary for an article much like that given in the first item above, except this one will be written after having received instruction in class.**
- **Identify effective and ineffective abstracts or executive summaries from a number of technical reports provided by the instructor. In addition to recognizing effective executive summaries, students are required to list why the summaries are of high or low quality.**
- **Write an Executive Summary for a technical report on a physics experiment.**

Figure 1. Student activities in the Written Communication Module

This module contains material for three 50-minute classes. Before coming to the first class in the three-class series, students will be required to try their hand at writing an Executive Summary for an elementary scientific report. The first class combines a lecture and a group-interactive format to provide instruction on the attributes and fundamental components of effective executive summaries. Based on this information, students are required to refine their executive summaries in accordance with the guidelines provided. The second class begins with an interactive critiquing of the refined executive summaries. Next, instruction is provided regarding additional tips for writing effectively. After incorporating these tips into their executive summaries, students receive a homework assignment

to write an Executive Summary for a different technical report – one on approximately the same level of technical detail. In class three, the students receive further instruction on writing effective executive summaries before they are required to write an Executive Summary for a report describing a college-level physics experiment. Follow-on exercises are recommended in which students write engineering summaries for technical reports from the material in the current course in which the module is being offered.

This guide contains a discussion of several aspects important in teaching a module on presentation skills, including a set of objectives, a justification for learning these skills, classroom material, and potential assignments. Figure 2 itemizes these topics and the following sections address each of them.

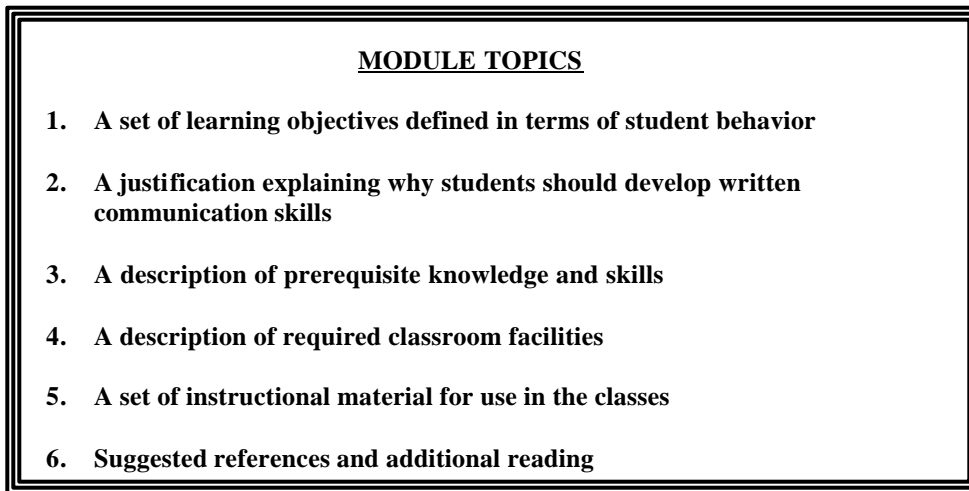
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- MODULE TOPICS**
- 1. A set of learning objectives defined in terms of student behavior**
 - 2. A justification explaining why students should develop written communication skills**
 - 3. A description of prerequisite knowledge and skills**
 - 4. A description of required classroom facilities**
 - 5. A set of instructional material for use in the classes**
 - 6. Suggested references and additional reading**

Figure 2. Module topics addressed in this module.

OBJECTIVES

The major educational objectives of this module all relate to the students' knowledge of executive abstracts and/or engineering summaries. Figure 3 defines a specific set of three educational objectives. One of the early PowerPoint slides in the material for Session 1 also lists these objectives.

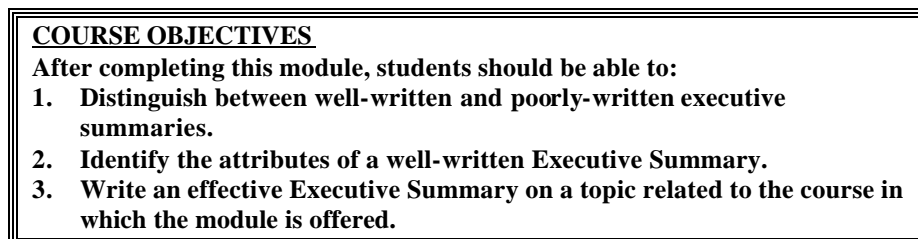
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- COURSE OBJECTIVES**
- After completing this module, students should be able to:**
- 1. Distinguish between well-written and poorly-written executive summaries.**
 - 2. Identify the attributes of a well-written Executive Summary.**
 - 3. Write an effective Executive Summary on a topic related to the course in which the module is offered.**

Figure 3. Course objectives for this educational module are focused on the students' knowledge of engineering abstracts/summaries.

