Writing for Publication in Medical Imaging

Kenneth M. Hanson

SPIE Medical Imaging Symposium
February 27, 2016 – San Diego, California

Overview

- Technical/scientific writing
- Preparation
  - figures and tables
  - organization of paper
- Writing the manuscript
  - getting started
  - revision, style
  - common problems in technical writing
  - word choice and usage
  - grammar and punctuation
- Tools for writing and manuscript preparation
- Formatting example – SPIE Proceedings
- Technical presentations

Publication

- What are your goals in publishing?
  - tell your story to reader, usually another expert
  - convey information, results, new technique
  - convince reader of validity of your results
  - receive recognition/credit for your work
- To accomplish your goals, your article must be professional in:
  - content
  - writing

- Poor writing will erode reader's confidence in your article
- Good writing will entice reader, leading to
  - acceptance of results
  - reading enjoyment

Technical writing

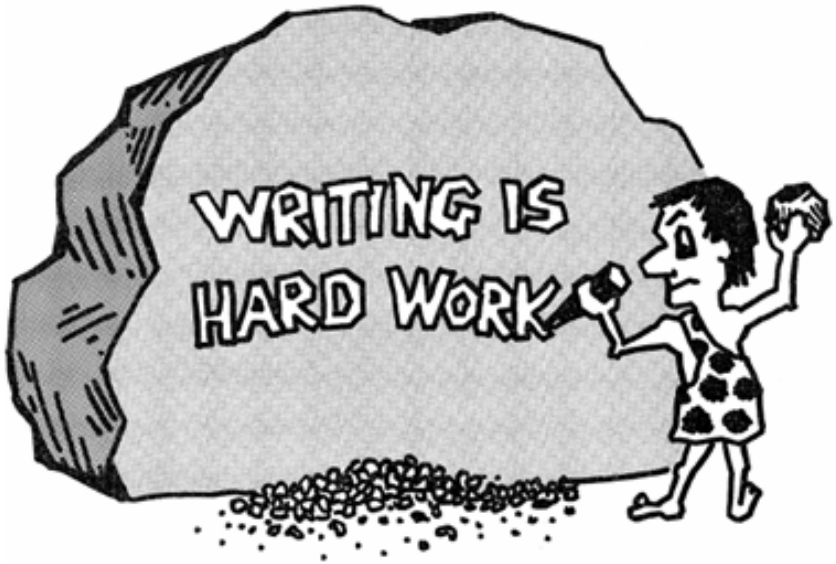
Effective communication of scientific information

Technical writing

- Principles of good technical writing
  - designed for concise and effective communication of technical ideas
  - widely accepted; not subjective or whimsical
  - based on rules of formal writing
  - not overly restrictive; still allow for author's personal writing style
- Goals in technical writing
  - make complex technical information understandable
  - make it agreeable for the reader to read and extract information
  - achieve **clarity**, **conciseness**, and **coherence**
    - clarity – meaning should be clear, understandable
    - conciseness – keep compact by using words with precise meaning
    - coherence – text should be interconnected, employing logical development

Technical writing

- Good technical/scientific writing
  - is a skill
  - can be learned and mastered
  - takes practice and **hard work**



- **Warning** –
  writing well can become addictive

- Techniques of good technical writing are useful elsewhere
  - grant writing
  - technical presentation
  - web-page design

Technical writing

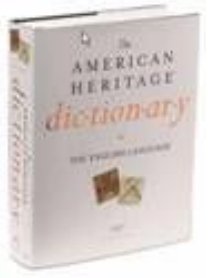
- You can learn good technical writing by
  - reading well-written journal articles
    - beware – not all published articles are written well
    - beware – rules of technical writing change with time
  - taking writing course
  - practicing writing –
    then have it rigorously reviewed
  - employing technical editor
  - using writers' aids

Technical writing

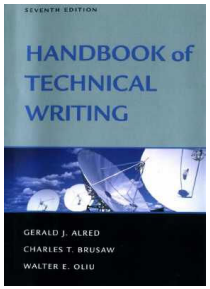
- Good technical writing is based on **formal writing**
- Rules of technical writing are more strict than in spoken English, which is informal and very flexible
  - when speaking, people tend not to use good grammar and vocabulary
  - informal spoken English is a poor guide for technical writing
- Learn by reading well-written books, newspapers, etc.
    - newspapers/magazines known for excellent writing
      - Wall Street Journal (wsj.com)
      - New York Times (nytimes.com)
      - Economist [British] (economist.com)
      - The New Yorker (newyorker.com)

Writers' aids

Indispensable resources for writers:



- Dictionaries – all about words
  - word meaning and usage
- Thesauruses – synonyms, alternative words, and antonyms
  - find the best word to convey intended meaning
- Technical writing guides
  - style
  - word usage
  - grammar
  - punctuation



Writers' aids

- Web is an invaluable resource
  - icon on right indicates suggested keyword for web search using the following:

wordiness

    - search for "english writing" plus suggested keywords

english writing wordiness

    - or designate a specific site

wordiness site:www.mhhe.com/mayfieldpub

wordiness site:owl.english.purdue.edu

Writers' aids

Good references are essential

- Dictionaries and thesauruses
  - *The Free Dictionary*; www.thefreedictionary.com
  - *Wordsmyth Dictionary and Thesaurus*; www.wordsmyth.net
  - *Roget's Thesaurus*; www.bartleby.com
  - *Synonym Finder* (book, Rodale) – alphabetical listing
- Technical writing; grammar, usage, and punctuation
  - *Handbook of Technical Writing*, Alred et al. (St. Martin's, New York, 2003); highly recommended
  - *Mayfield Handbook of Technical and Scientific Writing*; very helpful; www.mhhe.com/mayfieldpub/tsw/home.htm
  - *Online Writing Lab (OWL)*; owl.english.purdue.edu
- Many are online, but several good ones are not:
  Handbook of Technical Writing and *Synonym Finder*

English as a Second Language (ESL)

- Those who learn English as a Second Language (ESL) face special challenges

ESL

- Each language has its own rules and characteristics; there is a natural tendency to carry them over into English
  - some common usage problems are
    - transitive verbs (require object): *This technique allows to evaluate ...*
    - nonexistent words: *modelization*
    - missing or inappropriate articles: *a, an, the*
    - incorrect plural nouns: *datas → data ; informations → information*
    - misused pronouns: *It means that ...→ That means that ...*
      This means that ...→ That means that ...

English as a Second Language (ESL)

- Learn good English and good writing by reading well-written journal articles, books, magazines, and newspapers
- Learn about coping with ESL problems in
  - *Handbook of Technical Writing*
  - *Mayfield Handbook*
  - *Online Writing Lab (OWL)*
  - *An Outline of Scientific Writing*

British-English differences

- British and American English are not exactly the same; however, most rules of technical writing are the same
- Differences include:
  - spelling – differs for a small number of words:
    colour vs. color, programme vs. program, modelling / modeling, characterise / characterize connexion / connection, centre / center
  - punctuation – use of quotation marks; format of dates
  - collective nouns treated as plural in British English
    GE have announced a new CT scanner.
  - idioms – words or phrases with special meaning

British English

- Some journals require manuscripts be written in British English, some in American English, while other journals allow either
  - as author, you must be consistent
- A spell checker helps maintain consistent spelling

- For differences between British and American English, see en.wikipedia.org/wiki/American_and_British_English_differences

Preparation

Getting ready to write

Preparation

- In early stages, before writing, you need to organize your data and materials
  - during this phase, useful to keep future writing in mind
- Collect your information
  - assemble and organize measurements
  - analyze data; interpret in terms of model
  - graph results; display images
- Make a preliminary list of topics you wish to present
  - determine what is missing and obtain missing elements
- Assemble possible preliminary figures and tables

- Consider where to publish: journal, proceedings, report …
- Get your collaborators involved in preparation

Collaboration

What role will your collaborators play?

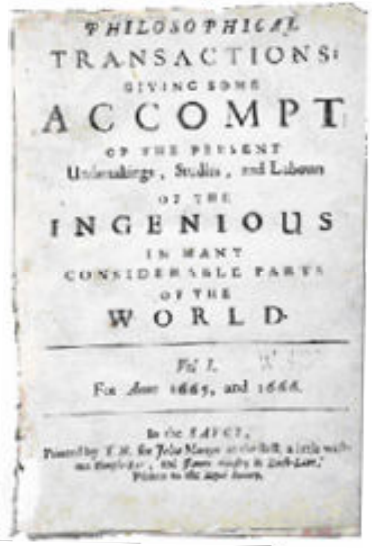
- Besides contributing to the research, they could also be involved in
  - planning the manuscript
  - preparation of results, figures, and tables
  - writing
  - reviewing and editing

Collaboration

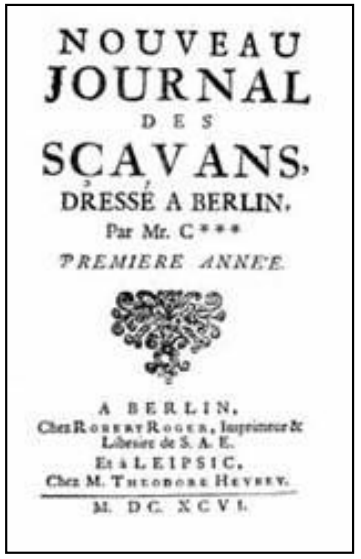
- If your collaborators willing to help with the writing
  - great!
  - primary author is responsible for
    - writing assignments & schedule
    - coordination of contributions
      - uniform use of style and symbols
    - meeting rules of publisher
    - meeting rules of institutions involved
    - submission of manuscript

Journals

- Considerations for publishing in a journal
  - prestige – peer reviewed
    - necessity for academicians
    - often improves quality of paper
  - read by many experts in field
  - sometimes edited for English
  - archival
  - publication process takes 6 – 24 months
    - online journals often speediest
  - fee charged for publication (page charges)
  - access may be limited by subscription


PHILOSOPHICAL
TRANSACTIONS:
GIVING SOME
ACCOMPT
OF THE PRESENT
Undertakings, Studies, and Labours
OF THE
INGENIOUS
IN MANY
CONSIDERABLE PARTS
OF THE
WORLD.

First scientific journals, 1665


NOUVEAU
JOURNAL
DES
SCAVANS,
DRESSÉ A BERLIN.
Par Mr. C***
PREMIERE ANNÉE.

A BERLIN,
Chez Robert Roger, Imprimeur & Libraire de S. A. E.
Et à LEIPSIC,
Chez M. Theodore Heyser.
M. DC. XCVI.

Proceedings

- Considerations for publishing in a proceedings (collection of papers associated with a conference)
  - not usually peer reviewed; less prestigious
  - seen by fewer researchers than journals
  - semi-archival (depends on publisher)
  - seldom edited for English
  - usually require “camera-ready” manuscript
  - publication usually easier and faster than for journals

Journals and proceedings in medical imaging

- Each journal has own technical scope and readership; some examples in medical imaging:
  - *IEEE Transactions on Medical Imaging* – image processing (IP), algorithms, clinical applications
  - *Radiology* – clinical applications
  - *Medical Physics* – clinical applications, radiation therapy
  - *Journal of Electronic Imaging* – optics, algorithms, IP
  - specialty journals in various subfields: MRI, ultrasound
- Proceedings abound
  - SPIE – Medical Imaging Symposium and others
  - IEEE – Medical Imaging Conference
  - myriad topical specialty conferences

Choosing a journal or proceedings

- Factors for choosing between a journal or proceedings:
  - scope of publication – does your paper fit?
  - prestige
  - readership
  - online availability; access restrictions
  - amount of effort you are willing to expend

- Remember, it may be possible to publish same work in both a proceedings and a journal, if you adhere to the publishers' rules
  - proceedings paper must typically be enhanced for subsequent journal publication
  - SPIE encourages publication of Proceedings articles in their journals

Life of a journal manuscript

- Typical sequence for publication in journals
  - permission obtained for reprinted matter (figures)
  - institutional clearance obtained
  - author submits manuscript
  - editor has it reviewed by two or more experts
  - manuscript accepted (rarely), rejected, or returned to author with recommendations for revision
  - author revises and resubmits manuscript

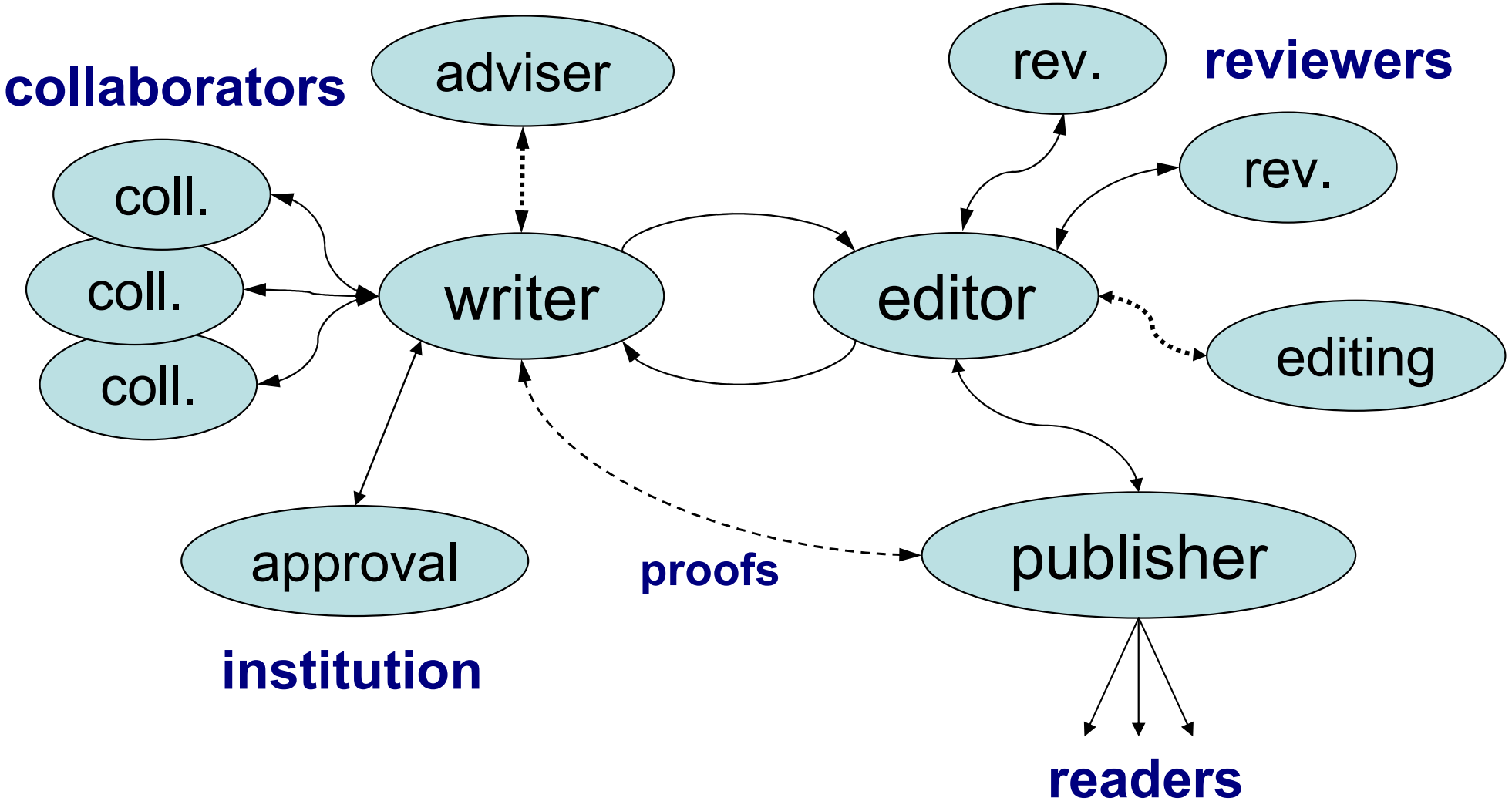
Life of a journal manuscript (2)

