Writing and LaTeX Tips for academic writing in the AERO-CORE Lab

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Writing and LaTeX tips are presented to guide future document creation. Writing best practices are addressed, along with common writing errors to avoid. A summation of useful LaTeX functions is presented to reduce coding errors and increase writing efficiency. Finally a holistic suggestion for the writing process is reviewed. The first sentence in the abstract is the most important sentence in a document. The first sentence is what people will read first, and is what they will use to determine if the paper is relevant or worth reading. The first sentence should describe the overall purpose of the paper, or what was performed. The rest of the abstract acts as a condensed paper, discussing the high-level process and results.

Contents

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I. Nomenclature

The nomenclature should be laid out according to the journal/conference/thesis requirements. Common nomenclatures sections include: Abbreviations, Symbols, Greek Symbols, Roman Symbols, Subscripts, and Superscripts. Within each of these nomenclature sections, symbols are organized alphabetically. An example nomenclature is presented in this section, however, always refer to the formatting requirements of where a document is being submitted to.

Symbols

c_{mean} = mean aerodynamic chord, m

$\mathbf{F}_{\text{aero}}$ = aerodynamic force vector along the body axes, N

$\mathbf{F}_g$ = force of gravity vector, N

$\mathbf{F}_{\text{net}}$ = total force vector, N

$\mathbf{F}_T$ = force vector of engine thrust, N

Greek Symbols

α = angle of attack, rad

β = angle of sideslip, rad

$\delta_a, \delta_e, \delta_r$ = control surface deflections, rad

Subscripts

0 = nominal coefficient

II. Writing

Clear and concise writing is critical in science to convey research, making it a paramount skill to exercise. This section outlines advice, tips, and suggestions to consider when writing. The writing instruction provided is in no way conclusive, however, it is the author's hope that this document will be developed through time to ease students into the expectations of academic writing. Sources that go more in-depth on writing instruction include work by Nature Education [1], Springer [2], and AIAA [3].

A. Document Setup

The most important thing to consider before even beginning to write is *what are the expectations*. Every technical writing conference/journal/thesis will have a set of formatting requirements [3, 4]. Review these requirements **before** writing to save time re-formatting everything later. These organizational formatting requirements are the be-all-end-all to discussions about formatting, the document must align with the requirements.

1. Tense

Tense is a common simple mistake that is easily correctable by considering the intent of the information. Tense is determined by what the sentence is describing [1], common sentence types and their associated tense are presented in Table 1.

Loose tense guidance is also inferred from what section of a scientific report the sentence is in. General tense guidance based on typical scientific writing sections is presented in Table 2. Exceptions to Table 2 do exist, and as such this table should only be used as a guide. One such major exception is that the present tense is always used when a specific result, figure, table, or paper is the subject of a sentence (as demonstrated throughout this document).

2. Figures and Tables

Figures and tables are useful tools to present complex visual data, or relate two concepts graphically. General presentation norms and rules exist that apply to figures and tables. A couple of these shared norms are listed here:

- Figures and tables must always be introduced in-text before they are presented,

Table 1 How tense changes based on the intent of the sentence [1].

Sentence Describes	Tense
Work done Work reported Observations	Past
General truths Atemporal facts	Present
Perspectives	Future

Table 2 General tense usage in scientific writing sections [5].

Section	Tense
Abstract	Past
Introduction	Present
Literature Review	Past and Present
Methods	Past
Results	Past
Discussion	Past, Present, and Future
Conclusion	Past, Present, and Future

- Figures and tables should not have titles,
- Figure and table text should match document size and font,
- Captions should remain within the margins of the figure/table they describe,
- Captions should be sufficiently descriptive to know what the figure will contain without viewing it,
- Captions should end with a period (as they are a proper sentence).

Specific figure considerations include:

- Colour should be chosen in such a way that data will still be differentiable in greyscale,
- Gradient colour should start/end light/dark, not have white in the middle of the gradient as this could become confusing in greyscale, an example of gradients is presented in Fig. 1,
- Ideally, different data symbols should be utilized to ensure data is differentiable in greyscale,
- Colour choice should be considerate of colourblind people [6],
- Sub-figures require captions,
- Axes labels should be present and contain units,
- Axes should end on definitive numbers.

Examples of these aforementioned norms are presented in Fig. 1 and 2. How to create figures is discussed in Section III.D.

The significance of a figure/table should always be discussed just prior, or just after it is introduced. As per A. Ramirez-Serrano (personal communication, March 22, 2022), it is the author's responsibility to "digest" the figure information and clearly present the important elements to the reader.