JUSTIFICATION

The ability to summarize technical works in a concise form is a skill that is vital for engineers. Throughout their careers engineers are continually being asked to produce brief (one-page) documents on technical subjects including

being asked to formulate their ideas for a project, to summarize the results of a research effort or project, to make proposals for future efforts, and many others. The ability to produce a well-written, concise Executive Summary is a skill that can often be a “career-maker.” In practice, an engineer’s written communication skills can be as important as his or her technical skills because managers and colleagues judge the quality of engineer's ideas by the quality of his or her expression of these ideas.

Written communication skills tend to always appear on company lists showing the most important skills for success as an engineer. Surveys to identify attributes that are important for success as an engineer almost always include written communication skills, for example, Benefield et al 's study (1997). Finally, the agency that accredits engineering education programs (ABET) requires that accredited engineering programs demonstrate that their graduates have effective communication skills.

The PowerPoint material for Session 1 includes a justification slide along with slides showing “desirable skills” lists from Boeing and Kimberly Clark. In addition, there is information about Benefield’s results and about ABET requirements. The instructor may use any or all of these slides, or any justification that he or she feels is more convincing to the students.

PREREQUISITE KNOWLEDGE OR SKILLS:

This module requires no specific prerequisite knowledge. However, it is best if students have successfully completed a fundamental English composition course.

CLASSROOM REQUIREMENTS:

There should be a computerized projection system in the room for presenting the PowerPoint slides.

INSTRUCTIONAL MATERIAL:

This section provides the instructor with information and tips on how to implement the module into their course. The discussion is presented on a “day-by-day” basis to assist them with their preparation to deliver the information in the module.

Prior to Class One

Students are required to complete an assignment prior to the first day of class in the module. Instructors must be sure to make this assignment or the information in the first class will not be able to be presented in accordance with the guidelines presented in this Instructor’s Guide and in the Powerpoint slides.

The homework assignment requires for each student to receive a copy of an elementary technical report. A sample report appears at the end of this Guide as Attachment A. Note that the sample report does not include an Executive Summary. The students are required to read the technical reports and to write an Executive Summary. At this point, students have received no instruction on either technical writing or Executive Summaries, so what they produce is likely to be quite rough – that is absolutely acceptable. What they write will not be evaluated. However, it is imperative that they begin to think about what an Executive Summary should look like, what information it should include, etc.

The number of reports to be distributed to the students is entirely up to the instructor. Because students will work in teams, it is important that not each student receives a different report. It is suggested that the instructor distribute the reports such that three- to four-person teams can be assembled later in the class (where each team member has been working on the same technical report – but each student writes their own Executive Summary).

Class One

Objective: The objective of the first class is to introduce students to the key components in an Executive Summary and to have them refine their draft executive summaries in accordance with the information provided in class. At the end of the period they should be able to list the key components of an Executive Summary.

Materials: The students will require the Executive Summaries they wrote in their pre-class assignments.

Mode of Delivery: Class One includes

- a period in which the instructor presents some information on the board (justification for studying technical writing and the core components of a technical report),
- an interactive/team session in which the students suggest key components of an Executive Summary (this effort is based on them having attempted to write an Executive Summary in their pre-class assignment),
- an instructional period in which the instructor informs the students of key components of an Executive Summary, and
- an in-class homework assignment to get them to apply the information they have just been supplied.

Guidelines for the Instructor: Initially, the instructor will present some information: (1) as to why technical writing is important, (2) on the key components of a technical report, and (3) hinting at the components of an Executive Summary. Next, the students are to get together in small teams (team members will have addressed the same technical report in their pre-class assignment). The teams are to generate a short list of things that they believe should be included in an Executive Summary. It is important that the students be sufficiently motivated to take this exercise seriously. One way of achieving this is to have them write and discuss their answers on the board when they are finished. Of course, the best way to do this will be up to the instructor. After the students have completed this activity, then the instructor will present slides showing the key components of an Executive Summary. This is an excellent time to have discussions with the students as to why they think these things are important, what things they think have been left out, and what things are not necessary. Finally, the students are to refine their Executive Summaries based on the information covered in class.