- Typical sequence for publication in journals (cont'd)
  - editor or reviewers check to see if changes are acceptable
  - if revised manuscript is accepted, it may be edited for English
  - editor sends manuscript to publisher for dissemination
  - galley proofs sent to author for approval or correction
  - journal bills institution for page charges
  - article published

- Process can take from 6 to 24 months
  - author can speed process by responding quickly to editor's requests

Life of a journal manuscript

- A manuscript goes through many steps to be published



Author's responsibilities

Primary author is responsible for:

- Organization of paper and quality of writing
- Dealing with own institution's requirements
  - adviser/supervisor's approval
  - institutional approval after review for copyright and security issues
  - page charges
- Ensuring manuscript meets publisher's requirements
  - format – single/double spaced text, etc.
    - citations and reference list
    - figures, photos, multimedia
  - submission protocol – internet, electronic media, hardcopy, …
- Communicating with editor and publisher

Dealing with editor and reviewers

- If revision of manuscript is requested
  - consider seriously the reviewers' comments
    - they most likely have some good points
    - revise your manuscript accordingly and resubmit
  - if you think reviewers misunderstand your manuscript or are in error
    - **do not reply in anger**; deal with disagreement diplomatically
    - ask friends/colleagues for advice
  - editor has final decision
- If manuscript is rejected, consider
  - performing additional research or taking new approach and resubmitting
  - submitting to a different, more suitable journal

Figures and tables

Telling the story in pictures

Floats – figures and tables

- Figures and tables
  - called floats – distributed throughout published article
    - should be placed near their first reference
  - **should support text** (and visa versa)
- References to floats must be made in text
  - refer to each by figure or table number
    - numbers assigned in order of reference
    - do not write “in the following figure”
      - position of figure usually not fixed until full paper is typeset
      - instead, write “in Fig. 2”

Floats – figures and tables

- Figures – graphs, block diagrams, maps, images
  - figures and their captions should tell the story
    - ideally, they should describe results without relying on text
  - graphs useful for displaying behavior of data
  - caption should describe the figure and provide link to text
  - caption placed below figure
- Tables
  - lists of calculated results, experimental conditions, measurements, etc.
  - caption should describe the entries in each column
  - caption placed above table

Figures

- Anticipate how graphs and images will appear in published article
  - how big will they be? one column or two?
    - communicate with editor about your preferences
  - make sure
    - lines and axes are thick enough
    - symbols and fonts are large enough
    - dependent on size of final graph and proportion
  - use color to distinguish lines only if paper will be published in color
    - note that many printed journals now provide online access to articles, which usually include color figures
    - often, copies or printed version are only in B&W
  - use solid, dashed, and dotted lines, and various data symbols
  - caption should describe the figure and provide link to text

Graphs

- Example of well-formed graph
  - sans-serif font (Arial)
  - legible text
  - axes and curves thick enough
  - dashed curve used to distinguish it
  - graphical elements in good proportion
  - (axis-label fonts could be a little larger)
- Caption explains the graph (but could say more)
  - centered below graph

A good figure makes reading easier

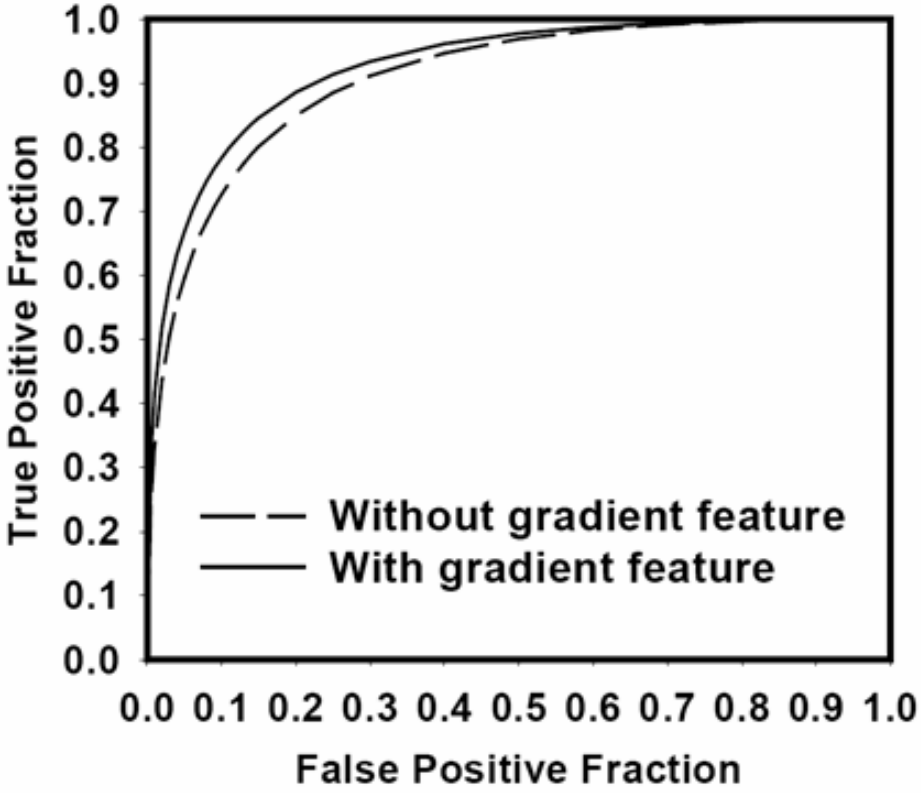


Fig. 5. ROC curves for classifying nodules and non-nodule structures.

Proc. SPIE **5370**, p. 119 (2004)

Graphs

- Example of a poorly presented figure
  - axes and curves too thin
  - no axis labels; axis numbers and legend illegible
  - caption difficult to understand
    - reader must refer to main text for meaning
    - non-standard abbreviations

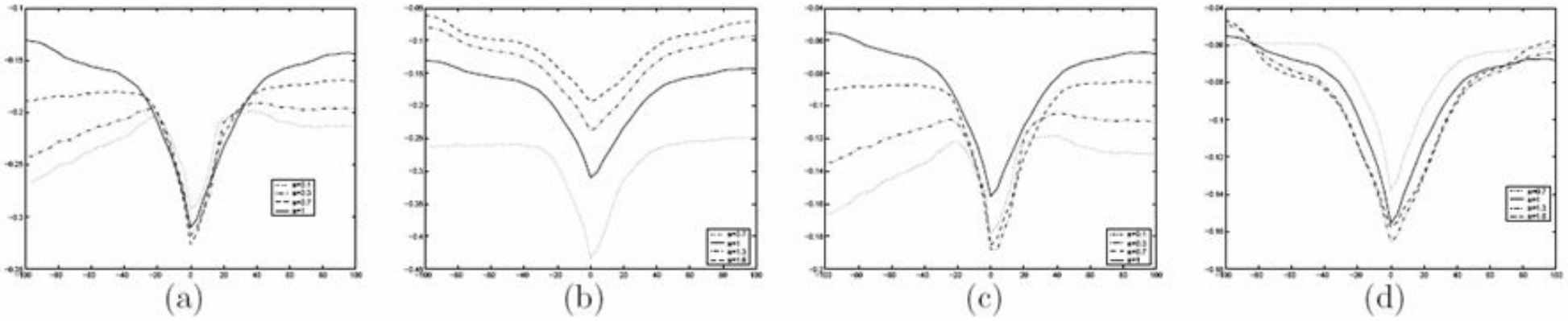


Figure 6. MR to CT registration. Curves of (a) $nGMI^R$ (b)$nGMI^T$ (c)$NGMI^R$ (d)$NGMI^T$ over x-shifts.

Proc. SPIE **5370**, p. 14 (2004)

Poor figures can detract from presentation

Diagrams

Diagrams are useful for illustrating complex concepts

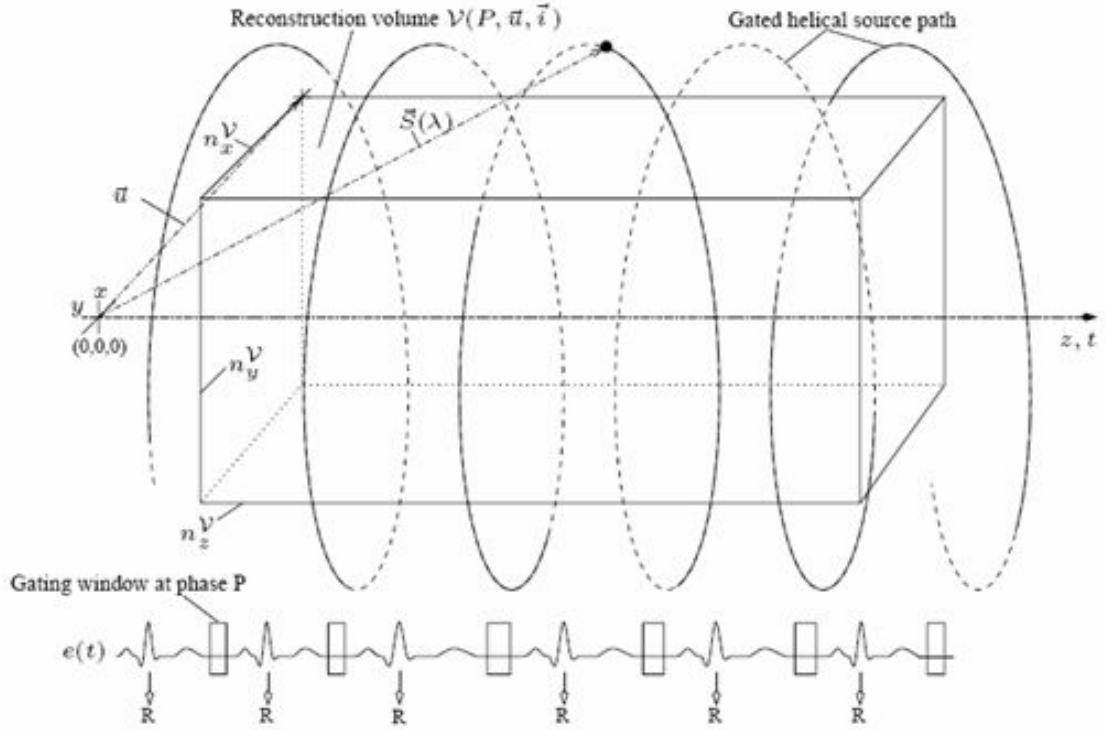


Figure 1. This figure shows the principle of a gated helical CT acquisition. The source moves on a helical path $\vec{S}(\lambda)$, and an ECG signal $e(t)$ is recorded in parallel. Based on a defined cardiac phase P, the acquired data are gated resulting in an interrupted helix. A volume $\mathcal{V}(P, \vec{u}, \vec{i})$ is reconstructed with the gated data, representing the heart at the defined phase.

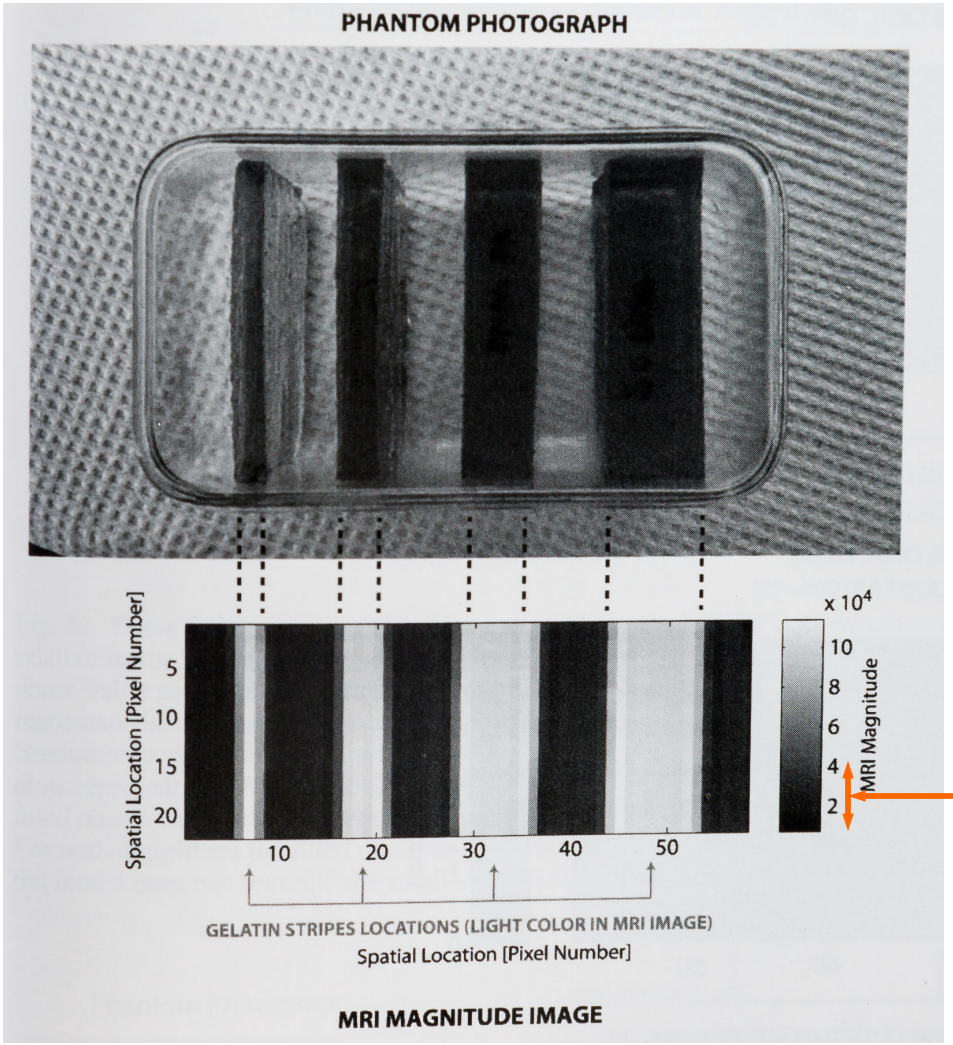
Proc. SPIE **5370**, p. 74 (2004)

Images

- Images are important because they often represent the final results, especially in medical imaging
- Use of color is sometimes necessary
  - if color not available, try to make your point in B&W and grayscale
- Try to display important aspects by
  - choosing appropriate grey-scale windows (min and max values)
  - selecting size of image
  - cropping uninteresting areas
- Avoid
  - displaying the image with too high contrast
  - using different grey-scale windows for images that are meant to be visually compared

Grayscale images

- Grayscale images in printed journals often appear too dark



no discrimination

Borsic et al., TMI **35**, p.250 (2016)

Demene et al., TMI **34**, p.2282 (2015)

Grayscale images

- Grayscale images in printed journals often appear too dark
  - reason: they were prepared on overly bright monitors
- Solution – edit on monitor with luminosity of no more than around 100 nits (candelas/sqm) and gamma ≈ 2.2
  - this luminosity roughly matches typical room lighting
  - monitors typically come with luminosity of 200 nits or more
  - be aware that dark regions lose level discrimination when printed
- For best results, calibrate monitor
  - use calibration device from Datacolor or X-rite
  - color profile (.icc) is created by calibration procedure
    - used by color-aware apps to display images
    - ensures accurate colors and uniform grayscale
  - use monitor with IPS screen
    - image appears the same for all viewing angles

Images

Color can clarify presentation, but will images be published in color?