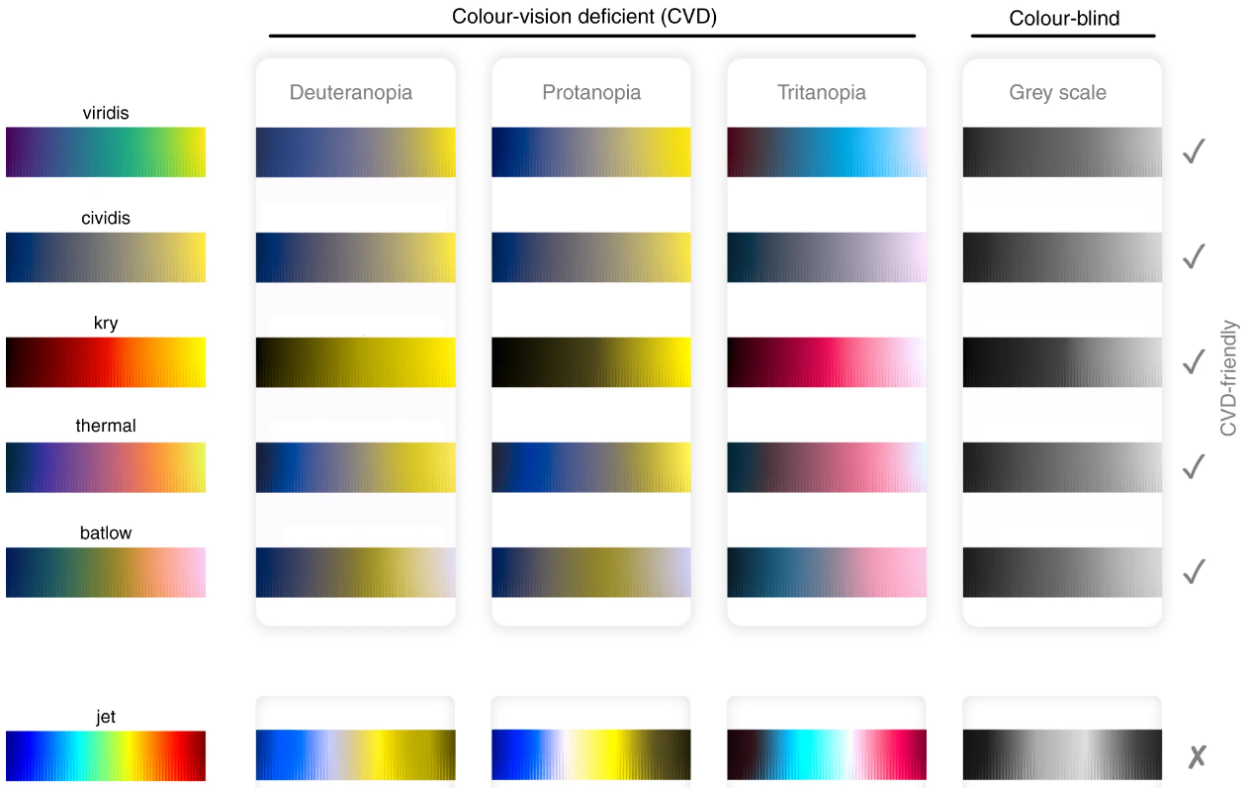


Fig. 1 How common gradients appear to various colourblind diagnoses, adapted from Crameri et al. [6].

3. Equations

Equations are similar to figures and tables in that they are addressed in-text prior to their presentation. Unless otherwise stated, the first time a variable is used in an equation it is presented in-text before or just after the equation. Exceptions to the rule do exist inline with formatting guidelines specific to the conference/journal/thesis being written. An example equation highlighting how aerodynamic forces are added is presented in Eq. 1,

$$F_{\text{net}} = F_{\text{aero}} + F_{\text{g}} + F_{\text{T}} \tag{1}$$

where F_{net}, F_{aero}, F_{g}, and F_{T} represent net force, aerodynamic force, gravitational force, and thrust force, respectively.

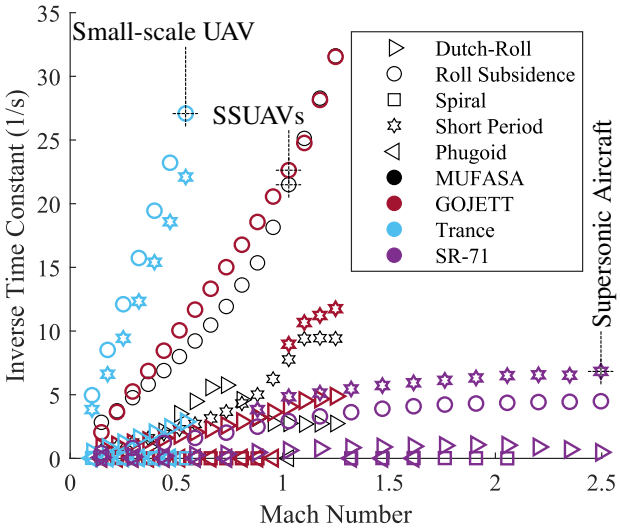


Fig. 2 MUFASA B aerodynamic design and coordinate system [7]. Notice how different symbols and colours are used. Also note how the ends of the x and y axes are denoted by a number and not left ambiguously floating.

B. General Writing

Common writing mistakes and misconceptions are presented in this section. It is the authors hope this list is useful (and error-free). Great writing resources are found online [3], and at the University of Calgary [8, 9]. The Student Success Centre [8] in particular is a great resource for 1-on-1 writing help and support, with extremely knowledgeable staff. It is strongly recommended to seek assistance **BEFORE** completing a document. By requesting feedback early, more time can be spent writing properly instead of editing what has already been written.

1. Sentence Structure

Conciseness is key in academic writing, readers "want to find the relevant information quickly and efficiently," [2]. Sentences should only contain **one idea**, and be no longer than 20-25 words in length [2].

2. Language

A conference/journal/thesis requires exact language be used. Using words such as *can*, *could*, and *would* make the document sound uncertain. This type of uncertain wording should only be used when discussing future work, which is always inherently uncertain. Do not write "*...this can be seen in Fig...,*", instead write "*...this is presented in Fig...*".

A word on the use of the word *this*. The word *this* should not start a sentence unless it is followed directly with an indication of what *this* is. A sentence should be a standalone idea, thus, without reiterating to the reader what *this* is, it is very easy for the reader to become confused. Parallel to this concept of the uncertainty of *this* is how authors

sometimes use *it* without explaining what *it* is they are referring to.

Word choice is paramount and matters. While often used interchangeably in normal language, *compute*, *evaluate*, and *calculate* suggest very different approaches were taken. Consider what verbs are being used throughout the document and what they imply.

3. Commas

Always use the Oxford comma when making a list. The Oxford comma helps the reader understand if the last two items in a list are together or separate.

Commas should also be used after transition words, such as "..., however,...".

C. Referencing

Referencing is a vital part of science, a way to track that all scientific statements are supported by evidence [10]. It is imperative that references are used properly and correctly associated to the factual information they are related to. As stated by Mertens and Baethge [10]:

> A reference citation is supposed to provide accurate underpinning for a statement and to represent the current state of research, or, in the case of a maverick opinion, to ensure it is recognizable as such. [10]

Some good rules of thumb to guide if you need to reference a statement are:

- Did you perform the task/experiment?
- If commenting about an industry trend, do you have years of first-hand experience in that industry?
- Is the statement common knowledge (ie. it is a first year taught engineering concept/fact)?
- Did you develop this equation, figure, diagram?
- Was the idea, method, statement learnt from another source (ie. a textbook or article)?

If the answer to any of the first four is no, or the last is yes, then you **NEED** a reference. If a reference cannot be found to support a statement, either the statement is incorrect, or it is too broad and should be reworded to be more defensible.

References are placed at the end of a sentence if describing a single idea, if describing multiple ideas, referencing is placed just behind the idea it is associated with. Proper referencing is also a topic formally covered by the Student Success Centre [8] and University of Calgary [9].

III. LaTeX Coding Best Practices

This section outlines some key coding functions that are extremely helpful when working with LaTeX. For readers new to LaTeX "LaTeX is a high-quality typesetting system; it includes features designed for the production of technical and scientific documentation," [11]. LaTeX is written via the use of an editing software. Common editing programs include OverLeaf for online usage, or MikTeX with TeXstudio for offline usage.

A. Document Setup

Long LaTeX documents become very confusing, very quickly if a proper file structure is not established. LaTeX uses one document to import required userpackages, set formats, and generate a .PDF document. It is suggested to use the main LaTeX document only for the global userpackages, and the calling of subsequent document files. Therefore, limited writing should occur within the main LaTeX file. Sections of a document should be individual files, added to the main file via the command `\input{}`. An example file structure, with LaTeX files in the main folder, and supporting photos and resources in sub-folders, is presented in Fig. 3.