Class Two

Objective: The objective of the second class in the Written Communications Module is to have the students develop a process that they can use to write an Executive Summary.

Materials: The students will use the executive summaries they wrote as in-class/homework assignments from Class One. In addition there is a handout describing a process for constructing an effective Executive Summary.

Mode of Delivery: Class Two includes

- a period in which the students critique each other's executive summaries,
- an in-class, team exercise in which students are to develop a process for writing an Executive Summary,
- a period in which the instructor relates a generally accepted process for writing an Executive Summary, and
- an in-class/homework assignment.

Guidelines for the Instructor: Class Two is comprised of several short periods. In the first segment of the class, students are asked to critique each other's Executive Summaries. This exercise allows for the students to (1) see alternative ways of attacking the problem they were assigned as homework, and (2) receive some feedback from their peers. It is vital that students put forth effort to make their feedback meaningful and constructive.

In the second segment of the class students are asked to develop a process by which they can write an Executive Summary. The in-class, team exercise is for them to do just that. It is important to note that they may well go into this exercise totally confused. So, the instructor might have to get them started by spotting them something like "clearly identify your audience" or "start by writing the objective of the paper." However, if students work hard at this exercise, the rest of the class will be far more meaningful to them. To properly motivate the students, the instructor should probably have them turn in this assignment.

In the third segment of the class, the instructor presents a generally accepted process for writing an Executive Summary to the class. This is an excellent opportunity to engage the students in a discussion of which of the steps they included, which they left out, and why.

The final part of the class is to give the students an assignment to use this process in writing an Executive Summary. By this time the students are likely tired of working with the technical reports they have been using. Thus, the instructor is strongly encouraged to assign them new technical reports. Aside from simply implementing the process, students are to evaluate the effectiveness of the process.

Class Three

Objective: The objective of the third class in the module is to have students be able to identify well-written abstracts and executive summaries, and to provide them with some information to help them improve their writing.

Materials: The students will use the Executive Summaries they wrote for homework in Class Two, and they will use a collection of Abstracts and/or Executive Summaries supplied by the instructor. In addition, there is a handout on tips for improving technical writing.

Mode of Delivery: Class Three includes

- a period in which students critique each other's Executive Summaries,
- an in-class, team exercise in which students evaluate the effectiveness of sample Abstracts or Executive Summaries,
- a period in which the instructor describes some tips for improving technical writing, and
- a homework assignment.

Guidelines for the Instructor: Like Class Two, Class Three consists of several short segments. In the first segment of the class, students are again asked to critique each other's Executive Summaries.

In the second segment, students work first as individuals then as teams to identify general points that they could use to improve the effectiveness of their technical writing. This is the kind of thing that many of them will have had in their English Composition courses, but will likely not remember. Thus, the instructor might again have to "prime the pump."

In the third segment of the class, the instructor presents ten tips for improving technical writing. As in the previous classes, this material is probably most effective when the students are engaged in meaningful discussion about the material.

The final part of the class is to give the students an assignment to exercise their skills. In the first part of the assignment, the students are required to write an Executive Summary for a technical paper. This technical paper should be more complex than their previous two papers. In the second part of the assignment, the students are required to critique several Abstracts and/or Executive Summaries. The second part of the assignment is included because although it is important for students to be able to write effectively, it is also important for them to be able to identify well-written documents.

Post-Module Follow-Up

After this three-class module on technical writing, students will have written and refined three Executive Summaries, and they will have critiqued numerous others. However, the ability to write effectively is a skill that must be exercised often. Thus, it is extremely important for the instructor to give the students additional practice in writing an Executive Summary. It is highly recommended that the instructor provide the students with a technical article from a field related to the current course in which the student is enrolled. And, to have them write an effective Executive Summary for that article. This exercise will only be effective if the instructor provides the students with meaningful feedback on their performances.

This exercise should be repeated at least two times after the students complete the Written Communications Module.