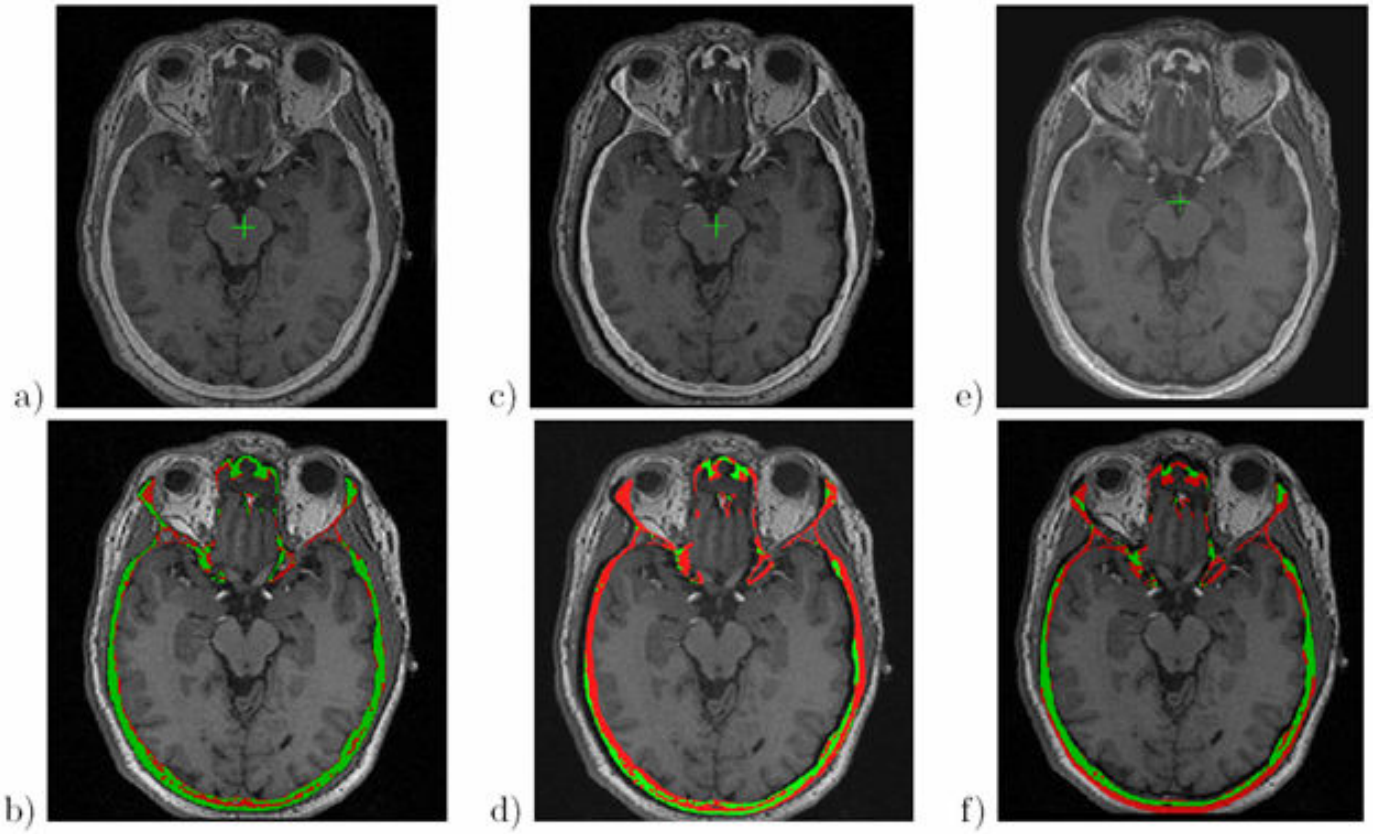


Figure 4. The figure illustrates the benefit of the color-coded registration assessment result versus conventional fusion of CT and MR datasets. The upper row shows conventionally fused datasets, the lower row shows a fused dataset with the overlaid color code. a) and b) show a well-registered image pair, c) and d) show an image pair with a purposely introduced mis-registration of 3 mm in mediolateral direction, e) and f) show an image pair with a purposely introduced mis-registration of 3 mm in anterioposterior direction. The color-code assessment result highlights bad (red) correspondences between the bone voxels in CT and MR images, that may otherwise pass unnoticed.

Proc. SPIE **5370**, p. 16 (2004)

Tables

Tables are often difficult to understand without reading the main text, but they relate necessary details

Table 1. Cumulative frequency distribution of tracking jitter (in pixels) relative to manually tracked coronary angiography features. The first three features are devices used for angioplasty that were tracked without injecting radiographic contrast material. The last three features are coronary arteries filled with radiographic contrast material.

Feature Tracked	Sequences/frames	50%	60%	70%	80%	90%	95%	99%
Sequences with no contrast material								
Guidewires	25/774	1.00	1.00	1.41	1.41	2.24	2.83	5.10
Stents	25/932	1.00	1.00	1.00	1.41	2.00	2.24	5.66
Balloon Markers	25/1119	1.00	1.00	1.41	1.41	2.24	3.16	10.63
Sequences with contrast material								
Normal Vessels	25/998	1.41	2.00	2.24	2.83	3.61	5.00	10.05
Stented Vessels	25/1023	1.41	1.41	2.00	2.24	3.61	5.10	13.60
Stenotic Vessels	25/1100	1.41	2.24	2.24	3.00	4.12	5.83	13.60

Proc. SPIE **5367**, p. 298 (2004)

- Example of a good table
  - has a descriptive caption (centered above table)
  - is well organized

Multimedia and hyperlinks

- Multimedia increasingly available in e-publications (online, CDs)
- Multimedia include
  - video – sequence of images (time-evolving phenomena, simulations)
  - audio – sound clips
  - interactive demonstrations
- Multimedia can illuminate better than stationary figures
  - consider how you might put multimedia to good use
  - but only when they help achieve the goal of the paper
- Hyperlinks (Ted Nelson, 1963)
  – active links to elsewhere in paper or on-line material
  - references
  - appendices
  - other online material

Organization

The foundation for logical development

Standard article organization

- *Title*
- *Authors and affiliations*
- *Abstract*
- *Keywords (or citation index)*

Front matter (publishing lingo)

- *Introduction*
- *Materials and methods*
- *Results*
- *Discussion*
- *Conclusion*

Body of article

- *Acknowledgments*
- *Appendices*
- *References*

End matter

- Floats (figures and tables)

Reader's approach to reading an article

- For lack of time, most readers will not read the whole article
- Consider typical order in which a reader might read the article
  1. title (& author list)
  2. abstract (& keywords)
  3. figures and their captions
  4. skim text and section headings
  5. conclusion
  6. equations
  7. portions of main text in more detail

- Consequently, make sure that elements at the top of the list are especially well crafted

Front matter

Material that precedes the body of the article

- *Title*
  - concisely describe main theme of work presented in paper
  - not be too long (≤ 12 words)
- *Authors*
  - list of those who directly participated in work
- *Affiliations*
  - institutions with which authors are associated

Front matter (2)

- *Abstract*
  - concise, clear, and informative summary of presented work
  - single paragraph
  - not too long (< 200-250 words)
  - avoid lengthy background
  - many readers only read the title and abstract
- *Keywords* or citation indices
  - select these very carefully
  - researchers will search databases for keywords

Title

- The title is the most visible part of article
- Goals for the title
  - informative about what is in the paper
  - provide some context, not too esoteric
  - distinctive – grab reader's interest
  - no longer than about 12 words
- The title is not
  - a replacement for the abstract
  - a sentence
- Do not start with an article: *A (An)* or *The*
- Avoid all but the best-known acronyms

Titles

- Some good article titles
  - *Edge completion from sparse data: a level-set approach*
  - *Functional imaging of the vascular bed by dynamic optical tomography*
  - *Validation of complex cascaded models of medical-imaging systems by Monte Carlo*
  - *Evaluation of algorithms for segmentation of the prostate boundary from 3D ultrasound images*
  - *Automatic detection of red lesions in digital color fundus photographs*

- Rule of thumb – title should contain no more than about 12 words

Titles

- Some not-so-good titles
  - *Moving linkage*
  - *High-frame-rate and high-resolution ultrasound imaging with virtual-source element in B-mode ultrasound system based on sparse synthetic transmit aperture method*
  - *Simulation study comparing the imaging performance of a solid-state detector with a rotating-slat collimator versus parallel-beam collimator setups*
  - *Computerized multiple-image analysis on mammograms: performance improvement of automated nipple identification for registration of multiple views using texture and geometric convergence analyses*
- First title is too short; rest are too long, 21-24 words
  - strive for conciseness
  - find balance between not enough and too much information

Abstract

- Example of a well-written abstract:

For a signal-detection task, the Bayesian ideal observer is optimal among all observers because it incorporates all the statistical information about the raw data from an imaging system. The ideal-observer test statistic, the likelihood ratio, is difficult to compute when uncertainties are present in backgrounds and signals. In this work, we propose a new approximation technique to estimate the likelihood ratio. This technique is a dimensionality-reduction scheme we will call the channelized-ideal observer (CIO). We can reduce the high-dimensional integrals of the ideal observer to the low-dimensional integrals of the CIO by applying a set of channels to the image data. Lumpy backgrounds and circularly symmetric Gaussian signals are used for simulations studies. Laguerre-Gaussian (LG) channels have been shown to be useful for approximating ideal linear observers with these backgrounds and signals. For this reason, we choose to use LG channels for our analysis. The concept of efficient channels is introduced to closely approximate ideal-observer performance with the CIO for signal-known-exactly (SKE) detection tasks. Our preliminary results using one to three LG channels show that the performance of the CIO is better than the channelized-Hotelling observer for the SKE detection tasks.

background

problem statement

proposed solution

results

S. Park et al., *Proc. SPIE* **5372**, pp. 12-21 (2004)

- concise summary of article contents
- logical structure and development
- single paragraph; 191 words

Body of article

Substance of article; the main story

- *Introduction*
  - more informative than *Abstract*
  - introduce reader to context of paper
  - provide brief background, referring to previous work
  - briefly state problem to be addressed and how it will be solved
  - provide outline of paper
- *(Background)*
  - additional section, if more space needed for background material

Body of article (2)

- *Materials and Methods*
  - describe means by which work was done
    - apparatus
    - materials
    - methodological approach
    - analysis tools, algorithms
    - software, applications
  - section headings may vary
- *Results*
  - present research results
  - interpret in terms of theory or model
- The above two categories may include multiple sections
  - use descriptive section and subsection headings
    - headings should read like an outline of the article

Body of article (3)

- *Discussion* (optional)
  - establish relationships among data and results
  - review results as a whole, comparing with predictions
- *Conclusion*
  - summarize succinctly what the results demonstrate
    - avoid hyperbole – don't claim more than supported by results
  - relate results to general problem
  - indicate implications for field
  - suggest possible follow-on work

Repetition of message

- The main message should be stated in the
  - (*Title*)
  - *Abstract*
  - at least three times in the body
    - *Introduction*
    - *Results* or *Discussion*
    - *Conclusion*

Body of article – equations

- Equations
  - placed in body of article (or appendices)
  - fewer are generally better, except when math is central theme
    - consider publication, audience, purpose of article
  - be brief when summarizing background material
  - in text, outline math reasoning and state assumptions made
- Detailed derivations may go in appendices
  - helps reader follow central themes of the body
- Generally avoid step-by-step derivations in journal articles
  - unless that is purpose of journal or article
  - derivations may be included in technical reports

End matter

Auxiliary material, but essential to article

- *Acknowledgments*
  - credit those who helped by providing funds, material, apparatus, data, ideas, inspiration, or advice
- *References*
  - cite foundational or background work
  - list sources of information and techniques
  - avoid plagiarism by including all sources
  - give credit where warranted
  - format reference list as specified by publisher

End matter (2)

- *Appendices* (optional)
  - additional material that distracts from central theme of body
  - detailed description that is not desirable in body
  - derivations or proofs
  - sizable tables

Writing the manuscript

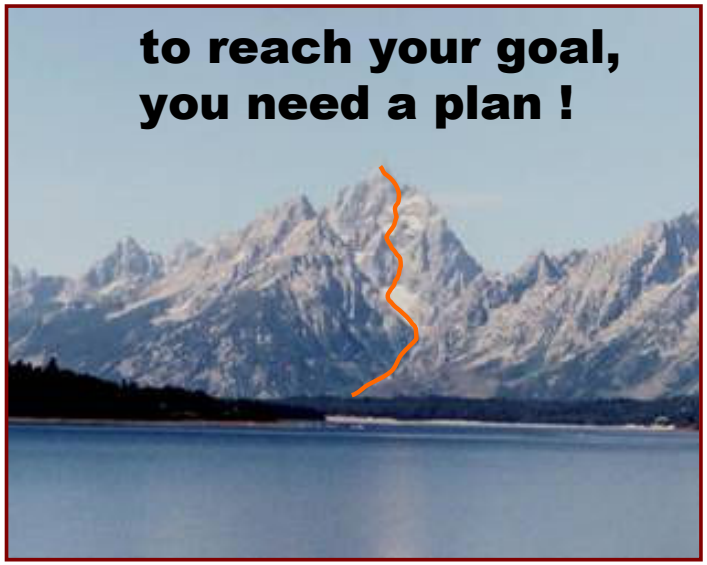
Planning, organizing, writing, and revising

Overview of the writing process

- Planning the article
  - identify purpose, audience, and scope of your paper
    - these will affect how you write your paper
- Organization
  - achieved by creating a solid outline
  - provides framework for logical development
- First draft
  - base on outline
  - may be roughly written, then refined through revision
- Revision – recursive process
  - goal of revision is clarity, conciseness, and coherence
  - edit for style, word choice, and grammar
- **Find the best approach for you**

Planning - purpose

- Start writing process with a plan
- Identify purpose of article
  - solve a problem
  - convey new information
  - express a point of view
  - persuade reader of something



Planning – audience and scope

- Identify audience
  - to whom do you want to tell your story?
  - why would they want to read your article?
  - what is their level of expertise?
  - will they be receptive to you and your message?
- Determine scope of presentation
  - how much detail should you include?
  - how much background?
  - what level of understanding should you aim for?
  - depends on purpose and audience
- Decisions about audience and scope are interrelated

Development and organization

- Method of subject development provides
  - logical thread of presentation
  - framework for organization
  - support for your results and conclusions
- Logical development is accomplished through
  - coherent article structure
    - arrange sections in logical sequence
    - use of transition elements to link parts
  - supported by standard article organization

Standard article organization

- *Title*
- *Authors and affiliations*
- *Abstract*
- *Keywords (or citation index)*

Front matter

- *Introduction*
- *Materials and methods*
- *Results*
- *Discussion*
- *Conclusion*

Body of article

- *Acknowledgments*
- *Appendices*
- *References*

End matter

- Floats – figures and tables

Outline

Create an outline before beginning to write

- Will be used as the skeleton for the manuscript
  - provides organization and structure
  - establishes overall logic of presentation
  - should include every topic you want to mention
- Some ways to get started:
  - give informal talk to colleagues or friends
    - record topics presented
  - if you have collaborators, involve them
    - brainstorming can be effective way to generate good ideas

In need of organization

Outline

- While composing the outline, keep in mind
  - standard article organization
  - order of topics and subtopics to provide logical development
  - figures and tables and how they will support text
- After first draft of outline, check for logical sequence of topics

Outline – example from paper on MCMC

I. Introduction
    A. background
    B. Bayesian inference with Markov Chain Monte Carlo
    C. organization of article
II. Traditional MCMC algorithms
    A. Metropolis algorithm
    B. Gibbs algorithm
    C. statistical efficiency of MCMC sequence
    D. MCMC issues
III. Hamiltonian MCMC algorithm
    A. adjoint differentiation
    B. convergence test
IV. Results for multidimensional Gaussian distributions
    A. 2D distributions
    B. isotropic multidimensional distributions
    C. correlated multidimensional distributions
V. Discussion