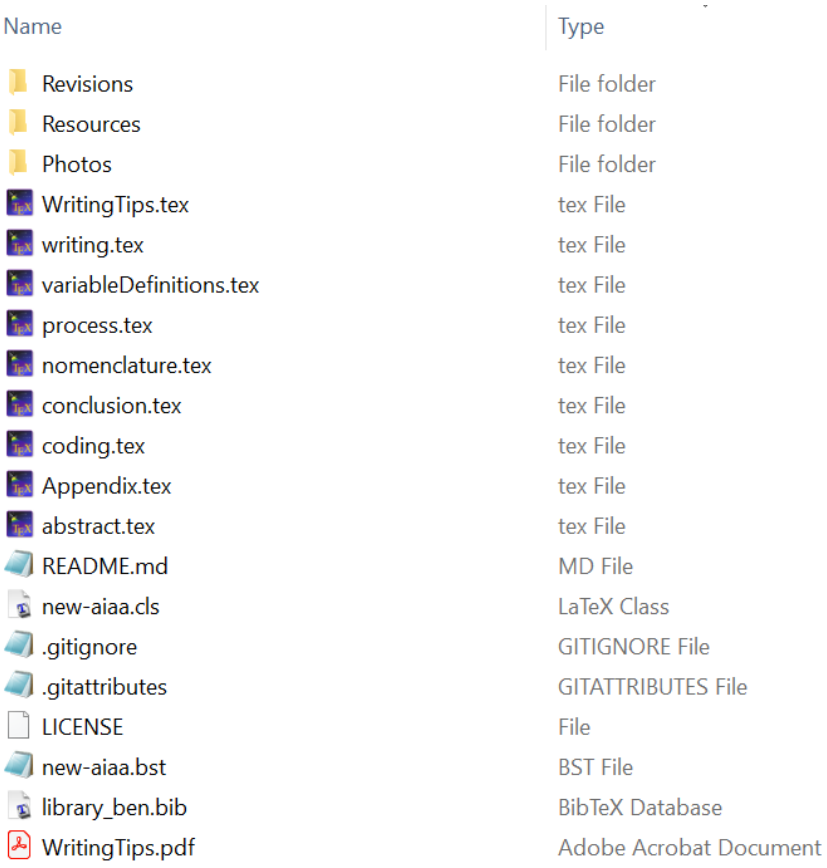


Fig. 3 Example file structure for a LaTeX document project.

In Fig. 3, the main LaTeX file is named *WritingTips.tex*. This main file then imports code written in the remaining .TEX files. File types ending with .CLS and .BST are files used to automatically format the main document. File types ending with .BIB is for the BibTeX bibliography entries.

B. Internal Document Referencing

LaTeX automatically handles referencing using its built-in `\ref{}` or the often preferred *cleveref* userpackage `\cref{}`. How referencing works is a `\label{}` is placed at a section title (`\label{sec:}`), in an equation

(`\label{eqn:}`), in a table (`\label{tab:}`), or in a figure (`\label{fig:}`). With a label in place, say in Fig. 4, the Cleveref is used to add a reference in text. For example, Fig. 4 is labelled *fig:mufasaB2*, so to reference it in-text the code is `\cref{fig:mufasaB2}`.

C. Citations

Always check the style and expected format of references for the journal/conference/university the paper will be submitted to. When citing, ensure the BibTEX file has all the required information to be displayed according to the journal/conference/university requirements. Unfortunately, the BibTEX data fields required vary slightly between referencing formats. It is suggested to be extra cognizant of how the references are appearing when switching between referencing styles. An example BibTEX entry for work by Durante [7] is provided in Section VI.A. Additional BibTEX entry formats are found online, with common types being `@article{}`, `@inproceedings{}`, `@techreport{}`, `@mastersthesis{}`, `@phdthesis{}`, `@book{}`, and `@misc{}`.

Based on the BibTEX identification name (ex. *BenThesis* in Section VI.A) references are easily cited in-text and added to the bibliography. Multiple commands are used to automatically cite a work depending on the presentation desired:

- `\cite{BenThesis}` cites the text numerically as follows: [7],
- `\citep{BenThesis}` acts very similarily to the previous command in IEEE and AIAA as follows: [7], however, this command behaves differently with the APA citation style,
- `\citeauthor{BenThesis}\cite{BenThesis}` automatically fills in the authors name and then adds the numerical reference, automatically linking both, as follows: Durante [7].

D. Figure Creation

Figures and diagrams should appear crisp, ideally they are vector files meaning they can be infinitely zoomed in without getting blurry. Examples of vector files include .PDF, .EPS, and .SVG. Diagram text should align with the document text exactly, as presented in Fig. 4. One way to ensure diagram text always matches the LATEX document text is by creating the diagrams in InkScape. The diagram creation video is outlined in the following YouTube video: `https://youtu.be/NbHKJNMsYqE?si=W-XXTR8T_Izss_j1`. Note, this YouTube example only works for InkScape Version 1.1. Figure 4 is generated using the source code presented in Section VI.B.

If it is not possible to use a vector file, a photo file such as .PNG is best. Attempt to avoid the use of .JPG files as the image displayed is more compressed and prone to blur.

If multiple related figures are presented than the LATEX *subfigure* command should be used. An example of a subfigure is presented in Fig. 5, with the associated source-code presented in Section VI.C.

Matching the formatting of plotted results to the LATEX document they will be presented in is critically important.