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LIST OF ATTACHMENTS

Attachment A: Sample Technical Report to be Distributed in Conjunction with the Pre-Class Assignment

Attachment B: Sample Abstract for Final Homework Assignment

Attachment C: Handout on a Process for Writing an Executive Summary

Attachment D: Handout on Ten Tips for Improving Technical Writing

Attachment A:
Sample Technical Report to be Distributed in Conjunction with the Pre-Class Assignment

This report was copied from: <http://www.union.edu/PUBLIC/BIODEPT/Jumpamine.html>

**THE EFFECTS OF JUMPAMINE CHLORIDE ON JUMPING PERFORMANCE
IN TWO SPECIES OF FROGS OF THE GENUS RANA**

By
Billie Preston

Executive Summary



Introduction

Jumpamine chloride (JCl-) is a natural waste product of muscle metabolism in many species of frogs. Phrogsucker et al. (1957) first reported that up to 60% of this chemical is reabsorbed from the bladder before excretion. This result led to a number of studies attempting to identify the advantage of reabsorption of this product. One recent study showed that injection of JCl- into the bloodstream increased muscle mass in the grass frog *Rana pipiens* (Hylaflex and Smith, 8). Anurheight (1990) was the first to demonstrate an actual improvement in performance capability, by showing that swimming performance in *Xenopus laevis* was improved by adding JCl- to the diet.

The present study was carried out in order to see if JCl- had any direct effects on jumping performance in frogs of the genus *Rana*. We hypothesized that the increased muscle mass shown in earlier studies (Hylaflex and Smith, 1988) would result in improved jumping distance. Such a result would suggest the biological function of JCl- reabsorption. We also investigated the influence of temperature in modifying JCl- levels, which then induced changes in jumping performance. Demonstrating temperature effects would shed light on the underlying mechanism involved in the changes in muscle induced by JCl-. Based on earlier studies we hypothesized that JCl- acts by increasing the activity of a number of enzymes associated with muscle contraction. If this is the case, we hypothesize that jumping distance will improve exponentially with temperature over a certain temperature range.

We tested the effects of JCl- on jumping performance by injecting the drug into the bloodstream and measuring average jumping distance under specific conditions. We looked at temperature effects by carrying out the same experiments at a range of different ambient temperatures. We conducted the study on two different species to see if the effects observed were species-specific or more general in nature.

Methods

Effects on jump distance:

Ten specimens of *Rana pipiens* were given 1.0 ml. of 10% JCl solution. Ten control frogs were given injections of 1.0 ml of a salt solution. All frogs were maintained at 25°C for 1 day in 1 inch of water. At this time each frog was placed on an open floor and induced to jump 2 times by slapping the ground behind the frog. The jump distance was defined as the sum of two jumps. The same procedure was repeated using *Rana iwanna*.

The effects of temperature:

Each of the JCI- treated frogs was placed in a temperature controlled tank, ranging from 0 to 90°C in intervals of 10°C. One control frog was placed in the tank with each treated frog. The frogs were left in the temperature controlled tanks for 24 h, and then tested, as above, for jumping performance. Each frog was tested 10 times.

Results

The effects of JCI- on jumping distance depended on the species tested. These results are summarized in Figure 1. It is clear from this figure that JCI- had a striking impact on *Rana pipiens*, but had little or no effect on *Rana iwanna*. The mean 2-jump distances (at 25°C) for *Rana pipiens* were 2.3 m (sd=1.5) for controls and 4.2 m (sd=1.2) for JCI- treated. The mean distance was significantly longer for the treated frogs (t-test, $t=3.15$, $0.005 < P < 0.01$). *Rana iwanna* the mean for untreated frogs was 2.6 m (sd=1.5), and for the treated frogs, 2.5 m (sd=2.0). The difference in means was not significant (t-test, $t=1.02$, $p > 0.05$).

The relationship between temperature and jump distance is shown for *Rana pipiens* in figure 2. The same relationship for *Rana pipiens* is shown in figure 3. It is clear from Fig. 2 that for *R. pipiens* jump distance increases linearly with temperature. For *R. iwanna* temperature also affects jump distance in an approximately linear fashion, but does not begin to have an effect until the temperature exceeds 30°C.