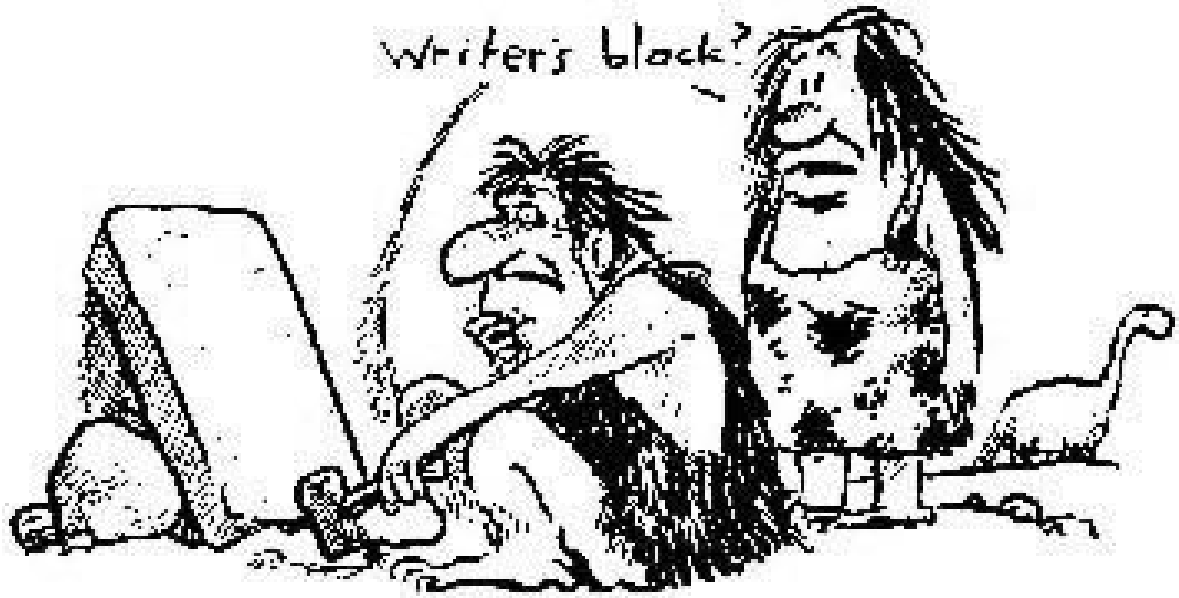
Writing the first draft

- Base first draft on outline
  - outline provides organization
    - topics and subtopics of outline become sections and subsections
    - paragraphs derived from from subtopics and sub-subtopics
  - skip *Abstract*, *Introduction*, and *Conclusions*
    - these are often easier to write after everything else

Writing the first draft – tactics

Useful techniques for beginning to write:

- Write first draft quickly
  - don't worry too much about spelling and style
  - start with sections that are easiest to write
  - write using stream-of-consciousness mode
    - just put down key phrases, snippets
    - need not be complete sentences



Writing the first draft – tactics

- Some more tactics
  - set aside blocks of time to write, perhaps an hour or more
  - establish goal for writing in each session
  - make sure your environment is conducive to writing
  - if severely blocked, dictate into voice recorder, then transcribe
    - alternatively, record informal presentation to colleagues

- **Remember:**
  First draft is not ready to show anyone
  – wait until after first revision

Revision – where good writing happens

- Revision is a crucial step in creating a well-written manuscript
  - usually takes many passes through manuscript; recursive process
  - check for style and proper formal English with the goal of achieving **clarity, conciseness, and coherence**
  - review content and organization
    - does it say what you want?
      - include all the data, graphs, images, etc.?
    - is it easy to read and follow logic of presentation?
  - make sure it is accurate, complete, and truthful

Revision

- If first draft is very rough, first revision may be to complete sentences and make manuscript readable
- General approach
  - first, see manuscript as a whole
    - rearrange sections and paragraphs to improve logical development
    - identify what is missing and add new text
    - linkage between sections – transition elements
  - then focus on details
    - sentence construction
    - conciseness, word choice
    - English – grammar, punctuation, and spelling
    - references, floats
  - read several times, each time looking for particular type of concern

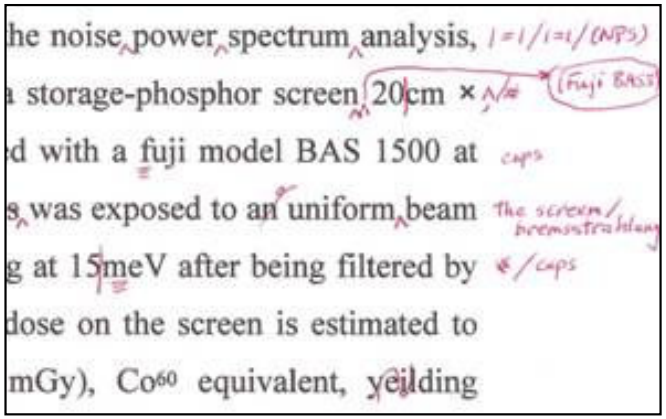
Revision – tactics

A useful strategy for revising a manuscript

- Print it out!
  - while some authors might prefer to revise on computer monitor, a paper copy may provide better continuity

- Make cursory notations in text or margin, correct document later
  - use standard proofreading marks, especially if for someone else
  - use 1½ to 2 times line spacing to allow insertion of notes, new text

example of marked up text



Revision – tactics

- Take a break
  - put manuscript down for a couple of days, if you have enough time
- Have colleague(s) or technical editor critically proofread it
- Read the paper out loud; hear how it sounds
- When in doubt about English rule, look it up in writing guide
- Create new versions often and save old versions until finished
  - you may want retrieve parts of previous version

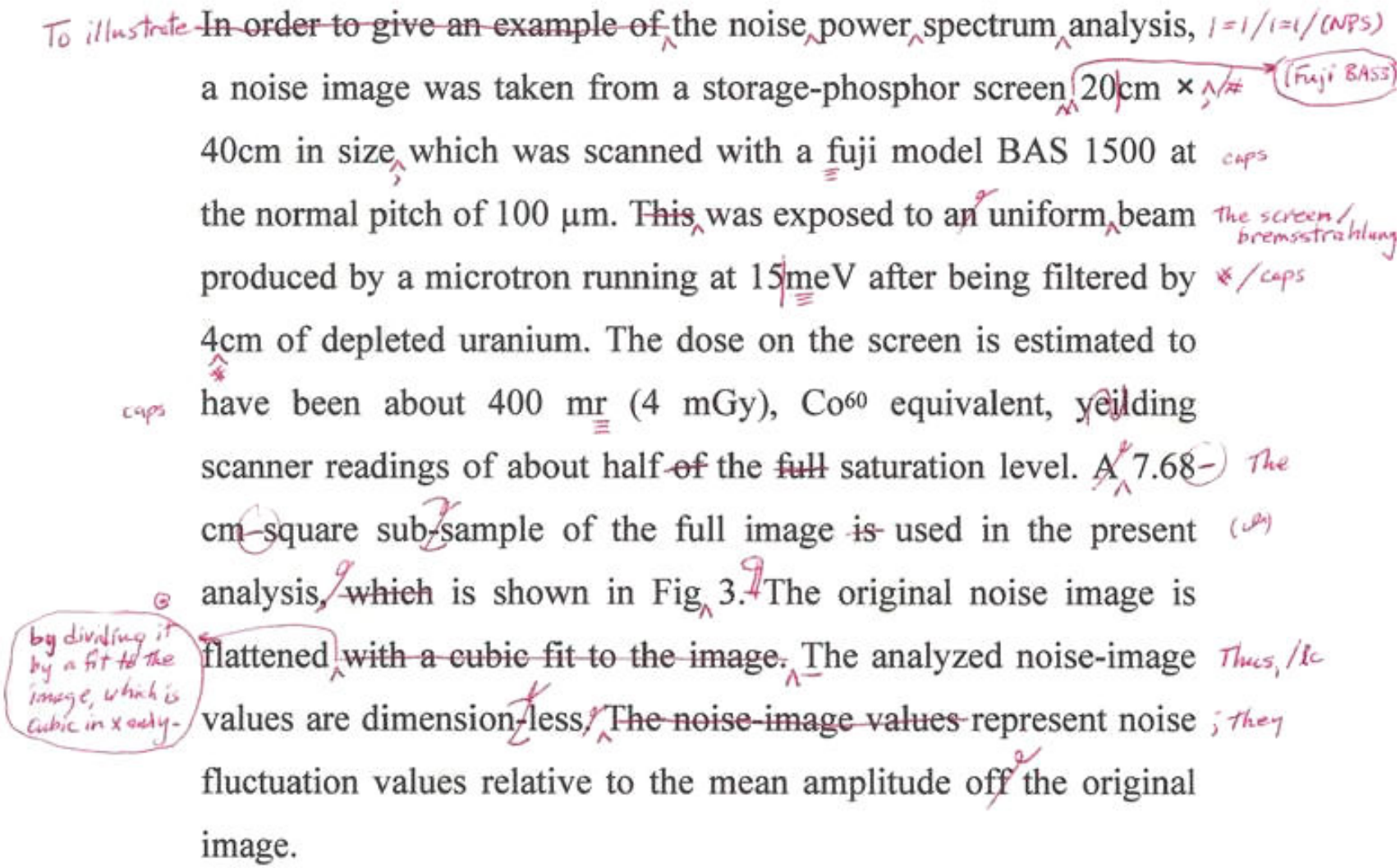
Revision – Proofreading marks

- Example of text that needs revision

In order to give an example of the noise power spectrum analysis, a noise image was taken from a storage-phosphor screen 20cm × 40cm in size which was scanned with a fuji model BAS 1500 at the normal pitch of 100 μm. This was exposed to an uniform beam produced by a microtron running at 15meV after being filtered by 4cm of depleted uranium. The dose on the screen is estimated to have been about 400 mr (4 mGy), Co^{60} equivalent, yeilding scanner readings of about half of the full saturation level. A 7.68 cm square sub-sample of the full image is used in the present analysis, which is shown in Fig 3. The original noise image is flattened with a cubic fit to the image. The analyzed noise-image values are dimension-less. The noise-image values represent noise fluctuation values relative to the mean amplitude off the original image.

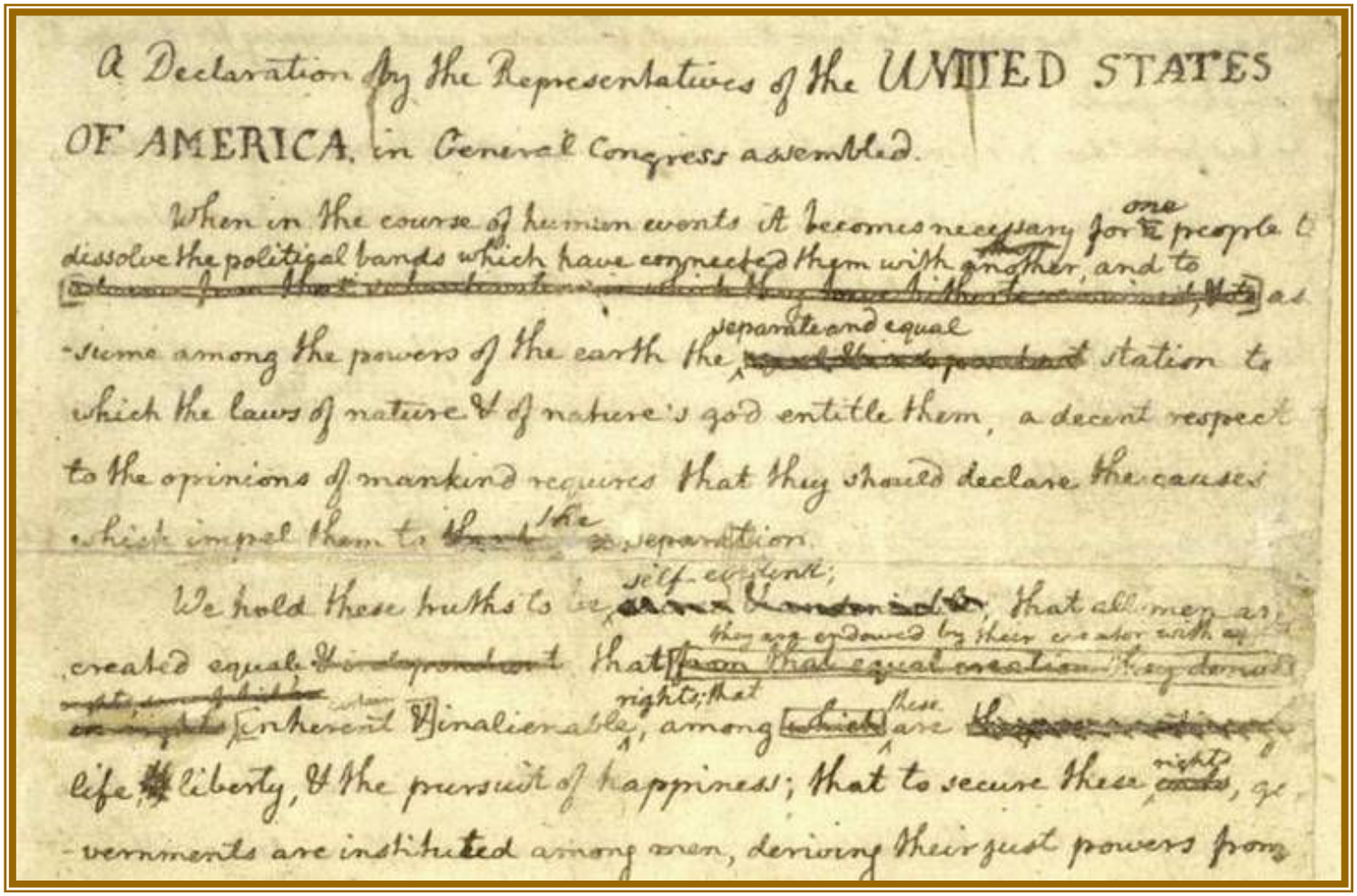
Revision – proofreading marks

- Revision example with various conventional proofreading marks
  - several ways shown; in practice, be consistent



Revision – Declaration of Independence

- Thomas Jefferson made many changes to the Declaration to clarify meaning and reach accord with his colleagues
  - do not be ashamed to revise what you wrote



A Declaration by the Representatives of the UNITED STATES OF AMERICA, in General Congress assembled.

When in the course of human events it becomes necessary for one people to dissolve the political bands which have connected them with another, and to assume among the powers of the earth the separate and equal station to which the laws of nature & of nature's god entitle them, a decent respect to the opinions of mankind requires that they should declare the causes which impel them to the separation.