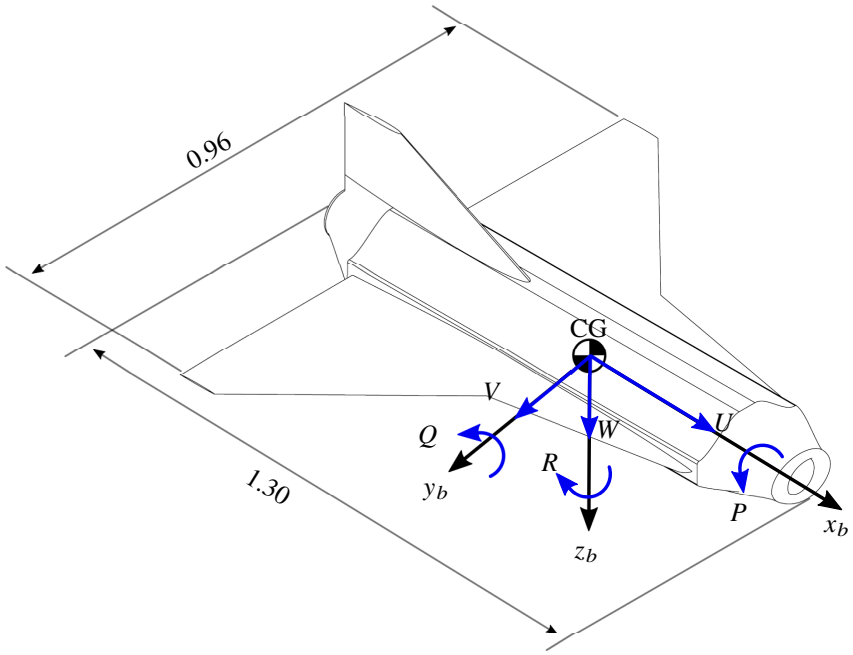
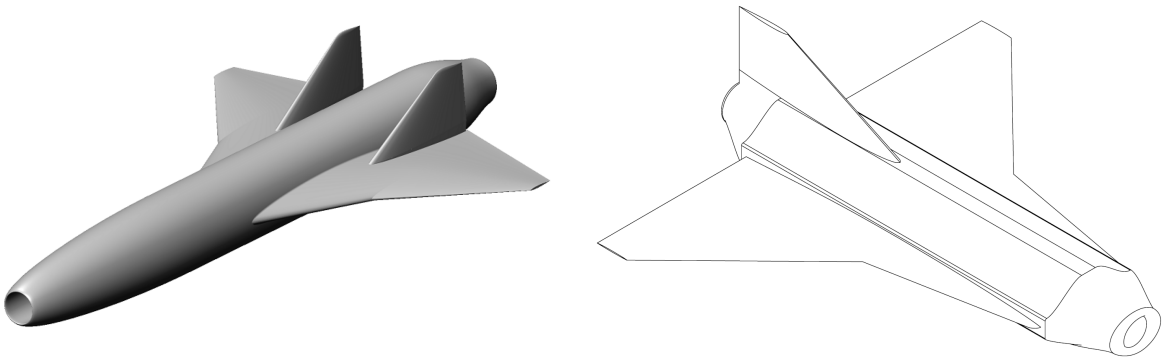


Fig. 4 MUFASA B aerodynamic design and coordinate system.



(a) MUFASA A.3, adapted from Gair [12].

(b) MUFASA B.1.

Fig. 5 MUFASA project aircraft versions (not to scale).

All rules provided in Section II.A.2, and exemplified in Fig. 2 should be followed. An example of MATLAB code used to auto-format plotted data for LaTeX is presented in Section VI.D. It is also worth noting that plotted data could be directly drawn in LaTeX using LaTeX code, however this workflow requires first generating the plotted data in Python according to A. Garcia (personal communication, December 05, 2023).

E. Table Creation

Useful LaTeX commands to generate tables meeting the requirements outlined in Section II.A.2 are presented in this section. A useful userpackage to generate tables with correct caption widths is *threeparttable*. To generate correct

thickness horizontal lines, the commands `\toprule`, `\midrule`, and `\bottomrule` are used. Manually typing table formatting is complex, and it is instead recommended to use a formatting tool, such as the TablesGenerator website. As an example, the code used to generate Table 2 is presented in Section VI.E.

F. Equations

When coding an equation, carefully consider what is a variable and what is a label. Variables should be in math text, while labels should be in regular text. For example, in Eq. 1, F_{net} is net force, not force as a function of variables $n \times e \times t$. Regular text can be inserted into an equation via the `\text{}` command.

Sometimes equations are exceptionally long, or a matrix is too tall. Some commands that aid with unwieldy equations include *smallmatrix*, *sideways*, *align*, and *split*. An example of how to split a long equation is presented in Section VI.F.

LaTeX allows for the creation of multiple unique mathematical symbols. A comprehensive overview of possible LaTeX symbols, and their associated commands, is presented in Section VI.G.

G. Custom Variable Creation

Local LaTeX document variables are a way to aid in typing repetitive words or numerical values. These custom variables also aid in document consistency when referring to repeated words or values. An example of using locally defined document variables is creating a command to represent the word *ArduPilot*. Due to the letters in *ArduPilot*, it is an awkward word to type and a coding shorthand is created using the command: `\newcommand{\ap}{ArduPilot}`. Now, by typing `\ap\`, the word ArduPilot is seamlessly inserted into the text. Note that the `\` following the `\ap` indicates a space should be left following the word ArduPilot.

LaTeX variables also work when inserted into InkScape generated figures, as outlined in the following YouTube video: `https://youtu.be/r0G44lxhTwc?si=SVSKCUj6mTy4rGCN`. Using variables in a diagram increases writing efficiency as it reduces the need to manually regenerate diagrams to change a variable when using the workflow presented in Section III.D.

IV. Process

A. Backups

Backing-up a document should be a priority, not an afterthought. Rewriting a paragraph is unfortunate, rewriting an entire thesis would be soul crushing. Multiple backup methods exist such as OneDrive, DropBox, GitHub, OverLeaf, or physical local backups, to name a few. While one is good, it is suggested to use multiple backup methods should a device or service become unexpectedly unavailable. This backup method also applies to data, always ensure data is backed-up.

B. Revision Control

Revision control refers to the process of tracking changes to a document, or structured information. When writing, revision control takes two forms, iterative and milestone revision control.

Iterative revision control refers to tracking the small changes a document naturally undergoes. Maybe a paragraph was removed in error, instead of rewriting, proper revision control should allow the document to be rolled back to a state where that paragraph exists. A very powerful program for this type of revision control is GitHub, which integrates with both physical machines and OverLeaf.

Milestone revision control refers to when a document is in a state to be reviewed. As indicated by C. Johansen (personal communication, May 25, 2023), revisions should be denoted sequentially following R1, R2, R3. Documents with feedback will have the reviewer's initials appended to the filename. An example document filename on revision three that was reviewed by C. Johansen would appear as: `AIAA_Scitech2024_Abstract_RocketTests_Smith_R3_CJ.pdf`.

V. Conclusion

Clear and concise writing is a skill that requires it be a forethought, not an afterthought. Understanding the writing process reduces frustrations and increases writing efficiency. Document expectations should be considered prior to beginning, feedback should be sought early on, and writing best practices should be implemented throughout. LaTeX is a powerful tool to aid in final formatting, with multiple userpackages that exist. By combining all the topics presented in this document, it is the author's hope that the reader's documents will be more enjoyable to write, and easier to review.

Acknowledgments

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References

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[11] The LaTeX Project, "LaTeX – A document preparation system," Retrieved from: https://www.latex-project.org/, 2023.

[12] Gair, S. R., "Manufacture, Refinement and Low-Speed Flight Testing of a Small-Scale, High-Speed Uncrewed Aerial Vehicle," [Master's thesis, University of Calgary], 2023. Avaliable: https://dx.doi.org/10.11575/PRISM/41705.