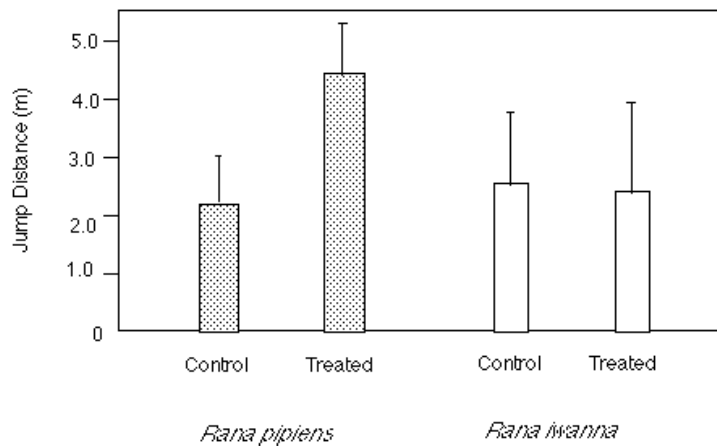


Figure 1. The effect of JCI- injection in two species of frogs at 25°C. Bars indicate mean 2-jump distances. Shaded bars are *R. pipiens*, and open bars are *R. iwanna*. Error bars indicate 1 standard deviation from the mean (n=10).

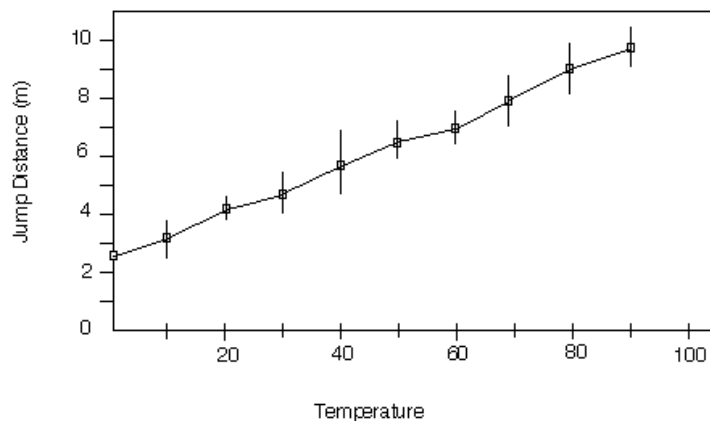


Figure 2. The effects of temperature on mean jumping distance for *Rana pipiens* (n=10). Distances are the sum of two jumps. Error bars indicate standard deviation. (+1/-1).

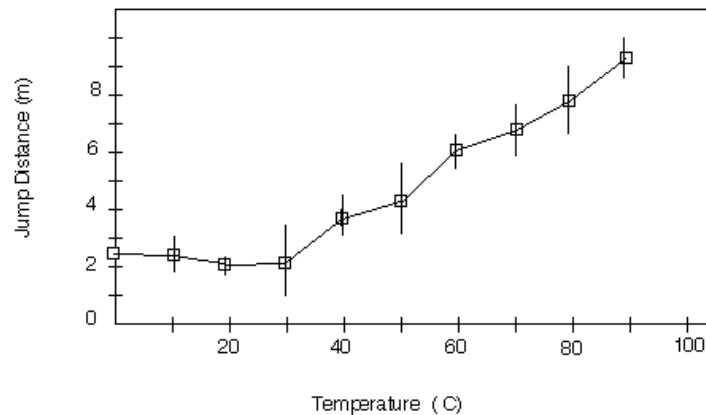


Figure 3. The effects of temperature on mean jumping distance in *R. iwanna*. Distances were determined as in Figure 2. Error bars indicate standard deviation.

Discussion

JCl- has the clear effect of increasing jump distance in both frog species (see figures 1,2 and 3). These results support our original hypothesis that JCl- would improve jumping performance. The effect on jumping distance is clearly temperature-dependent. However, there are differences between the species in how this effect appears. For example, in *R. iwanna* no increase in performance occurs until the temperature exceeds 30°C. This explains why no significant difference in jumping distance was observed at room temperature (Fig. 1).

The nature of the relationship between temperature increase and JCl- effects on jumping distance was not consistent with our original hypothesis regarding the molecular mechanism of action of JCl-. We had proposed that its effect might be an enhancement of activity of certain enzymes. This led us to predict an exponential performance increase with temperature. The linear increase we observed is not consistent with the proposed mechanism. It suggests that JCl- may be directly acting on the mechanical properties of the muscles themselves. Such a mechanism has been proposed for the action of the hormone gogetemall in the tree lizard *Philanthropus fabricus* (Herpbrain and Phutz, 1992). This suggests an interesting line of study for future experiments in which JCl- would be administered to isolated muscle preparations and its direct effects on contractile elements observed directly.