We hold these truths to be self-evident; that all men are created equal; that they are endowed by their creator with certain inherent & inalienable rights; that among these are life, liberty, & the pursuit of happiness; that to secure these rights, governments are instituted among men, deriving their just powers from

www.loc.gov/exhibits/treasures/images/decp1.jpg

Writing style

Revise for clarity, conciseness, and coherence

Good technical writing style

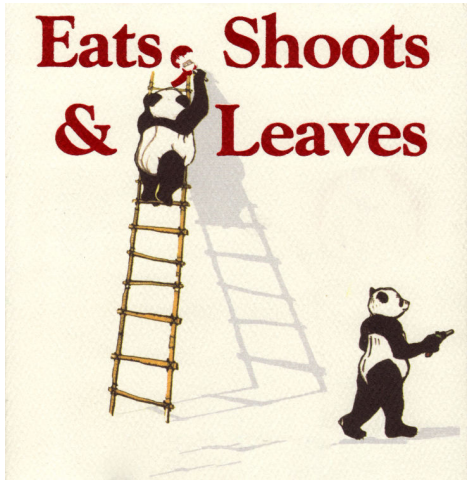
Style is how you say things

- Good style is imposed in the revision process
- Goal is **clarity**, **conciseness**, and **coherence**
  - clarity
    - employ correct word usage, grammar, punctuation, and spelling
    - avoid ambiguity, colloquialism, slang, and shoptalk
  - conciseness
    - use words with precise meaning; avoid wordiness
  - coherence
    - maintain logical development through overall organization
    - use transition elements throughout
- Common problems will be described in following sections
- For guidance, read Strunk and White's "Elements of Style"

Good technical writing style

Clarity – make sure you say what you want to say

- Clearly state your conclusion
  - do not leave out the "punch line," assuming it does not need to be said
- Avoid humor, irony, sarcasm, mockery, innuendo
  - these are easily misunderstood, especially in different cultures
  - these forms should not be used in formal writing
- Be aware of possible ambiguities in wording
  - consider alternative interpretation of text
  - uncertainty often caused by not knowing whether a word is verb or noun
    - for example: *eats, shoots & leaves*



© Lynne Truss

Transition elements

- Transition elements are crucial for keeping the reader on track
  - purpose is to link together different parts of article
- Effective transitions are needed at all levels of article structure
  - article
    - *Introduction* connects with previous work and lays out organization
    - *Conclusion* summarizes what has been presented
  - section
    - begin each section with short introduction to establish its relationship to previous section and the overall context
  - paragraph
    - use topic sentence and logical development within each paragraph
    - establish links between paragraphs
  - sentence
    - use compound sentences with transition or subordinating conjunctions

Transition elements – cross referencing

- Many publishers do not support hypertext (yet)
  - no active electronic links to other relevant material
- However, the writer may provide virtual links
  - make reference to other parts of the manuscript
    - sections
    - equations
    - figures
    - appendices
  - reader can jump to referenced material to get further information
  - or reader can just keep reference in mind
- Each passage must have coherent theme
  - transitions should not detract from linear presentation of thoughts

Paragraphs

- The paragraph is the unit of composition
- Organizing principles
  - unity
    - focus on a central topic
    - topic sentence
      - placed first, second, or last in paragraph
  - development
    - advance the topic through logical argument
  - coherence
    - sentences should hang together
    - transition elements link sentences
      - connecting phrases (*On the other hand, …*; *Therefore, …*)
      - repetition of keywords while avoiding redundancy and monotony
- Paragraphs should not be too long (or too short)

Paragraph length

- Consider appearance of text on page
  - lengthy text with no paragraph breaks is daunting; puts off reader
  - reader should feel able to jump in at several places on each page
- Paragraph should comprise 7 to 14 lines of text (rule of thumb)
  - number of words in a paragraph depends on publication format
    - *SPIE Proceedings*: column width = 17 cm; 17 words/line
      => paragraph length ~ 120 to 240 words
    - *IEEE Trans. Med. Imag.*: column width = 9 cm; 10 words/line
      => paragraph length ~ 70 to 140 words
- For variety, vary paragraph length
  - some shorter than 7 lines; only occasionally longer than 14 lines
- Break up paragraphs that are too long

Example of text without paragraph breaks

To illustrate the noise-power-spectrum (NPS) analysis, a noise image was taken from a storage-phosphor screen (Fuji BAS 3), 20 cm × 40 cm in size, which was scanned with a Fuji model BAS 1500 at the normal pitch of 100 μm. The screen was exposed to a bremsstrahlung beam produced by a microtron running at 15 MeV, after being filtered through 4 cm of depleted uranium. The dose on the screen is estimated to have been about 400 mR (4 mGy), Co^{60} equivalent, yielding scanner readings of about half the saturation level. The original noise image is flattened by dividing it by a fit to the image, which is cubic in *x* and *y*. Thus, the analyzed noise-image values are dimensionless; they represent noise fluctuation values relative to the mean amplitude of the original image. A 7.68-cm-square subsample of the full-size image is used in the present analysis, which is shown in Fig. 3. The NPS estimates obtained using the algorithm outlined in Sec. 3 are presented in Fig. 4. The error bars shown indicate the estimated rms uncertainties. The lowest-frequency point comes from a 24×24 pixel^2 image, obtained by averaging the original 768^2 pixel^2 noise image over sections, each $2^5 = 32$ pixels square. For comparison, also shown is the NPS obtained using a standard Fourier-transform technique.[5] The match between the Fourier-based result shown in Fig. 4 and that of the proposed algorithm is very good, except for the point at 0.106 mm^{-1}. The strong disagreement there is most likely caused by the fact that in the Fourier analysis, spatial frequency components below 0.04 mm^{-1} are removed. The spatial-domain calculation for this image takes 45 s on a PC with an AMD K6 processor running at 166 MHz, whereas the Fourier transform method takes about five times longer.

Proc. SPIE **3336**, p. 248 (1998)

This text is not approachable; it is difficult to read.

Same text with paragraph indentation

To illustrate the noise-power-spectrum (NPS) analysis, a noise image was taken from a storage-phosphor screen (Fuji BAS 3), 20 cm × 40 cm in size, which was scanned with a Fuji model BAS 1500 at the normal pitch of 100 μm. The screen was exposed to a bremsstrahlung beam produced by a microtron running at 15 MeV, after being filtered through 4 cm of depleted uranium. The dose on the screen is estimated to have been about 400 mR (4 mGy), Co^{60} equivalent, yielding scanner readings of about half the saturation level.

The original noise image is flattened by dividing it by a fit to the image, which is cubic in *x* and *y*. Thus, the analyzed noise-image values are dimensionless; they represent noise fluctuation values relative to the mean amplitude of the original image. A 7.68-cm-square subsample of the full-size image is used in the present analysis, which is shown in Fig. 3.

The NPS estimates obtained using the algorithm outlined in Sec. 3 are presented in Fig. 4. The error bars shown indicate the estimated rms uncertainties. The lowest-frequency point comes from a 24×24 pixel^2 image, obtained by averaging the original 768^2 pixel^2 noise image over sections, each $2^5 = 32$ pixels square.

For comparison, also shown is the NPS obtained using a standard Fourier-transform technique.[5] The match between the Fourier-based result shown in Fig. 4 and that of the proposed algorithm is very good, except for the point at 0.106 mm^{-1}. The strong disagreement there is most likely caused by the fact that in the Fourier analysis, spatial frequency components below 0.04 mm^{-1} are removed.

The spatial-domain calculation for this image takes 45 s on a PC with an AMD K6 processor running at 166 MHz, whereas the Fourier transform method takes about five times longer.

Proc. SPIE **3336**, p. 248 (1998)

This text is approachable and easier to read. One can get the sense of the passage from the first sentence in each paragraph.

Same text with paragraph indentation and spacing

To illustrate the noise-power-spectrum (NPS) analysis, a noise image was taken from a storage-phosphor screen (Fuji BAS 3), 20 cm × 40 cm in size, which was scanned with a Fuji model BAS 1500 at the normal pitch of 100 μm. The screen was exposed to a bremsstrahlung beam produced by a microtron running at 15 MeV, after being filtered through 4 cm of depleted uranium. The dose on the screen is estimated to have been about 400 mR (4 mGy), Co^{60} equivalent, yielding scanner readings of about half the saturation level.

The original noise image is flattened by dividing it by a fit to the image, which is cubic in *x* and *y*. Thus, the analyzed noise-image values are dimensionless; they represent noise fluctuation values relative to the mean amplitude of the original image. A 7.68-cm-square subsample of the full-size image is used in the present analysis, which is shown in Fig. 3.

The NPS estimates obtained using the algorithm outlined in Sec. 3 are presented in Fig. 4. The error bars shown indicate the estimated rms uncertainties. The lowest-frequency point comes from a 24×24 pixel^2 image, obtained by averaging the original 768^2 pixel^2 noise image over sections, each $2^5 = 32$ pixels square.

For comparison, also shown is the NPS obtained using a standard Fourier-transform technique.[5] The match between the Fourier-based result shown in Fig. 4 and that of the proposed algorithm is very good, except for the point at 0.106 mm^{-1}. The strong disagreement there is most likely caused by the fact that in the Fourier analysis, spatial frequency components below 0.04 mm^{-1} are removed.

The spatial-domain calculation for this image takes 45 s on a PC with an AMD K6 processor running at 166 MHz, whereas the Fourier transform method takes about five times longer.

Original SPIE Proc. format: This text is the easiest to read.

Proc. SPIE **3336**, p. 248 (1998)

Sentences

- Simple sentence structure promotes clarity and readability
  - aim for readability level of first-year college student
  - generally use subject-verb-object construction
    - avoid complicated sentence structure to explain complex ideas
- Compound sentences can be useful,
  if straightforward and not too long
- Use
  - strong verbs
  - active voice
  - first person, when appropriate

Sentences

- Sentences should be not too long (< 20 – 25 words)
  - break long sentences up into manageable sizes
  - avoid choppy writing by combining too-short sentences
  - vary sentence length to prevent monotony
- Equations are part of a sentence; punctuate accordingly
  - equation numbers are always referred to in parentheses, e.g., *Eq. (9)*

Sentences – compound

- Deviation from simple sentence construction can be useful
  - provide sentence variety; define relationship between ideas
- Compound sentence consists of two or more independent clauses
  - (a clause includes a subject and a predicate, like a sentence)
  - connect clauses with comma, semicolon, or coordinating conjunction
- Compound sentences
    - *The x-ray tube had a large focal spot, so we used a collimator to constrain the beam.*
    - *The radiographs had excellent image quality, but we still could not detect the lesion.*
    - *The microscope, which we borrowed from the biology department, allowed us to visualize the defect.*
    - *The uncertainty can not be estimated by analytic means; therefore we use Markov Chain Monte Carlo to sample the posterior.*

Sentences – subordination

- Subordination through sentence structure
  - shows relationship between ideas
  - provides sentence variety, conciseness, emphasis
  - formed using subordinating conjunctions to connect dependent to independent clause
    - *because, if, while, when, though, although, since, whereas…*
  - critically important to use appropriate conjunction; otherwise reader will be confused
    - *because* and *although* have opposite meanings, are not interchangeable
- Subordination of ideas
    - *Because the input signals were too strong, the data were corrupted.*
    - *The original estimate is consistent with our results, although its uncertainty is somewhat larger.*
    - *Analysis with the t-distribution produces stable results, whereas with the normal distribution does not.*

Sentences – parallelism

- Use parallel structure for clarity

parallel

  - *The x rays pass through the patient, through the collimator, and into the detector.*

- make sure all elements of a list are same part of speech
  - *No: The elements of the detector are the following: converter, scintillator, and detecting the light.*

    Yes: The elements of the detector are the following: converter, scintillator, and photodiode.

Verbs – strong/weak

strong verb

- Use strong verbs in place of weak ones
- Avoid using nominalization
  - *weak verb + noun*
  - some weak verbs: *make, do, conduct, perform*
  - instead, use a strong verb
    - *No: We perform a calculation using Eq. (8) to obtain the results shown in Fig. 2.*
      Yes: We calculate the results shown in Fig. 2 using Eq. (8).
- Avoid use of *get/got/gotten*
    - *No: We have got many problems …; Yes: We have many problems …*
    - *OK: We get the right solution with …;*
      Better: We obtain the right solution with …

Verbs – tense

- Use *present tense* as a general rule
  - although it may seem unnatural to write about the past in the present tense, it is often desirable
- Other tenses may be used when appropriate,
  but **do not switch tenses too often**
  - *past* may be used to refer to
    - previous work done by others
    - work that you did for the paper (calculations, experiments)
    - earlier sections in your paper
  - *future* may be used
    - to later sections in your paper
    - to refer to future work

Active voice

- Voice indicates the relation of the subject to the action of the verb
  - active voice – the subject acts
  - passive voice – the subject is acted upon
    - ***Passive:*** *It was hypothesized by Bethe in 1937 that …*
      Active: *In 1937 Bethe hypothesized that …*
    - ***Passive:*** *The figure of merit is based on the area under the curve.*
      Active: *We base our figure of merit on the area under the curve.*
- Active voice is desirable because it generally
  - improves clarity
  - reduces ambiguity and wordiness

active

First person

first person

- Write in first person, when appropriate
  - person indicates the writer's relation to the material presented
    - writing in first person shows direct involvement; is more immediate
    - writing in second or third person indicates impersonal relation
  - use first person, singular if one author; plural for two or more
    - plural first person may be used for a single author to include reader
    - *I conclude that …*
      We can conclude that …
  - use first person when writing about
    - your choices, opinions, expectations
    - your measurements, calculations, conclusions

First person

- Writing in first person tends to promote active voice
  - *No:* *The results are calculated using Monte Carlo.*
    Yes: *We calculate our results using Monte Carlo.*
- Do not use *the writer* or *one* to avoid writing in first person
  - *No:* *The writer can only conclude that …*
    No: *One can only conclude that …*
    Yes: *I can only conclude that …*
    Better: *I conclude that …*

Ambiguous modifiers

- Place modifiers close to the words they modify
  - *No:* *All students are not talented in mathematics.*
    (no student is talented)
    Yes: *Students are not all talented in mathematics.*
- Avoid long strings of modifiers in front of nouns
  - *No:* *The highly efficient minimum-bias linear-estimator calculation…*
    Yes: *The calculation based on the linear estimator with minimum bias, which is highly efficient, …*

Readability

- Example of clarity in technical writing
  - Hans Bethe, "Nuclear Physics: B. Nuclear Dynamics, Theoretical," *Rev. Mod. Phys.* **9**, p. 71 (1937)

> In an atomic collision, the interaction between the incident particle and the individual electrons of the atom is small, as we have already mentioned. Therefore it is comparatively seldom that a particle in passing through an atom imparts energy to an atomic electron; in other words, inelastic collisions are rare. In most cases, the incident particle will go through the atom without interacting with any particular atomic electron and without losing any energy; it will only be affected by the average field of force of the atom and will be deflected thereby (elastic scattering). The time which the particle spends in the atom is of the order of the atomic dimensions divided by the velocity of the particle. For electrons, the time is even smaller because the electron is accelerated inside the atom. Because of this short time spent inside the atom, it is highly improbable that, e.g., radiation is emitted in the collision. Thus atomic collisions are characterized by a very large elastic scattering, a smaller inelastic scattering, and a very small probability of the emission of radiation.