[13] Heinkenschloss, M., "LaTeX Mathematical Symbols," Technical report, Rice University, 2016.

VI. Appendix

A. BibTeX Format

An example BibTeX entry for work by Durante [7]. Note, this BibTeX reference has been formatted with data entries for the AIAA reference format.

```
@mastersthesis{BenThesis,
author = {Durante, Benjamin Joseph},
pages = {1--128},
school = {University of Calgary]},
title = {Flying and Handling Qualities of Small-Scale Supersonic Uncrewed Aerial Vehicles},
note = {{Avaliable: \url{https://dx.doi.org/10.11575/PRISM/40789}}},
type = {{[Master's} Thesis},
year = {2023}
}
```

B. Figures in LaTeX

Figure 4 is generated using the following source code:

```
\begin{figure}[hbt!]
\centering
\captionsetup{width=0.7\textwidth}
%\includegraphics[width=0.7\textwidth]{Photos/MUFASA/MUFASA-ISO-Frames-BodyLength.png}
\def\svgwidth{0.7\textwidth}
\input{Photos/MUFASA/MUFASA-ISO-Frames-BodyLength.eps_tex}
\caption{MUFASA B aerodynamic design and coordinate system.}
%\caption[Short caption for list of figures]{This is the full caption that will appear
under the figure.}
\label{fig:mufasaB2}
\hfill
\end{figure}
```

C. Sub-Figures in LaTeX

Figure 5 is generated using the following source code:

```
\begin{figure}[hbt!]
\centering
\begin{subfigure}{0.48\textwidth}
\centering
\captionsetup{width=0.95\linewidth}
\includegraphics[width=0.95\linewidth]{Photos/Aircraft/MUFASA_Gair}
\caption{MUFASA A.3, adapted from \citeauthor{ShaunThesis} \cite{ShaunThesis}.}
\end{subfigure}
\begin{subfigure}{0.48\textwidth}
\centering
\captionsetup{width=0.95\linewidth}
\includegraphics[width=0.95\linewidth]{Photos/Aircraft/MUFASA_ISO}
\caption{MUFASA B.1.}
\end{subfigure}
\caption{MUFASA project aircraft versions (not to scale). \label{fig:aircraftComparison}}
```

```
\end{figure}
```

D. MATLAB Figure Saving

The following MATLAB code automatically saves generated figures. The code adjusts the figure text and size, and saves each figure into three file types (.png, .eps, and .svg). The code requires that each figure generated has a unique figure name. The figure name from MATLAB is used as the filename, and is extremely useful once multiple result figures are displayed in one document. [13]

```
function SaveGeneratedFigures(FolderName,SaveStuff)
%SaveGeneratedFigures Saves open figures
%   Saves stuff

if SaveStuff == true
    % Acquires list of all open figures
    FigList = findobj(allchild(0), 'flat', 'Type', 'figure');
    % Goes through and saves one by one
    for iFig = 1:length(FigList)
        % Setup height plotting options
        height.NumericalList = [4,3.6,3.5,3.25,3.25];
        height.WrittenList = {'','-Short','','-2column','-Short-Narrow'};
        % The final width entry is denoted above by "-Short-Narrow"
        width.NumericalList = [6.5,6.5,6,4.4,3.25];
        width.WrittenList = {'','','Presentation-','',''};
        % Determining the name of the current figure
        FigHandle = FigList(iFig);
        FigName   = get(FigHandle, 'Name');
        % Hide title, if there is one
        title('')
        for heightOptionsindex = 1:length(height.NumericalList)
            % Set the font values
            if strcmp(width.WrittenList(heightOptionsindex),'Presentation-')
                % Set the font values for presentations
                fontInfo.font = 'calibri';
                fontInfo.size = 12;
```

```
            else
                % Set the font values for documents
                fontInfo.font = 'times';
                fontInfo.size = 10;
                % Font size AIAA = 10
                % Font size Thesis = 11
            end
            FormatPictures(height.NumericalList(heightOptionsindex),width.
                NumericalList(heightOptionsindex),fontInfo) % Formats each
                figure a certain height in inches
            FigNamePrinted = [width.WrittenList{heightOptionsindex} FigName(
                find(~isspace(FigName))) height.WrittenList{heightOptionsindex
                }];
            % Saves the figures as 3 formats png for viewing, svg for
            % presentations and eps colour for LaTeX
            saveas(FigHandle,fullfile(FolderName, FigNamePrinted),'png')
            saveas(FigHandle,fullfile(FolderName, FigNamePrinted),'epsc')
            saveas(FigHandle,fullfile(FolderName, FigNamePrinted),'svg')
            %savefig(FigHandle, fullfile(FolderName, FigName, '.fig'));
        end
        close(FigHandle)
    end
    close all
end
end

function [] = FormatPictures(Height,Width,fontInfo)
%FormatPictures Format Figures for printing into a thesis
%   Format figures for printing in a thesis


```

```
% Look for all axes in a figure
AllAxes = findobj( get(gcf,'Children'), '-depth', 1, 'type', 'axes');

% Maintains the y-axis (basically stops the y-axis from being recomputed
% automatically and screwing up the relationship plots
set(AllAxes,'ylimmode','manual')

% Set font to times and size to Thesis format of 11
set(AllAxes,'fontname',fontInfo.font,'fontsize',fontInfo.size)
% Replaced gca (ie. current axis) with something to look for all axes

% Set figure size to paper width
set(gcf, 'Units', 'Inches', 'Position', [0, 0, Width, Height], 'PaperUnits', '
    Inches', 'PaperSize', [Width, Height])
end
```

E. Tables in LaTeX

Table 2 is generated using the following source code:

```
\begin{table}[hbt!]
\centering
\begin{threeparttable}[b]
\caption{General tense usage in scientific writing sections \cite{tenseScientificWriting}.}
\label{tab:tenseBasedOnSection}
\begin{tabular}{cc}
\toprule
\textbf{Section} & \textbf{Tense} \\ \midrule
Abstract & Past \\
Introduction & Present \\
Literature Review & Past and Present \\
Methods & Past \\
Results & Past \\
Discussion & Past and Present, and Future \\
```

```
Conclusion & Past, Present, and Future \\ \bottomrule
\end{tabular}
\end{threeparttable}
\end{table}
```