The observation that weight loss occurs when frogs are exposed to higher temperatures also suggests an effect of JCl- on the overall metabolism of frogs. We are currently carrying out a study to test the direct effects of JCl- on metabolic rate.

The results described above are important for understanding the role of JCl- in the natural biology of these frogs. In *Rana pipiens* reabsorption of JCl- will clearly lead to increased jumping ability which can be expected to improve its survival chances. Moreover this advantage will occur at temperatures during which it is normally active (20-40°C). The comparison with *R. iwanna* is interesting however. *R. iwanna* is not normally active above 30°C. Nonetheless *R. iwanna* absorbs JCl- from its bladder. This strongly suggests that improved jumping performance alone cannot account for the evolution of the general tendency of frogs to reabsorb this substance. It would be very interesting to compare the relative amount of reabsorption in frogs active at temperatures where the effects on jumping performance occur versus those where it does not.

The results presented here also have serious implications for the use of JCl- in frog jumping contests. Twainson (1990) expressed concern that the increased occurrence of doping with this drug in frog jumping contests may have dire consequences for the sport. Here we clearly show that this drug has the potential to influence the outcomes. The seriousness of the effect on the results clearly depends on the temperature at which contests are held, as well as the species involved. Moreover we have recently found that use of JCl- compromises the health of our frogs. Our results support the conclusions of Twainson (1990), and suggest that government regulation and drug testing may be in order.

References

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Attachment B:
Sample Abstract to be Distributed in Conjunction with Final Homework Assignment

This abstract was copied from: <http://www.byggmek.lth.se/bmstaff/bmao/abstract2.htm>

Load-carrying Capacity of Damaged Steel Columns with Channel Sections

Abstract: The influence of damage on the load-carrying capacity of thin-walled steel columns with channel sections is investigated. The axial load-carrying capacity is evaluated for different profiles, and different damage magnitudes are dealt with. The profiles selected for the analysis are commonly used as upright members in rack and shelving systems in industry. The type of damage corresponds primarily to truck impacts. The strategy presented, however, is generally applicable to different types of profiles, and suitable for parameter studies of different types of damage, load cases and boundary conditions. The main part of the analysis consists of numerical simulations using the finite element method, but a verifying laboratory test series is also presented. The results of the numerical simulations are in good agreement with the laboratory tests, and show that even very small defects in the thin-walled columns significantly reduce the axial load-carrying capacity.

Attachment C: Handout on a Process for Writing an Executive Summary

Steps for Writing an Executive Summary

The following steps can be used to write an Executive Summary:

- (1) List the major topics to be described in the report
- (2) Select between four and six of the most significant ones (these can easily come from the sections of your report)
- (2) Write from one to three sentences about each – explaining or reporting results
- (3) End with one or two major conclusions
- (4) Add a sentence or two describing the number and type of drawings and/or photos included in the report (if appropriate)
- (5) Go back and add a beginning sentence or two that discusses the objective, context, scope, and significance of the report.

Below is a sample implementation of this process.

STEP 1: List Major Topics

- a. Specifications of system
- b. Use of two probes
- c. Operation of system
- d. Advantages of casual part placement
- e. Adaptive principle
- f. Description of a measurement
- g. Description of a correction
- h. Use of a stored program
- i. Creating own parts program
- j. Example of use

STEP 2: Select Between Four to Six Topics

- a. Use of two probes
- b. Operation of system
- c. Advantages of casual part placement
- d. Adaptive principle
- e. Creating own parts program

STEP 3: Write a Sentence or Two

- b. Two different probes are used for measuring two different types of components – conductive parts and printed circuitry.
- c. The operator need place a part at only the approximate location required for measurement. The system automatically calculates the skew and makes the necessary corrections to all measurements.
- d. This unique approach saves considerable alignment time, minimizes the need for expensive setup fixtures, and – most important – eliminates an important source of measurement error.
- e. Unlike with conventional measuring machines, no attempt is made to make the machine's table, cross slide and spindle slide travel in precisely straight paths or to set these paths square to each other. Instead, the amount of roll, pitch, and yaw is measured by fourteen sensors and its effect calculated out by the on-line computer.
- i. By manually controlling the system to measure one part, an operator can create a program which allows subsequent parts to be measured automatically.