Common problems in technical writing

Frequently seen mistakes

Common problems

Some of the most common problems in technical writing:

- Passive voice
  - active voice improves clarity
    - *Passive:* *It was hypothesized by Bethe in 1937 that …*
      Active: *In 1937 Bethe hypothesized that …*

active

- Nominalization (*weak verb* + *noun*)
  - instead, use a strong verb
    - *No:* *We perform a calculation using Eq. (8) to obtain the results shown in Fig. 2.*
      Yes: *We calculate the results shown in Fig. 2 using Eq. (8).*
    - *No:* *We made measurements of the rise in temperature …*
      Yes: *We measured the rise in temperature …*

nominalization

Common problems

- Wordiness — wordiness
  - eliminate unnecessary words to achieve conciseness
  - watch out for wordy clichés, e.g., *for the reason that* → *because*
- Comma missing after introductory phrase or clause — comma
  - *No*: *To test our hypothesis we calculate ... ;*
    Yes: *To test our hypothesis, we calculate ...*
- Compound modifiers (adjectives) without hyphens — punctuation
  - use hyphens to connect modifying words that go together
    - *No*: *... the high spatial frequency components are attenuated ... ;*
      Yes: *... the high-spatial-frequency components are attenuated ...*

Common problems

- Missing or inappropriate articles (*a, an, the*) — articles
  - *No:* *Analysis requires statistical model ... ;*
    Yes: *The analysis requires a statistical model ...*
  - *No:* *From a x-ray image, we conclude ...;*
    Yes: *From an x-ray image, we conclude ...*
- Treating countable nouns as uncountable — countable
  - *No:* *less problems ... ;* *Yes:* *fewer problems ...*
  - *No:* *so much artifacts ... ;* *Yes:* *so many artifacts ...*
  - *No:* *Ten items or less. ;* *Yes:* *Ten items or fewer.*
- Transitive verbs without a direct object — transitive
  - *No:* *This algorithm allows to calculate ... ;* (object missing)
    Yes: *This algorithm allows us to calculate ...*

Common problems

- Inappropriate use of words
  - *in order to* – should be avoided, except to prevent ambiguity
    - *No: In order to control …* ; *Yes: To control …*
  - *which, that, who*
    - use *that* before a restrictive phrase (without comma)
      - *The approach that proved to work best …*
      - a restrictive phrase specifies or defines its object
    - use *which* to begin a nonrestrictive phrase, with comma before and after
      - *Our approach, which we adopted from Andrews, proved to work well.*
    - use *who* when referring to a person or people
      - *People who follow Wagner's suggestion …*

that which

Common problems

- Inappropriate use of words
  - *due to* – do not use in place of *because of*
    - *No: The computer failed due to …* ;
      Yes: The computer failed because of …
  - *data* is a plural countable noun, especially in technical writing; similarly *spectra, criteria, phenomena, momenta, radii, …*
  - *This*, at beginning of sentence with no following noun, often indicates ambiguous reference
    - *No: This means that …* ; *Yes: This result means that …*

Common problems

- Inappropriate use of jargon

  jargon

  - appropriateness of jargon depends on expertise of intended audience
- Too many acronyms
  - acronyms should be defined at first use, with few exceptions
- Inappropriate use of punctuation

  punctuation

  - correct punctuation enhances readability

    (,) comma – pauses the flow of a sentence to prevent ambiguity
    (e.g., series, introductory phrase, nonessential phrase)

    (:) colon – initiates series

    (;) semicolon – initiates independent clause

    (–) dash – sets off phrases with emphasis

    ( ) parenthesis – encloses nonessential words and phrases

Word choice and usage

Choose words carefully to convey precise meaning

Word choice

- Choose words carefully to convey precise meaning
  - pick powerful words with definite meanings
  - avoid
    - ambiguity
    - ornate or erudite words
    - wordiness and redundancy
    - informal and incorrect English usage
    - idioms, unnecessary jargon, shoptalk

Choose words for meaning

- Use thesaurus or synonym finder
  to find best word to express your idea
- Beware of connotations – secondary meaning of a word
  - for example, the following words are synonymous (have the same or nearly the same meaning):
    method, system, routine, manner, mode, fashion, way.
    However, they each have a different secondary meaning
    and are not always interchangeable
  - good writing must respect connotation
  - writer must consider how secondary meaning might lead to ambiguity
- Use dictionary to ascertain correct meaning and usage

Dictionary/thesaurus

- "method" – *The Free Dictionary* www.thefreedictionary.com

pronunciation

meth·od (mĕth'əd)

definitions/ usage

n.

1. A means or manner of procedure, especially a regular and systematic way of accomplishing something: *a simple method for making a pie crust; mediation as a method of solving disputes.* See Usage Note at methodology.
2. Orderly arrangement of parts or steps to accomplish an end: *random efforts that lack method.*
3. The procedures and techniques characteristic of a particular discipline or field of knowledge: *This field course gives an overview of archaeological method.*
4. Method A technique of acting in which the actor recalls emotions and reactions from past experience and uses them in identifying with and individualizing the character being portrayed.

origin

[Middle English, *medical procedure*, from Latin `methodus`, *method*, from Greek `methodos`, *pursuit, method* : `meta-`, *beyond, after*; see **meta-** + `hodos`, *way, journey*.]

synonyms/ connotations/ usage

Synonyms: **method, system, routine, manner, mode, fashion, way**
These nouns refer to the plans or procedures followed to accomplish a task or attain a goal. *Method* implies a detailed, logically ordered plan: *"I do not know of a better method for choosing a presidential nominee"* (Harry S. Truman). *System* suggests order, regularity, and coordination of methods: *"Of generalship, of strategic system . . . there was little or none"* (John Morely).
. . .

Dictionary/thesaurus

- "method" – *Wordsmyth Dictionary and Thesaurus* www.wordsmyth.net

meth·od

pronunciation: me thəd

features: Word Explorer

part of speech: noun

definition 1: plan or mode of procedure; way.
The farmers eventually developed more efficient methods of growing crops.
He has an exciting method of teaching the guitar to young students.

synonyms: approach, manner, mode, modus operandi, plan, procedure, system, way
similar words: arrangement, design, fashion, formula, means, performance, practice, program, routine, scheme, style, technique

definition 2: systematic and orderly arrangement of actions.
There was no method to how she planted the garden.

synonyms: means, organization, procedure, process, system, technique
similar words: arrangement, design, discipline, plan, practice, program, routine, schedule, scheme

definition 3: (often pl.) the manner in which one conducts business or the like.
It's an honorable goal, but I question the methods they're using to achieve it.

synonyms: manner, mode, procedure, technique, way
similar words: approach, practice, style

related words: architecture, conception, expedient, measure, medium, organization, path, procedure, proceeding, tack, way, wise

Thesauruses

- "method" – *Synonym Finder* (Rodale, 1986); only available in print
  - words listed alphabetically, as in a dictionary

method, *n.* **1.** way, manner, mode, process, procedure, *Latin. modus operandi*; means, technique, formula, principle, practice.
2. order, system, plan, design, discipline; course, routine, program, line; standard, precept, code, guide, pattern; methodology, rule, attack, approach, line, wise.
3. arrangement, sequence, systematization, methodization; disposition, array, distribution, assignment, disposal; categorization, classification, organization.

methodical, *adj.* **1.** systematic, orderly, ordered, regular, exact, uniform, constant; methodic, business-like, regulated, routine, tidy, neat, step by step.
2. painstaking, laborious, slow; exact, meticulous, precise, punctilious.

- Another good on-line thesaurus www.thesaurus.com

Beware the thesaurus

- Thesaurus – warning
  - don't try to impress the reader with long or esoteric words
  - be careful about using words you don't know; they may not be appropriate
    - original sentence:
      Essentially all inference about uncertainties in models, the reliability of their potential predictions, and so forth, stems from the posterior.
    - revised with indiscriminate use of thesaurus:
      Fundamentally each and every a fortiori reasoning in connection with indeterminations in facsimiles, the responsibility of their dormant prognostications, and everything else, springs up from the backside.
    - above is good example of "Creative Obfuscation"
      – J. S. Armstrong, *IEEE Trans. Prof. Comm.* **PC-25**, pp. 30-32 (1982)

- Nevertheless, a thesaurus can be very useful, when carefully used

Strive for conciseness

- Streamline your text by removing unnecessary words
- Avoid redundancy
  - **No:** *...so therefore ...* ; **Yes:** *...therefore ...* ; **Yes:** *...so ...*
  - **No:** *in a short period of time* ; **Yes:** *in a short period*
  - **No:** *concentrate on the basic fundamentals ...* ;
    Yes: *concentrate on the fundamentals ...*
- Avoid unneeded prepositions (often used incorrectly in speech)
  - **No:** *where the problem is at* ; **Yes:** *where the problem is*
  - **No:** *how big of a difference ...* ; **Yes:** *how big a difference ...*
  - **No:** *fill up the beaker ...* ; **Yes:** *fill the beaker ...*

Avoid wordiness

wordiness

- Eliminate wordy phrases
  - common examples
    - **No:** *In order to control …* ; **Yes:** *To control …*
      (*in order to* sometimes helps clarify sentence meaning)
    - **No:** *… in the event that …* ; **Yes:** *… if …*
    - **No:** *It should be noted that …* ; **Yes:** *Note that …*
    - **No:** *… at the present time …* ; **Yes:** *… now …*
    - **No:** *… for the reason that …* ; **Yes:** *… because …*
    - **No:** *… through the use of …* ; **Yes:** *… by …* ; **Yes:** *… with …*
    - **No:** *… for all of the calculations*; **Yes:** *… for all the calculations*
      (except, use *of* for pronouns: *all of them*)

Informal English

- Colloquial language, used in casual conversation, should not be used in technical writing
  - **No:** *So what's up with that?*
  - **No:** *To get up to speed, we did a literature search.*
  - **Yes:** *To learn more, we conducted a literature search.*
- Idioms are groups of words whose meaning differs from literal definition

idioms

  - they are understood only in particular regions or in certain eras
    - *go over a manuscript = review a manuscript*
    - *carry out the calculation = perform the calculation* or *calculate*
    - *figure out the error = determine the error; find the error*
  - many idioms are not universally recognized, so avoid those

Informal English

prepositions

- Unnecessary prepositions plague informal English
  - many idioms involving prepositions can be replaced for conciseness
    - *No*: *do over* ; *Yes*: *repeat*
    - *No*: *figure out* ; *Yes*: *solve*
    - *No*: *look up* ; *Yes*: *search for*
    - *No*: *on account of* ; *Yes*: *because*
  - some prepositions used in speech may be eliminated in tech. writing
    - *No*: *Based on all of the data …* ; *Yes*: *Based on all the data …*
    - *No*: *We determined where the leak was at.*
      Acceptable: *We determined where the leak was.*
      Best: *We found the leak.*
  - some idioms are acceptable but must be used with proper proposition (check dictionary for proper usage)
    - *No*: *focus at something* ; *Yes*: *focus on something*
    - *No*: *consistent as* ; *Yes*: *consistent with*

Informal English

- Avoid slang, which is very informal and faddish

slang

  - *No:* *We lucked out, and hit upon a totally cool algorithm.*
  - *No:* *We ended up with zilch.* ; *Yes:* *The result was negative.*
- Avoid shoptalk – jargon used only by you and your colleagues
  - *lineout* may mean something to you and your coworkers, but not to your readers

Jargon

jargon

- Jargon is highly specialized technical word or phrase, unique to certain specialties
- Examples of jargon
  - *noise power spectrum*
  - *Fourier transform*
  - *support vector machine*
  - *bioluminescent emission tomography*
  - *MLO mammo CAD; VC CAPD for CRC; AP B mode US*

Jargon

- Appropriateness of jargon depends on intended audience
  - when writing for experts (journal and proceedings articles), jargon can be helpful for concisely saying what you mean
  - when writing for non-experts (non-specialty magazines), use as little jargon as possible, and always define it

Abbreviations

- Use abbreviations to refer to figures, equations, sections, etc., except at the beginning of a sentence

abbreviations

  - *Yes*: *As shown in Fig. 3, … ;* *But*: *Figure 3 shows …*
  - *Yes*: *Substituting Eq. (6) into … ;* *But*: *Equation (6) enables us to …*
- Do not italicize abbreviations derived from foreign languages
  - *No*: *et al.* ; *Yes*: et al.
- Generally avoid abbreviations – spell them out in English
  - i.e. that is; preceded and followed by commas
  - e.g. for example; preceded and followed by commas
  - viz. namely; preceded and followed by commas
- A few standard abbreviations are acceptable
  - et al. (*et alii*), and others
  - etc. (*et cetera*), and so forth; do not use after *such as*

Abbreviations in medical imaging

- In general, define abbreviations and acronyms at first use (even in abstract); need depends somewhat on context
- The following usually do not need to be defined in MI context:
  - CT, MR computed tomography, magnetic resonance
  - PET positron-emission tomography
  - FFT fast Fourier transform
  - rms root mean square
  - 3D three dimensional
- The following should generally be defined:
  - US ultrasound
  - DC direct current or zero-frequency component
  - NPS noise power spectrum
  - ROC receiver-operating characteristic

Measurement units

units

- Measurement units are usually abbreviated
  - mm millimeter; length
  - s second; time
  - HU Hounsfield units; x-ray CT amplitude
  - Hz Hertz = second^{-1}; frequency
  - pt. points; length in type setting
- Generally include space after number and **do not italicize** units
  - *No*: 2.47 *mm* ; *No*: 2.47mm; *Yes*: 2.47 mm
  - *No*: 6pts. ; *No*: 6 *pt.* ; *Yes*: 6 pt.
  - *But*: 54ºC
  - *But*: 5% [no space between number and % symbol]

- See AIP Style Manual for list of abbreviations of physical-units

Grammar and punctuation

Rules, rules, rules, and exceptions

Grammar

- Grammar deals with how words are properly used, particularly in regard to parts of speech and sentence construction
- English grammar has many rules; all must be obeyed
- Partial list of grammatical rules:
  - agreement of number and case
  - number agreement: subject, verb, pronoun
  - subjective/objective pronouns: who, whom
- Some of most commonly broken rules are mentioned in following slides
- See writing style guides for more details [Hacker]

Plurals

- General rule for forming a plural of a noun is to add an *s*
  - *algorithm / algorithms*
  - *sum / sums*
  - *element / elements*
  - exceptions (for nouns ending in *s, x, z, ch,* and *sh*, add *es*)
    - *plus / pluses*
    - *quiz / quizzes* (note exception to exception)
  - exceptions (for nouns ending in *y*, add *ies*)
    - *recovery / recoveries*

Plurals

- Some less obvious rules for forming plurals:
  - Greek letters: θ / θ's
  - mathematical symbols: c_j / c_j's
  - acronyms: MRI / MRIs
    - but, NPS/ NPS's
  - abbreviated units: cm / cm ; example: 5 cm (no italics, no s)

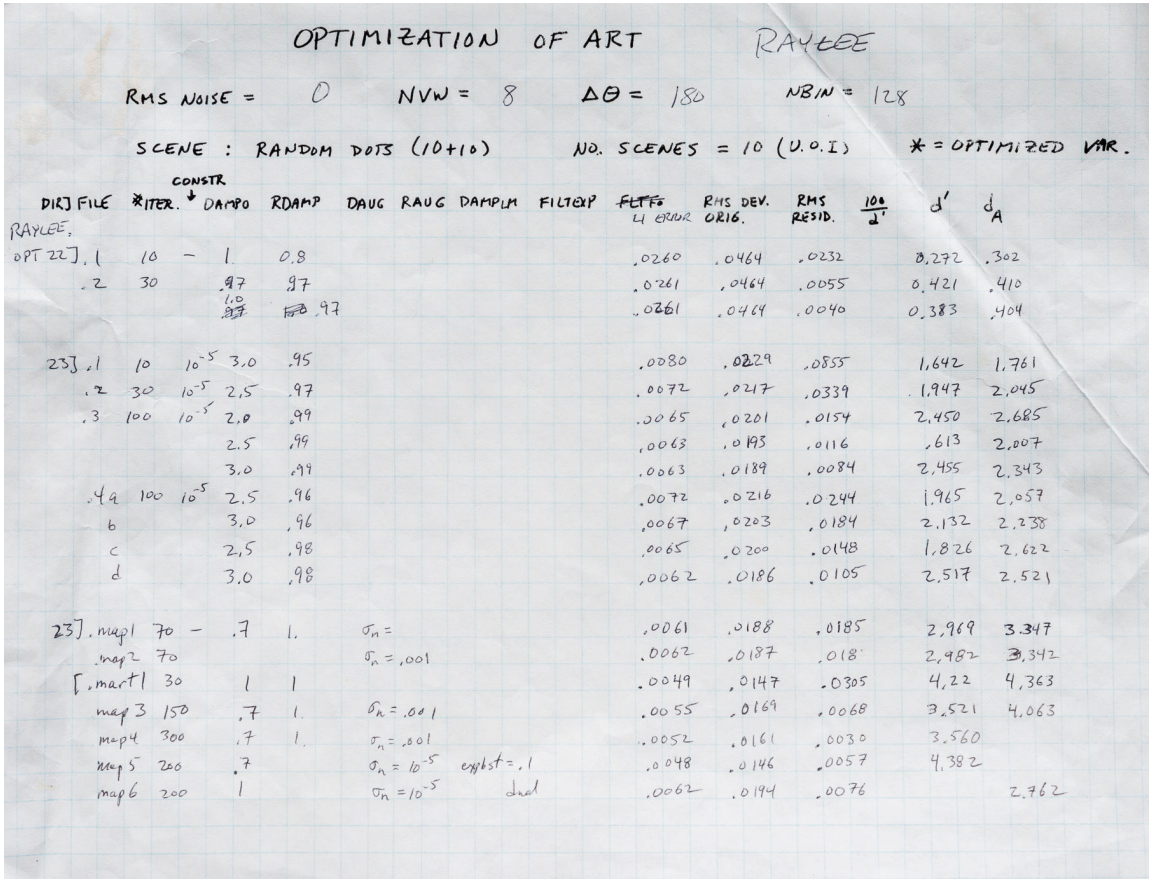
Plurals

- Latin or Greek nouns often cause problems
  - **singular / plural**

    axis / axes
    index / indices
    analysis / analyses
    hypothesis / hypotheses
    criterion / criteria
    phenomenon / phenomena
    matrix / matrices
    vertex / vertices
    datum / data
    maximum / maxima
    medium / media
    minimum / minima
    colloquium / colloquia
    spectrum / spectra
    radius / radii
  - *No: This data is … ; Yes: These data are …*
  - but
    - *equilibrium / equilibriums*
      formula / formulas

Data – a plural, countable noun

- When someone says "data," envision numbers on a data sheet
  - numerical observations, measurements, or calculated results
- As such, in formal technical writing it is appropriate to use "data" as a plural, countable noun



OPTIMIZATION OF ART — RAYLEE

RMS NOISE = 0 NVW = 8 $\Delta\theta$ = 180 NBIN = 128

SCENE : RANDOM DOTS (10+10) NO. SCENES = 10 (U.O.I) * = OPTIMIZED VAR.