F. Long Equations in LaTeX

Splitting a long equation, as presented in Eq. 2 from Durante [7], is achieved via the code in this section:

```
\begin{align}
\begin{split}
\begin{bmatrix}
\dot{P} \\
\dot{Q} \\
\dot{R}
\end{bmatrix} &=
\begin{bmatrix}
I_{\textup{xx}} & 0 & I_{\textup{xz}} \\
0 & I_{\textup{yy}} & 0 \\
I_{\textup{xz}} & 0 & I_{\textup{zz}}
\end{bmatrix}^{-1}
\left(
\left( \left( k_{0} + k_{1} V_{a}^{-2} \right) \delta_{T} S \rho V_{a}^{2} \frac{1}{2}
\begin{bmatrix}
1 \\ 0 \\ 0
\end{bmatrix} \times \left( \bar{r}_{\text{EC}} - \bar{r}_{\text{CG}}\right) +
\bar{M}_{\textup{aero}} \right) \right. \\
& \qquad \left. -
\begin{bmatrix}
0 & -R & Q \\
R & 0 & -P \\
-Q & P & 0
\end{bmatrix}
\begin{bmatrix}
I_{\textup{xx}} & 0 & I_{\textup{xz}} \\
```

```
0 & I_{\textup{yy}} & 0 \\
I_{\textup{xz}} & 0 & I_{\textup{zz}}
\end{bmatrix}
\begin{bmatrix}
P \\
Q \\
R
\end{bmatrix}
\right)
\end{split} \label{eqn:dotAngularRateStateExpandedComplete}
\end{align}
```

$$\begin{bmatrix} \dot{P} \\ \dot{Q} \\ \dot{R} \end{bmatrix} = \begin{bmatrix} I_{\text{xx}} & 0 & I_{\text{xz}} \\ 0 & I_{\text{yy}} & 0 \\ I_{\text{xz}} & 0 & I_{\text{zz}} \end{bmatrix}^{-1} \left(\left(\begin{pmatrix} \left(k_0 + k_1 V_a^{-2}\right) \delta_T S \rho V_a^2 \frac{1}{2} \begin{bmatrix} 1 \\ 0 \\ 0 \end{bmatrix} \times (\bar{r}_{\text{EC}} - \bar{r}_{\text{CG}}) + \bar{M}_{\text{aero}} \end{pmatrix} \right. \right. \\ \left. \left. - \begin{bmatrix} 0 & -R & Q \\ R & 0 & -P \\ -Q & P & 0 \end{bmatrix} \begin{bmatrix} I_{\text{xx}} & 0 & I_{\text{xz}} \\ 0 & I_{\text{yy}} & 0 \\ I_{\text{xz}} & 0 & I_{\text{zz}} \end{bmatrix} \begin{bmatrix} P \\ Q \\ R \end{bmatrix} \right) \right. \tag{2}$$

G. LaTeX Commands

This section covers common LaTeX commands, reproducing a document created by Heinkenschloss [13].

LaTeX Mathematical Symbols

The more unusual symbols are not defined in base LaTeX (NFSS) and require `\usepackage{amssymb}`

1 Greek and Hebrew letters

α	\alpha	κ	\kappa	ψ	\psi	F	\digamma	Δ	\Delta	Θ	\Theta
β	\beta	λ	\lambda	ρ	\rho	ε	\varepsilon	Γ	\Gamma	Υ	\Upsilon
χ	\chi	μ	\mu	σ	\sigma	$\varkappa$	\varkappa	Λ	\Lambda	Ξ	\Xi
δ	\delta	ν	\nu	τ	\tau	φ	\varphi	Ω	\Omega		
ϵ	\epsilon	o	o	θ	\theta	ϖ	\varpi	Φ	\Phi	$\aleph$	\aleph
η	\eta	ω	\omega	υ	\upsilon	ϱ	\varrho	Π	\Pi	$\beth$	\beth
γ	\gamma	ϕ	\phi	ξ	\xi	ς	\varsigma	Ψ	\Psi	$\daleth$	\daleth
ι	\iota	π	\pi	ζ	\zeta	ϑ	\vartheta	Σ	\Sigma	$\gimel$	\gimel

2 LaTeX math constructs

$\frac{abc}{xyz}$	\frac{abc}{xyz}	$\overline{abc}$	\overline{abc}	$\overrightarrow{abc}$	\overrightarrow{abc}
f'	f'	$\underline{abc}$	\underline{abc}	$\overleftarrow{abc}$	\overleftarrow{abc}
$\sqrt{abc}$	\sqrt{abc}	$\widehat{abc}$	\widehat{abc}	$\overbrace{abc}$	\overbrace{abc}
$\sqrt[n]{abc}$	\sqrt[n]{abc}	$\widetilde{abc}$	\widetilde{abc}	$\underbrace{abc}$	\underbrace{abc}

3 Delimiters

$\vert$	\vert	$\{$	\{	$\lfloor$	\lfloor	/	/	$\Uparrow$	\Uparrow	$\llcorner$	\llcorner
$\vert$	\vert	$\}$	\}	$\rfloor$	\rfloor	$\backslash$	\backslash	$\uparrow$	\uparrow	$\lrcorner$	\lrcorner
$\Vert$	\Vert	$\langle$	\langle	$\lceil$	\lceil	[	[	$\Downarrow$	\Downarrow	$\ulcorner$	\ulcorner
$\Vert$	\Vert	$\rangle$	\rangle	$\rceil$	\rceil	]	]	$\downarrow$	\downarrow	$\urcorner$	\urcorner

Use the pair `\left`s_1 and `\right`s_2 to match height of delimiters s_1 and s_2 to the height of their contents, e.g., `\left|` *expr* `\right|` $\left|\ expr\ \right|$ `\left\{` *expr* `\right\}` $\left\{\ expr\ \right\}$ `\left\Vert` *expr* `\right.` $\left\Vert\ expr\ \right.$

4 Variable-sized symbols (displayed formulae show larger version)

$\sum$	\sum	$\int$	\int	$\biguplus$	\biguplus	$\bigoplus$	\bigoplus	$\bigvee$	\bigvee
$\prod$	\prod	$\oint$	\oint	$\bigcap$	\bigcap	$\bigotimes$	\bigotimes	$\bigwedge$	\bigwedge
$\coprod$	\coprod	$\iint$	\iint	$\bigcup$	\bigcup	$\bigodot$	\bigodot	$\bigsqcup$	\bigsqcup

5 Standard Function Names

Function names should appear in Roman, not Italic, e.g.,

Correct: `\tan(at-n\pi)` $\longrightarrow \tan(at - n\pi)$
Incorrect: `tan(at-n\pi)` $\longrightarrow tan(at - n\pi)$

arccos	\arccos	arcsin	\arcsin	arctan	\arctan	arg	\arg
cos	\cos	cosh	\cosh	cot	\cot	coth	\coth
csc	\csc	deg	\deg	det	\det	dim	\dim
exp	\exp	gcd	\gcd	hom	\hom	inf	\inf
ker	\ker	lg	\lg	lim	\lim	lim inf	\liminf
lim sup	\limsup	ln	\ln	log	\log	max	\max
min	\min	Pr	\Pr	sec	\sec	sin	\sin
sinh	\sinh	sup	\sup	tan	\tan	tanh	\tanh