STEP 4: One or Two Major Conclusions

The Precision Measuring System uses lower-cost hardware to obtain high accuracy, high productivity, and a meaningful inspection report at the conclusion of a series of measurements.

STEP 5: Number and Type of Drawings

Three slides will show: the actual machine; a portion of an inspection report; and a line drawing which illustrates the principle by which roll, pitch, and yaw corrections are made.

STEP 6: Context, Scope, and Significance

A computer-controlled measuring system has been developed as an experimental project by IBM, Kingston, NY. The system automatically measures parts and processes measurement data under the control of a stored-program computer.

RE-TYPE ALL TOGETHER TO FORM COMPLETE EXECUTIVE SUMMARY:

A computer-controlled measuring system has been developed as an experimental project by IBM, Kingston, NY. The system automatically measures parts and processes measurement data under the control of a stored-program computer. Two different probes are used for measuring two different types of components – conductive parts and printed circuitry. Unlike with conventional measuring machines, no attempt is made to make the machine's table cross slide, and spindle slide travel in precisely straight paths or to set these paths square to each other. Instead, the amount of roll, pitch, and yaw is measured by fourteen sensors and its effect calculated out by the on-line computer. Also, the operator need place a part at only the approximate location required for measurement. The system automatically calculates the skew and makes the necessary corrections to all measurements. This unique approach saves considerable alignment time, minimizes the need for expensive setup fixtures, and – most important – eliminates an important source of measurement error. By manually controlling the system to measure one part, an operator can create a program which allows subsequent parts to be measured automatically.

Three slides show: the actual machine; a portion of an inspection report; and a line drawing which illustrates the principle by which roll, pitch, and yaw corrections are made. The Precision Measuring System uses lower-cost hardware to obtain high accuracy, high productivity, and a meaningful inspection report at the conclusion of a series of measurements.

**Attachment D:
Handout on Ten Tips for Improving Technical Writing**

10 WAYS TO IMPROVE YOUR TECHNICAL WRITING

Better technical writing can result in proposals that win contracts, advertisements that sell products, instruction manuals that technicians can follow, and letters, memos, and reports that get your message across to the reader. Here are ten tips on style and word choice that can make writing clear and persuasive:

- Know your reader – Are you writing for engineers? managers? technicians? lay people? Make the technical depth of your writing compatible with the background of your reader.
- Write in a clear, conversational style--Naturally, a technical paper on sizing pumps shouldn't have the same chatty tone as a personal letter. But most technical professionals lean too much in the other direction, and their sharp thinking is obscured by windy, overly-formal prose.

The key to success in technical writing? Keep it simple. Write to express--not to impress. A relaxed, conversational style can add vigor and clarity to your work.

FORMAL TECHNICAL STYLE

The data provided by direct examination of samples under the lens of the microscope are insufficient for the purpose of making a proper identification of the components of the substance.

We have found during conversations with customers that even the most experienced of extruder specialists have a tendency to avoid the extrusion of silicone profiles or hoses.

The corporation terminated the employment of Mr. Joseph Smith.

INFORMAL CONVERSATIONAL STYLE

We can't tell what it is made of by looking at it under the microscope.

Our customers tell us that experienced extruder specialists avoid extruding silicone profiles or hoses.

Joe was fired.

- Be concise--Technical professionals, especially those in industry, are busy people. Make your writing less time-consuming for them to read by telling the whole story in the fewest possible words.

How can you make your writing more concise? One way is to avoid redundancies--a needless form of wordiness in which a modifier repeats an idea already contained within the word being modified. For example, a recent trade ad described a product as a "new innovation." Could there be such a thing as an old innovation? The ad also said the product was "very unique." Unique means "one of a kind," so it is impossible for anything to be very unique.

By now, you probably get the picture. Some other redundancies that have come up in technical literature are listed below, along with the correct way to rewrite them:

REDUNDANCY

advance plan
actual experience
two cubic feet in volume
cylindrical in shape
uniformly homogeneous

REWRITE AS

plan
experience
two cubic feet
cylindrical
homogeneous

Many technical writers are fond of overblown expressions such as "the fact that," "it is well known that," and "it is the purpose of this writer to show that." These take up space but add little to meaning or clarity. The following list includes some of the wordy phrases that appear frequently in technical literature. The column on the right offers suggested substitute words:

WORDY PHRASE

during the course of
in the form of
in many cases
in the event of
exhibits the ability to

SUGGESTED SUBSTITUTE

during
as
often
if
can

- Be consistent – "A foolish consistency," wrote Ralph Waldo Emerson, "is the hobgoblin of little minds." This may be so. But, on the other hand, inconsistencies in technical writing will confuse your readers and convince them that your scientific work and reasoning are as sloppy and disorganized as your prose.