DIR] FILE	*ITER.	CONSTR ↓ DAMPO	RDAMP	DAUG	RAUG	DAMPLM	FILTOP	~~FLTF~~ L1 ERROR	RMS DEV. ORIG.	RMS RESID.	$\frac{100}{d'}$	d'	d_A
RAYLEE:													
OPT 22]. 1	10	– 1	0.8					.0260	.0464	.0232		0.272	.302
.2	30	.97	97					.0261	.0464	.0055		0.421	.410
		1.0 ~~.97~~	~~FAD~~ .97					.0261	.0464	.0040		0.383	.404
23] .1	10	10^{-5} 3.0	.95					.0080	.0229	.0855		1.642	1.761
.2	30	10^{-5} 2.5	.97					.0072	.0217	.0339		1.947	2.045
.3	100	10^{-5} 2.0	.99					.0065	.0201	.0154		2.450	2.685
		2.5	.99					.0063	.0193	.0116		.613	2.007
		3.0	.99					.0063	.0189	.0084		2.455	2.343
.4a	100	10^{-5} 2.5	.96					.0072	.0216	.0244		1.965	2.057
b		3.0	.96					.0067	.0203	.0184		2.132	2.238
c		2.5	.98					.0065	.0200	.0148		1.826	2.622
d		3.0	.98					.0062	.0186	.0105		2.517	2.521
23]. map1	70	– .7	1.	σ_n =				.0061	.0188	.0185		2.969	3.347
map2	70			σ_n = .001				.0062	.0187	.018		2.982	3.342
[.mart1	30	1	1					.0049	.0147	.0305		4.22	4.363
map3	150	.7	1.	σ_n = .001				.0055	.0169	.0068		3.521	4.063
map4	300	.7	1.	σ_n = .001				.0052	.0161	.0030		3.560	
map5	200	.7		$\sigma_n = 10^{-5}$			exptsf = .1	.0048	.0146	.0057		4.382	
map6	200	1		$\sigma_n = 10^{-5}$			dual	.0062	.0194	.0076			2.762

Example of *data*

A table of numerical results from computer simulations of CT reconstructions using various algorithms

[Hanson, circa 1990]

Nouns and qualifiers

countable

- Nouns are either *countable* or *uncountable*; also called *count* or *mass nouns*
  - referred to in terms of number vs. amount or quantity
  - use (*few, fewer, many*) with *countable* nouns
    - *a few pixels, fewer molecules, many people*
  - use (*little, less, much*) with *uncountable* nouns
    - *too much chlorine, little time, less energy*
  - on the other hand, use (*more, some, enough*) for both
    - *more pixels, some people, enough energy*
  - further examples
    - *how many items? / how much stuff?*
    - *a few items / a small amount of stuff*
  - articles *a* or *an* may be used with countable nouns, not with uncountable nouns
  - countable nouns may be plural, but generally not uncountable nouns

Articles

article

- Articles (*a, an, the*) function as adjectives, helping to specify which noun is meant
- *Definite* articles refer to a particular item (*the*)
  - **No:** *Computer stopped running.* ; **Yes:** *The computer stopped running.*
  - **No:** *Symbol † stands for …* ; **Yes:** *The symbol † stands for …*
- *Indefinite* articles (*a, an*) refer to an unspecified singular countable item
  - **No:** *We need new approach.* ; **Yes:** *We need a new approach.*
  - ▸ use *an* when following word begins with a vowel sound (not long u)
    - *an article, an hour, an electron, an x ray, an FFT, an SPIE meeting;* **but** *a unit, a unique result, a human gene, a SPIE meeting (spy)*
- Do not to use an article when the noun is meant generally
  - *Nausea is occasionally suffered by patients undergoing this procedure.*
  - **But:** *The nausea occasionally suffered by patients can be eliminated …*

Pronouns

- Pronouns take the place of nouns

pronoun

- Make sure pronouns refer clearly to the proper object (antecedent)
  - must agree in number, gender, and person
    - *We believe that our research shows …*
      (pronoun *our* agrees with pronoun *we*)
- Avoid vague pronoun reference
    - *No: The calculations are based on firm principles. They must be correct.* (does *they* refer to *calculations* or *principles*?)
      Yes: The calculations must be correct because they are based on firm principles.
    - *No: The detector has a defect that causes problems. This can degrade our results.* (*this* is too broad; ambiguous)
      Yes: The detector has a defect but sometimes runs well. This defect can degrade our results.
    - *No: It means that …* (*it* is too broad) ; *Yes: That means that …*

Relative pronouns

- *that/which/who* are relative pronouns
  - use *that* when following phrase or clause helps define (restrictive or essential phrase)
    - *The approach that proved to work best …*
  - use *which* when following phrase or clause does not help define (nonrestrictive or nonessential phrase)
    - *The approach, which we adopted from Andrews, proved to work well.*
  - use *who* when referring to a person or people
    - *People who follow Wagner's suggestion …*
    - *The researchers who published in the Physical Review obtained the correct results.* (restrictive clause)
    - *The researchers, who published in the Physical Review, obtained the correct results.* (nonrestrictive clause)
  - do not use *who* for collections of people
    - *The class that studied under Enrico Fermi learned the fundamentals.*

Verbs – transitive/intransitive

transitive

- Verbs are either transitive or intransitive
- Transitive verbs must have a direct object
  - *The results contain an error.*
  - *We evaluate Eq. (6) to obtain the result show in Fig. 2.*
  - *No: This approach allows to reconstruct ... ;* (no object)
    Yes: The approach allows one to reconstruct ...
- Intransitive verbs do not have a direct object
  - *The calculation succeeded.*
- Many verbs are both transitive and intransitive
  - *The experienced technicians performed the procedure best.*
  - *The experienced technicians performed best.*

Adverbs

placement

- Place adverbs as near verb as feasible
  - *No:* *In x-ray imaging usually a large number of photons are detected in each detector pixel.*
  - *Yes:* *In x-ray imaging, a large number of photons are usually detected in each detector pixel.*

- Adverbs are frequently overlooked in conversation
  - common mistakes made in spoken English:
    - *No:* *The algorithm converges quick.* ;
      Yes: *The algorithm converges quickly.*
    - *No:* *It works good.* ; *Yes:* *It works well.*

Word usage

- Be careful using *due to*; it is not interchangeable with *because of*
  - *due to* acts as an adjective, meaning *the result of*
  - *because of* acts as an adverb, meaning *as a result of*
  - do not use *due to* in place of *because of* in most circumstances
    - *No:* *The computer failed due to poor programming …* ;
      Yes: *The computer failed because of poor programming …*
  - however, *due to* may be used in place of *caused by* after the verb *be*
    - *OK:* *The computer failure was due to a bad connection.* ;
      Better: *The computer failure was caused by a bad connection*

Punctuation

- Inappropriate or missing punctuation marks can derail the reader, so use them carefully!
- The following slides mention only a few important uses
- Cursory summary of uses:
  - (.) period – terminates a sentence; abbreviations
  - (?) question mark – terminates a question
  - (!) exclamation point – terminates an exclamatory statement
  - (,) comma – pauses the flow of a sentence to prevent ambiguity
  - (-) hyphen – clarifies compound modifiers
  - (–) dash – sets off phrase with emphasis; don't overuse
  - (:) colon – initiates series
  - (;) semicolon – initiates independent clause
  - ( ) parenthesis – encloses nonessential words and phrases

Comma

- The comma is one of the most important elements of punctuation – it helps avoid ambiguity by phrasing the sentence
  - the comma acts like a traffic cop; it regulates the flow
- Comma is used:
  - after introductory phrase or clause:
    - *To test our hypothesis, we calculate …*
      - except possibly for short phrases, up to 2 or 3 words long
    - words signaling introductory phrase: *To, At, On, When, Until, As, Before, Because, Although, If*
  - after transitional expressions:
    - *Therefore, the results indicate the presence of …*
    - *However, we argue that …*

Comma (2)

- Comma is used:
  - between independent clauses linked by a coordinating conjunction (*and, but, or, not, so, yet, for*)
    - *The technique may be used for convolution, but not for ...*
  - to separate items in a series:
    - *Any one of the options shown in Fig. 8 could be used: A, B, or C.*
    - *A fast, accurate, and reliable algorithm is needed.*
  - to enclose nonrestrictive phrases:
    - *The apparatus, which we bought commercially, worked extremely well.*
    - a nonrestrictive phrase is not needed for the meaning of the sentence

Comma (3)

commas

- Refrain from using unnecessary commas
  - can be dropped when there is no ambiguity and flow is improved:
    - OK: *Thus the result is … ;* OK: *Thus, the result is …*
- The comma (as well as other punctuation marks) always goes inside quotation marks
    - *In his book, "Data Analysis," Sivia explains …*

Hyphenation

- Compound adjectives (modifiers) –
  use hyphens to connect words that go together

  hyphen

  - *No:* *... the high spatial frequency components are attenuated ...*
    Yes: *... the high-spatial-frequency components are attenuated ...*
    But: *... the high spatial frequencies are reduced ...*

  ▸ exception, adverbs ending in *-ly*

  - *No:* *... highly-variable results ...*
    Yes: *... highly variable results ...*

- Some words incorporate hyphens

  ▸ *x-ray* has several acceptable spellings: *x ray; x-ray; X ray; X-ray*

  - but always use hyphen in the compound adjective: *x-ray tube*

  ▸ *e-mail* is preferred

Summary of technical writing

- Organization of material is crucial
- Good technical writing style is achieved by
  - revision
  - paying attention to the details
  - using writing guides and dictionaries, especially when in doubt
  - having your writing critically edited by technical editor and/or knowledgeable colleagues
- Find the approach to writing that **works best for you**

Tools for technical writing

Learn more from books and web sites

Document processors

- MS Word
  - full featured
  - spelling checker and grammar checker
  - compatible/ interplay with other MS office products
  - WISIWYG editing
  - expensive
- OpenOffice
  - comparable to MSWord
  - free
- WordPrefect
  - full featured
- AbiWord
  - free

Document preparation

- LaTeX
  - used by many authors, accepted by most publishers
  - numerous desirable features
    - excellent equation formation
    - enforces publishing rules
    - automatic numbering of sections, figures, equations, etc.
    - citation and references made easy;
      bib files usable with various bibliography style files
    - AMS packages for enhanced mathematical capabilities
    - free
  - need word processor, DVI (Device Independent) viewer, and ability to convert to standard document format (PS, PDF,…)
  - style files for formatting manuscripts for SPIE Proceedings:
    http://kmh-lanl.hansonhub.com/spie/

Document preparation (2)

- LaTeX (cont'd)
  - dvips is LaTeX utility for producing PostScript file
    - for readable computer viewing of a PDF file produced from a PS file, make sure PDF file has scalable Type 1 PostScript fonts
    - in dvips, use '-P pdf' option
  - free distributions (including DVI viewer)
    - CTAN – archive for packages, classes, documentation
    - MikTeX (Windows)
    - TeX Live (all OSs)
    - OzTeX, CMacTeX, TeXShop (Mac)

Word processors/text editing

- Most computer OSs have native editors; the following are useful for Windows
- Ultraedit (win)
  - powerful features
  - useful for code development, as well as LaTeX source files
  - inexpensive ($30)
- Abiword (win)
  - document preparation, as well
  - spelling and grammar checker
  - free
- LyX (win)
  - front end to LaTeX; almost WYSIWYG
  - free

Online writing guides

- *Mayfield Handbook of Technical and Scientific Writing*, L. C. Perelman, J. Paradis, and E. Barrett; www.mhhe.com/mayfieldpub/tsw/home.htm
  - recommended; complete guide to technical writing from MIT; concise explanation of most aspects of technical writing; ESL pointers
- *Online Writing Lab (OWL);* owl.english.purdue.edu
  - guide to effective writing at college level; grammar and punctuation with exercises; English as a Second Language (ESL)
- *AIP Style Manual*; http://kmh-lanl.hansonhub.com/AIP_Style_4thed.html
  - American Institute of Physics gives stylistic guidance, especially relevant to physics articles

Online writing aids

- *Guide to Grammar and Style*; http://andromeda.rutgers.edu/~jlynch/Writing/
  - guide to general grammatical rules and style; in dictionary form
- *Merriam-Webster Dictionary and Thesaurus*; http://www.m-w.com
  - usable, gives etymology and pronunciation of words
- *The Free Dictionary (and Thesaurus)*; http://www.thefreedictionary.com
  - usable, gives etymology and pronunciation of words
- *Wordsmyth Dictionary and Thesaurus*; http://www.wordsmyth.net
  - very usable, although definitions are brief; identifies parts of speech

Online writing aids

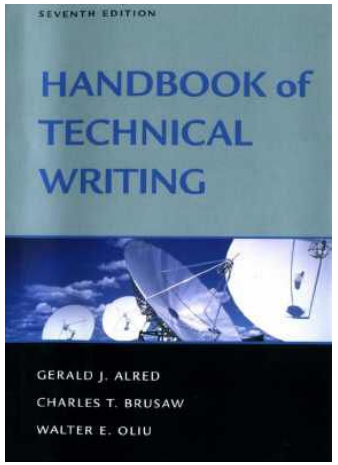
- *Bartleby Classic Online Books*; http://www.bartleby.com
  - a wonderful collection of writers' aids: Roget's Thesaurus, quotations, and more:
  - *Elements of Style*; http://www.bartleby.com/141/
    - classic handbook, written by William Strunk in 1918
  - *King's English*; http://www.bartleby.com/116/
    - by H. W. Fowler (1908), another classic
- "Politics and the English Language," George Orwell (1946); https://www.mtholyoke.edu/acad/intrel/orwell46.htm
  - essay on basic rules for clear writing
- Other useful references on my webpage http://kmh-lanl.hansonhub.com/techwriting.html