6 Binary Operation/Relation Symbols

$*$	\ast	$\pm$	\pm	$\cap$	\cap	$\lhd$	\lhd
$\star$	\star	$\mp$	\mp	$\cup$	\cup	$\rhd$	\rhd
$\cdot$	\cdot	$\amalg$	\amalg	$\uplus$	\uplus	$\triangleleft$	\triangleleft
$\circ$	\circ	$\odot$	\odot	$\sqcap$	\sqcap	$\triangleright$	\triangleright
$\bullet$	\bullet	$\ominus$	\ominus	$\sqcup$	\sqcup	$\unlhd$	\unlhd
$\bigcirc$	\bigcirc	$\oplus$	\oplus	$\wedge$	\wedge	$\unrhd$	\unrhd
$\diamond$	\diamond	$\oslash$	\oslash	$\vee$	\vee	$\bigtriangledown$	\bigtriangledown
$\times$	\times	$\otimes$	\otimes	$\dagger$	\dagger	$\bigtriangleup$	\bigtriangleup
$\div$	\div	$\wr$	\wr	$\ddagger$	\ddagger	$\setminus$	\setminus
$\cdot$	\centerdot	$\Box$	\Box	$\barwedge$	\barwedge	$\veebar$	\veebar
$\circledast$	\circledast	$\boxplus$	\boxplus	$\curlywedge$	\curlywedge	$\curlyvee$	\curlyvee
$\circledcirc$	\circledcirc	$\boxminus$	\boxminus	$\Cap$	\Cap	$\Cup$	\Cup
$\circleddash$	\circleddash	$\boxtimes$	\boxtimes	$\bot$	\bot	$\top$	\top
$\dotplus$	\dotplus	$\boxdot$	\boxdot	$\intercal$	\intercal	$\rightthreetimes$	\rightthreetimes
$\divideontimes$	\divideontimes	$\square$	\square	$\doublebarwedge$	\doublebarwedge	$\leftthreetimes$	\leftthreetimes

$\equiv$	\equiv	$\leq$	\leq	$\geq$	\geq	$\perp$	\perp
$\cong$	\cong	$\prec$	\prec	$\succ$	\succ	$\mid$	\mid
$\neq$	\neq	$\preceq$	\preceq	$\succeq$	\succeq	$\parallel$	\parallel
$\sim$	\sim	$\ll$	\ll	$\gg$	\gg	$\bowtie$	\bowtie
$\simeq$	\simeq	$\subset$	\subset	$\supset$	\supset	$\Join$	\Join
$\approx$	\approx	$\subseteq$	\subseteq	$\supseteq$	\supseteq	$\ltimes$	\ltimes
$\asymp$	\asymp	$\sqsubset$	\sqsubset	$\sqsupset$	\sqsupset	$\rtimes$	\rtimes
$\doteq$	\doteq	$\sqsubseteq$	\sqsubseteq	$\sqsupseteq$	\sqsupseteq	$\smile$	\smile
$\propto$	\propto	$\dashv$	\dashv	$\vdash$	\vdash	$\frown$	\frown
$\models$	\models	$\in$	\in	$\ni$	\ni	$\notin$	\notin

$\approxeq$	\approxeq	$\leqq$	\leqq	$\geqq$	\geqq	$\lessgtr$	\lessgtr
$\sim$	\thicksim	$\leqslant$	\leqslant	$\geqslant$	\geqslant	$\lesseqgtr$	\lesseqgtr
$\backsim$	\backsim	$\lessapprox$	\lessapprox	$\gtrapprox$	\gtrapprox	$\lesseqqgtr$	\lesseqqgtr
$\backsimeq$	\backsimeq	$\lll$	\lll	$\ggg$	\ggg	$\gtreqqless$	\gtreqqless
$\triangleq$	\triangleq	$\lessdot$	\lessdot	$\gtrdot$	\gtrdot	$\gtreqless$	\gtreqless
$\circeq$	\circeq	$\lesssim$	\lesssim	$\gtrsim$	\gtrsim	$\gtrless$	\gtrless
$\bumpeq$	\bumpeq	$\eqslantless$	\eqslantless	$\eqslantgtr$	\eqslantgtr	$\backepsilon$	\backepsilon
$\Bumpeq$	\Bumpeq	$\precsim$	\precsim	$\succsim$	\succsim	$\between$	\between
$\doteqdot$	\doteqdot	$\precapprox$	\precapprox	$\succapprox$	\succapprox	$\pitchfork$	\pitchfork
$\thickapprox$	\thickapprox	$\Subset$	\Subset	$\Supset$	\Supset	$\shortmid$	\shortmid
$\fallingdotseq$	\fallingdotseq	$\subseteqq$	\subseteqq	$\supseteqq$	\supseteqq	$\smallfrown$	\smallfrown
$\risingdotseq$	\risingdotseq	$\sqsubset$	\sqsubset	$\sqsupset$	\sqsupset	$\smallsmile$	\smallsmile
$\varpropto$	\varpropto	$\preccurlyeq$	\preccurlyeq	$\succcurlyeq$	\succcurlyeq	$\Vdash$	\Vdash
$\therefore$	\therefore	$\curlyeqprec$	\curlyeqprec	$\curlyeqsucc$	\curlyeqsucc	$\vDash$	\vDash
$\because$	\because	$\blacktriangleleft$	\blacktriangleleft	$\blacktriangleright$	\blacktriangleright	$\Vvdash$	\Vvdash
$\eqcirc$	\eqcirc	$\trianglelefteq$	\trianglelefteq	$\trianglerighteq$	\trianglerighteq	$\shortparallel$	\shortparallel
$\neq$	\neq	$\vartriangleleft$	\vartriangleleft	$\vartriangleright$	\vartriangleright	$\nshortparallel$	\nshortparallel