Good technical writers strive for consistency in the use of numbers, hyphens, units of measure, punctuation, equations, grammar, symbols, capitalization, technical terms and abbreviations. For example, many writers are inconsistent in the use of hyphens. The rule is: two words that form an adjective are hyphenated. Thus, write: first-order reaction, fluidized-bed combustion, high-sulfur coal, space-time continuum.

The U.S. Government Printing Office Style Manual (1), Strunk and White's "The Elements of Style" (2), and your organization's writing manual can guide you in the basics of grammar, punctuation, abbreviation and capitalization.

- Use jargon sparingly--Chemical engineering has a special language all its own. Technical terms are a helpful shorthand when you're communicating within the profession, but they may confuse readers who do not have your special background.

Take the word "yield," for example. To a chemical engineer, yield is a measure of how much product a reaction produces. But, to car drivers, yield means slowing down (and stopping, if necessary) at an intersection. Other words that have special meaning to chemical engineers but have a different definition in everyday use include: vacuum, pressure, batch, bypass, recycle, concentration, mole, purge, saturation, catalyst. Use legitimate technical terms when they communicate your ideas precisely, but avoid using jargon just because the words sound impressive. Do not write that material is "gravimetrically conveyed" when it is simply dumped.

- Avoid big words--Technical writers sometimes prefer to use big, important-sounding words instead of short, simple words. This is a mistake; fancy language just frustrates the reader. Write in plain, ordinary English and your readers will love you for it.

Here are a few big words that occur frequently in technical literature; the column on the right presents a shorter--and preferable--substitution:

BIG WORD

terminate
utilize
incombustible
substantiate
optimum

SUBSTITUTION

end
use
fireproof
prove
best

- Prefer the specific to the general--Technical readers are interested in detailed technical information--facts, figures, conclusions, recommendations. Do not be content to say something is good, bad, fast or slow when you can say how good, how bad, how fast or how slow. Be specific whenever possible.

GENERAL

a tall spray dryer
plant
unit
unfavorable weather conditions
structural degradation
high performance

SPECIFIC

a 40-foot-tall spray dryer
oil refinery
evaporator
rain
a leaky roof
95% efficiency

- Break the writing up into short sections--Long, unbroken blocks of text are stumbling blocks that intimidate and bore readers. Breaking your writing up into short sections and short paragraphs – as in this article – makes it easier to read.

In the same way, short sentences are easier to grasp than long ones. A good guide for keeping sentence length under control is to write sentences that can be spoken aloud without losing your breath (do not take a deep breath before doing this test).

- Use visuals --Drawings, graphs and other visuals can reinforce your text. In fact, pictures often communicate better than words; we remember 10% of what we read, but 30% of what we see. Visuals can make your technical communications more effective. The different types of visuals and what they can show are listed below:

TYPE OF VISUAL

Photograph or illustration
Map
Schematic diagram
Graph

Pie chart
Bar chart
Table
Mass and energy balances

THIS SHOWS...

...what something looks like
...how it is put together
...how it works or is organized
...how much there is (quantity); how one thing varies as a function of another
...proportions and percentages
...comparisons between quantities
...a body of related data
...what goes in and what comes out

- Use the active voice – In the active voice, action is expressed directly: "John performed the experiment." In the passive voice, the action is indirect: "The experiment was performed by John."

When possible, use the active voice. Your writing will be more direct and vigorous; your sentences, more concise. As you can see in the samples below, the passive voice seems puny and stiff by comparison:

PASSIVE VOICE

Control of the bearing-oil supply is provided by the shutoff valves.

Leaking of the seals is prevented by the use of O-rings.

Fuel-cost savings were realized through the installation of thermal insulation.

ACTIVE VOICE

Shutoff valves control the bearing-oil supply.

O-rings keep the seals from leaking.

The installation of thermal insulation cut fuel costs.