Online writing courses/tutorials

- Stanford University has an outstanding online course on technical writing.
  Go to https://class.stanford.edu/courses/
  and look for "SciWrite: Writing in the Sciences" taught by Kristin Sainani.
  Beneficial for thorough discussion of revision process with examples
  After registering, you can download videos and course slides.
  If you are really serious, you can take the 8-week course and get a certificate.
- Other online writing courses:
  - edX – https://www.edx.org/ consortium of major universities offering Massive Open Online Courses (MOOCs) for free
    - for example: Principles of Written English, an introduction to academic writing for English Language Learners
- Donald Knuth – creator of TeX and computer guru
  http://jmlr.org/reviewing-papers/knuth_mathematical_writing.pdf
  – lecture notes; list of "27 points for good writing in mathematics"
  Also, Knuth has many interesting and worthwhile videos on YouTube, e.g. "All Questions Answered"

Books

- *Handbook of Technical Writing*, G. J. Alred, C. T. Brusaw, and W. E. Oliu (St. Martin's, New York, 2008) [$26-39]
  - highly recommended; complete handbook on technical writing; entries arranged in alphabetical order; excellent index; ESL guidance; includes succinct guide to the writing process
  - online support material www.macmillanhighered.com



- *An Outline of Scientific Writing: For Researchers With English As a Foreign Language*, J. T. Yang (World Scientific, 1995) [$10-19]
  - may be especially useful to ESL writers; no index
- *MIT Guide to Science and Engineering Communication*, J. G. Paradis and M. L. Zimmerman (MIT, Cambridge, 2002) [$31]
  - discusses all types of technical communication; includes list of 27 guidelines for style and usage

Books

- *Rules for Writers*, D. Hacker (St. Martin's, 2003) [$9-40]
  - excellent college-level textbook; *www.macmillanhighered.com*
- *Prentice-Hall Handbook for Writers*, M. G. Kramer et al. (Prentice Hall, 1995) [$9-20]
  - comprehensive and concise reference
- *Chicago Guide to Communicating Science*, S. Montgomery (Univ. Chicago, 2002) [$19, pbk.]
  - detailed practical advice on technical writing and other forms of communication; chapter on ESL
- *Gregg Reference Manual: A Manual of Style, Grammar, Usage, and Formatting,* William A. Sabin (McGraw-Hill, 2010) [$38-65]
  - outstanding reference book; easy to use and understand
- *Chicago Manual of Style* (Univ. Chicago, 2010) [$31]
  - viewed by many as the definitive reference on style of written English; sometimes difficult to use

Books

- *Elements of Style,* W. Strunk Jr. and E. B. White (Allyn & Bacon, 1995) [$7, pbk.]
  - highly recommended short book; concisely states the basic rules for writing; more complete than the classic, written by Strunk in 1918
- *Synonym Finder* (Rodale, 1986) [$10-17, pbk.]
  - a thesaurus in dictionary form; easy to use
- *American Heritage Book of English Usage*, (Houghton Mifflin Harcourt, 1996) [$10, ebook, pbk.]
- *Writing: A College Handbook*, J. A. W. Heffernan and J. E. Lincoln (W. W. Norton, 2000) [$23-50]
  - excellent textbook on writing at the college level
- *Style: Toward Clarity and Grace*, J. M. Williams (Univ. Chicago, 1995) [$13]
  - textbook that shows how to write well; for writers who want to excel
- *On Writing Well*, W. Zinsser (Harper Perennial) [$9]
  - sage advice on how to improve your writing

Format for SPIE Proceedings

Example of formatting requirements

Manuscript format

Each publisher has its own format and rules. Follow them!

- Many details need to be considered
  - fonts and format
  - line spacing
  - paragraph indentation and spacing
  - section headings
  - citations and reference list
  - equations
  - floats – captions, placement
- A good approach is to use journal's templates and replace their text with yours
- Go to journal's web site for its formatting rules

SPIE Proceedings format

- As an example, consider format for SPIE Proceedings
- Manuscripts submitted to SPIE Proceedings must be “camera ready,” that is, what you submit is what gets published
- Author is responsible for formatting and appearance of article

- Style files for LaTeX and a template file for MSWord can be found on my web pages
  http://kmh-lanl.hansonhub.com/spie/

SPIE format – the beginning

Front matter
- format
- spacing
- fonts

Introduction
- heading format

Style template and guidelines for SPIE Proceedings

Anna A. Author1[a] and Barry B. Author2[b]

[a]Affiliation1, Address, City, Country;
[b]Affiliation2, Address, City, Country

ABSTRACT

This document shows the desired format and appearance of a manuscript prepared for the Proceedings of the SPIE. It contains general formatting instructions and hints about how to use LaTeX. The LaTeX source file that produced this document, `article.tex` (Version 2.81), provides a template, which can be used in conjunction with `spie.cls`.

Keywords: Manuscript format, template, SPIE Proceedings, LaTeX

1. INTRODUCTION

This document shows the desired format and appearance of a manuscript prepared for the Proceedings of the SPIE.* It is prepared using LaTeX2e[1] with the class file `spie.cls`. The LaTeX source file used to create this document is `article.tex`, which contains important formatting information embedded in it. These files are available on the Internet at `http://home.lanl.gov/kmh/spie/`. The font used throughout is the LaTeX default font, Computer Modern Roman, which is equivalent to the Times Roman font available on many systems. If this font is not available, use a similar serif font. Normal text has a font size of 10 points† for which the actual height of a capital E is about 2.4 mm (7 pt.) and the line-to-line spacing is about 4.2 mm (12 pt.). The font attributes for other parts of the manuscript, summarized in Table 1, are described in the following sections. Normal text should be justified to both the left and right margins. Appendix B has information about PostScript fonts.

To be properly reproduced in the Proceedings, all text and figures must fit inside a rectangle 6.75-in. wide by 8.75-in. high or 17.15 cm by 22.23 cm. The text width and height are set in `spie.cls` to match this requirement. The text should begin 1.00 in. or 2.54 cm from the top of the page. The right and left margins should be

SPIE format – tables and footnotes

Tables

- caption above
- caption format
- centered
- usually at top or bottom of page

Footnotes

- auxiliary author information
- format
- at bottom of page

Table 1. Fonts sizes to be used for various types of text. All fonts are Computer Modern Roman or an equivalent. Table captions should be centered above the table. When the caption is too long to fit on one line, it should be justified to the right and left margins of the body of the text.

Article title	16 pt., bold, centered
Author names and affiliations	12 pt., normal, centered
Section heading	11 pt., bold, centered (all caps)
Subsection heading	11 pt., bold, left justified
Sub-subsection heading	10 pt., bold, left justified
Normal text	10 pt., normal
Figure and table captions	9 pt., normal
Footnote	9 pt., normal

Further author information: (Send correspondence to A.A.A.)
A.A.A.: E-mail: aaa@tbk2.edu, Telephone: 1 505 123 1234
B.B.A.: E-mail: bba@cmp.com, Telephone: +33 (0)1 98 76 54 32
*This format was developed in 1995 by Rick Herman, SPIE, and Ken Hanson, Los Alamos National Laboratory.
†Font sizes are specified in points, abbreviated pt., which is a unit of length. One inch = 72.27 pt.; one cm = 28.4 pt.

SPIE format – figures

Figures

- caption below
- caption format
- centered
- do not wrap text around
- usually at top or bottom of page

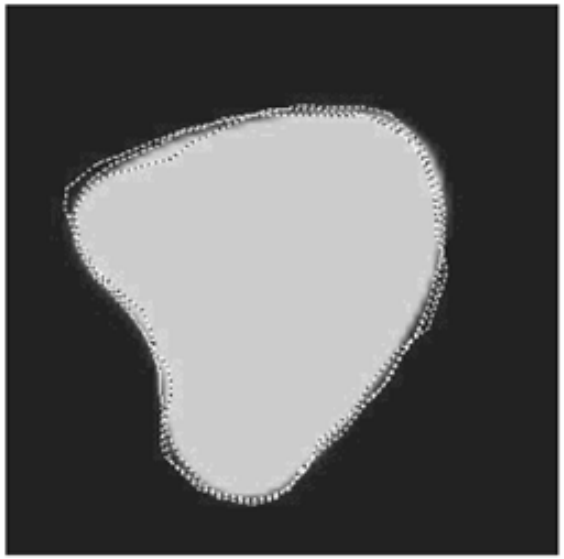


Figure 1. Figure captions are used to label the figure and help the reader understand the figure's significance. The caption should be centered underneath the figure and set in 9-point font. It is preferable for figures and tables to be placed at the top or bottom of the page. LaTeX tends to adhere to this standard.

4. FIGURES AND TABLES

Figures are numbered in the order of their first citation. They should appear in numerical order and on or after the same page as their first reference in the text. Alternatively, all figures may be placed at the end of the manuscript, that is, after the Reference section. It is preferable to have figures appear at the top or bottom of the page. Figures, along with their captions, should be separated from the main text by at least 0.2 in. or 5 mm.

Figure captions are centered below the figure or graph. Figure captions start with the figure number in 9-point bold font, followed by a period; the text is in 9-point normal font; for example, "**Figure 3.** Original image...". See Fig. 1 for an example of a figure caption. When the caption is too long to fit on one line, it should be justified to the right and left margins of the body of the text.

Tables are handled identically to figures, except that their captions appear above the table.

SPIE format - equations

Equations

- indent (centered)
- Eq. # right justified, in parentheses
- punctuation

A.1. Formatting Equations

Equations may appear in line with the text, if they are simple, short, and not of major importance; e.g., $\beta = b/r$. Important equations appear on their own line. Such equations are centered. For example, "The expression for the minus-log-posterior is

$$\phi = |\mathbf{y} - \mathbf{A}\mathbf{x}|^2 + \alpha \log p(\mathbf{x}) \,, \tag{1}$$

where α determines the strength of ..." Principal equations are numbered, with the equation number placed within parentheses and right justified.

Equations are considered to be part of a sentence and should be punctuated accordingly. In the above example, a comma follows the equation because the next line is a subordinate clause. If the equation ends the sentence, a period should follow the equation. The line following an equation should not be indented unless it is meant to start a new paragraph. Indentation after an equation is avoided in LaTeX by not leaving a blank line between the equation and the subsequent text.

References to equations include the equation number in parentheses, for example, "Equation (1) shows ..." or "Combining Eqs. (2) and (3), we obtain..." Using a tilde in the LaTeX source file avoids unwanted line breaks.

SPIE format – reference list

Reference list

- formats as specified by publisher
- journal names have standard abbreviations

REFERENCES

1. L. Lamport, *LaTeX: A Document Preparation System*, Addison-Wesley, Reading, Mass., 1994.
2. A. Eisenberg, *Guide to Technical Editing*, Oxford University, New York, 1992.
3. M. Goossens, F. Mittelbach, and A. Samarin, *The LaTeX Companion*, Addison-Wesley, Reading, Mass., 1997.
4. A. Gelman, J. B. Carlin, H. S. Stern, and D. B. Rubin, *Bayesian Data Analysis*, Chapman & Hall, London, 1995.
5. N. Metropolis, A. W. Rosenbluth, M. N. Rosenbluth, A. H. Teller, and E. Teller, "Equations of state calculations by fast computing machine," *J. Chem. Phys.* **21**, pp. 1087–1091, 1953.
6. S. F. Gull, "Developments in maximum-entropy data analysis," in *Maximum Entropy and Bayesian Methods*, J. Skilling, ed., pp. 53–71, Kluwer Academic, Dordrecht, 1989.
7. K. M. Hanson, "Introduction to Bayesian image analysis," in *Medical Imaging: Image Processing*, M. H. Loew, ed., *Proc. SPIE* **1898**, pp. 716–731, 1993.

Common formatting problems

- SPIE manuscripts often have the following formatting problems:
  - no added space between
    - title, authors list, and affiliations
    - before and after section headings
  - paragraphs not indented (or missing extra spacing)
  - wrong font sizes
  - *Abstract* is too long or consists of multiple paragraphs
  - not single spaced (1½ or double spacing used)
  - figures too small or poorly formatted

Technical presentations

Another form of technical communication

Technical presentations

- Scientists and engineers often need to give technical presentations
  - to explain/defend their work
  - in informal and formal settings

- Delivering a technical presentation is a skill
  - can be learned
  - improves with practice
  - benefits from many principles of technical writing

Technical presentations

- Many issues for technical presentations parallel those for writing
  - preparation – assemble material, decide where to present
  - organization – structure, logical development
  - visuals – graphs, images, photos
  - planning – purpose, audience, scope, logical development

Technical presentations

- Oral presentations differ from writing in following respects:
  - language less formal, more conversational
  - audience may interact with presenter;
  - you can ask questions of audience
    - helps keep them interested
    - see if they are following presentation
  - slides – provide organization, provide visuals (figures)
  - limit detail, information – strive for simplicity
    - purpose is to get across main point
  - presenter controls pace (not reader)
  - fixed time limit (usually)

- For further advice, see Robert Geroch's *Suggestions for giving talks* www.arxiv.org/pdf/gr-qc/9703019.pdf

Presentation organization

- Organization provides the basis for logical development
  - introduction
    - state purpose
    - provide background
  - body
    - develop the topic; what's new?
  - closing
    - state conclusion with conviction
    - suggest what to do next; provide motivation
- Transition is important to keep audience on track
  - provide transitions when your change topics – visually and verbally

Slides

- Slides should provide structure for your talk
  - avoid wordy text
  - use images and graphs to focus audience's attention
- Keep slides simple, uncluttered, and concise
  - no more than 4 or 5 main points per slide
  - use bullet for each major point; sub-bullets for additional information
  - use short punchy phrases; should read like a title, not a sentence
  - spelling and English usage should be correct (use spell checker!)
  - avoid numerous equations
    - instead, emphasize assumptions and logic
- Bear in mind that slides may be read at later time
  - will they be understandable?
  - make sure conclusion is clearly made

Slides

- Use slide-making software, e.g., Power Point, SliTeX, …
- Slides should be easy to read
  - font size should be no smaller than 18 pts.
    - serif fonts have enhanced features at end do stroke to help read them
      - this line is in 18-point Times Roman font (serif)
      - this line is in 18-point Arial font (sans serif)
        - » more legible than TR, but uses more space
  - no more than 10 – 12 lines per slide
  - graphs should be simple with thick lines and large lettering
  - rule of thumb:
    slide should be legible at arm's length printed on 8.5" ×11" paper

Slides – fonts legibility vs. space used

- Test to see which font is most legible – Times Roman
  - this line is written in 18-point font
    - this line is written in 14-point font **(14-point bold)**
      - » this line is written in 10-point font

- Test to see which font is most legible – Arial
  - this line is written in 18-point font
    - this line is written in 14 point font **(14 point bold)**
      - » this line is written in 10-point font

- Test to see which font is most legible – MS Ref. Serif
  - this line is written in 18-point font
    - this line is written in 14-point font **(14-point bold)**
      - » this line is written in 10-point font

- Test to see which font is most legible – Lucida Sans
  - this line is written in 18-point font
    - this line is written in 14-point font **(14-point bold)**
      - » this line is written in 10-point font

Presentation style

- Try to be relaxed and comfortable
  - relay on well-thought-out slides to give you confidence
  - write down outline of your talk beforehand
    - use these notes in case you need a cue
  - practice presentation beforehand on friends or colleagues
- Speak clearly and plainly
  - do not read from the slide word-for-word, nor from prepared text
  - use relaxed, extemporaneous style
  - modulate voice, avoid monotone
  - do not speak too fast
  - limit number of slides
    - allow 1 to 2 minutes per slide
    - depends on amount of detail you need to cover each slide

Presentation style

- Connect with audience
  - eye contact
  - pick several people to ‘talk to’
- Avoid mannerisms
  - verbal tics
    - for example, beginning each sentence with ‘so,’ ‘uh,’ ‘and’
  - fidgeting
  - ask colleagues or mentor to look for these or videotape yourself
- Dress appropriately
  - for formal presentation (e.g., conference), look professional
  - disheveled, unkempt appearance will put audience off
- **Do not go over your allotted time**

Thanks for your attention.
If you have any suggestions for improving this presentation, please let me know.

kmh@hansonhub.com