$\ncong$	\ncong	$\nleq$	\nleq	$\ngeq$	\ngeq	$\nsubseteq$	\nsubseteq
$\nmid$	\nmid	$\nleqq$	\nleqq	$\ngeqq$	\ngeqq	$\nsupseteq$	\nsupseteq
$\nparallel$	\nparallel	$\nleqslant$	\nleqslant	$\ngeqslant$	\ngeqslant	$\nsubseteqq$	\nsubseteqq
$\nshortmid$	\nshortmid	$\nless$	\nless	$\ngtr$	\ngtr	$\nsupseteqq$	\nsupseteqq
$\nshortparallel$	\nshortparallel	$\nprec$	\nprec	$\nsucc$	\nsucc	$\subsetneq$	\subsetneq
$\nsim$	\nsim	$\npreceq$	\npreceq	$\nsucceq$	\nsucceq	$\supsetneq$	\supsetneq
$\nVDash$	\nVDash	$\precnapprox$	\precnapprox	$\succnapprox$	\succnapprox	$\subsetneqq$	\subsetneqq
$\nvDash$	\nvDash	$\precnsim$	\precnsim	$\succnsim$	\succnsim	$\supsetneqq$	\supsetneqq
$\nvdash$	\nvdash	$\lnapprox$	\lnapprox	$\gnapprox$	\gnapprox	$\varsubsetneq$	\varsubsetneq
$\ntriangleleft$	\ntriangleleft	$\lneq$	\lneq	$\gneq$	\gneq	$\varsupsetneq$	\varsupsetneq
$\ntrianglelefteq$	\ntrianglelefteq	$\lneqq$	\lneqq	$\gneqq$	\gneqq	$\varsubsetneqq$	\varsubsetneqq
$\ntriangleright$	\ntriangleright	$\lnsim$	\lnsim	$\gnsim$	\gnsim	$\varsupsetneqq$	\varsupsetneqq
$\ntrianglerighteq$	\ntrianglerighteq	$\lvertneqq$	\lvertneqq	$\gvertneqq$	\gvertneqq		

7 Arrow symbols

$\leftarrow$	\leftarrow	$\longleftarrow$	\longleftarrow	$\uparrow$	\uparrow
$\Leftarrow$	\Leftarrow	$\Longleftarrow$	\Longleftarrow	$\Uparrow$	\Uparrow
$\rightarrow$	\rightarrow	$\longrightarrow$	\longrightarrow	$\downarrow$	\downarrow
$\Rightarrow$	\Rightarrow	$\Longrightarrow$	\Longrightarrow	$\Downarrow$	\Downarrow
$\leftrightarrow$	\leftrightarrow	$\longleftrightarrow$	\longleftrightarrow	$\updownarrow$	\updownarrow
$\Leftrightarrow$	\Leftrightarrow	$\Longleftrightarrow$	\Longleftrightarrow	$\Updownarrow$	\Updownarrow
$\mapsto$	\mapsto	$\longmapsto$	\longmapsto	$\nearrow$	\nearrow
$\hookleftarrow$	\hookleftarrow	$\hookrightarrow$	\hookrightarrow	$\searrow$	\searrow
$\leftharpoonup$	\leftharpoonup	$\rightharpoonup$	\rightharpoonup	$\swarrow$	\swarrow
$\leftharpoondown$	\leftharpoondown	$\rightharpoondown$	\rightharpoondown	$\nwarrow$	\nwarrow
$\rightleftharpoons$	\rightleftharpoons	$\leadsto$	\leadsto		
$\dashrightarrow$	\dashrightarrow	$\dashleftarrow$	\dashleftarrow	$\leftleftarrows$	\leftleftarrows
$\leftrightarrows$	\leftrightarrows	$\Lleftarrow$	\Lleftarrow	$\twoheadleftarrow$	\twoheadleftarrow
$\leftarrowtail$	\leftarrowtail	$\looparrowleft$	\looparrowleft	$\leftrightharpoons$	\leftrightharpoons
$\curvearrowleft$	\curvearrowleft	$\circlearrowleft$	\circlearrowleft	$\Lsh$	\Lsh
$\upuparrows$	\upuparrows	$\upharpoonleft$	\upharpoonleft	$\downharpoonleft$	\downharpoonleft
$\multimap$	\multimap	$\leftrightsquigarrow$	\leftrightsquigarrow	$\rightrightarrows$	\rightrightarrows
$\rightleftarrows$	\rightleftarrows	$\rightrightarrows$	\rightrightarrows	$\rightleftarrows$	\rightleftarrows
$\twoheadrightarrow$	\twoheadrightarrow	$\rightarrowtail$	\rightarrowtail	$\looparrowright$	\looparrowright
$\rightleftharpoons$	\rightleftharpoons	$\curvearrowright$	\curvearrowright	$\circlearrowright$	\circlearrowright
$\Rsh$	\Rsh	$\downdownarrows$	\downdownarrows	$\upharpoonright$	\upharpoonright
$\downharpoonright$	\downharpoonright	$\rightsquigarrow$	\rightsquigarrow		
$\nleftarrow$	\nleftarrow	$\nrightarrow$	\nrightarrow	$\nLeftarrow$	\nLeftarrow
$\nRightarrow$	\nRightarrow	$\nleftrightarrow$	\nleftrightarrow	$\nLeftrightarrow$	\nLeftrightarrow

8 Miscellaneous symbols

∞	\infty	$\forall$	\forall	$\Bbbk$	\Bbbk	$\wp$	\wp
∇	\nabla	$\exists$	\exists	$\bigstar$	\bigstar	$\angle$	\angle
∂	\partial	$\nexists$	\nexists	$\diagdown$	\diagdown	$\measuredangle$	\measuredangle
$\eth$	\eth	$\emptyset$	\emptyset	$\diagup$	\diagup	$\sphericalangle$	\sphericalangle
$\clubsuit$	\clubsuit	$\varnothing$	\varnothing	$\Diamond$	\Diamond	$\complement$	\complement
$\diamondsuit$	\diamondsuit	$\imath$	\imath	$\Finv$	\Finv	$\triangledown$	\triangledown
$\heartsuit$	\heartsuit	$\jmath$	\jmath	$\Game$	\Game	$\triangle$	\triangle
$\spadesuit$	\spadesuit	ℓ	\ell	$\hbar$	\hbar	$\vartriangle$	\vartriangle
$\cdots$	\cdots	$\iiiint$	\iiiint	$\hslash$	\hslash	$\blacklozenge$	\blacklozenge
$\vdots$	\vdots	$\iiint$	\iiint	$\lozenge$	\lozenge	$\blacksquare$	\blacksquare
$\ldots$	\ldots	$\iint$	\iint	$\mho$	\mho	$\blacktriangle$	\blacktriangle
$\ddots$	\ddots	$\sharp$	\sharp	$\prime$	\prime	$\blacktriangledown$	\blacktriangledown
$\Im$	\Im	$\flat$	\flat	$\square$	\square	$\backprime$	\backprime
$\Re$	\Re	$\natural$	\natural	$\surd$	\surd	$\circledS$	\circledS

9 Math mode accents

$\acute{a}$	\acute{a}	$\bar{a}$	\bar{a}	$\acute{\acute{A}}$	\Acute{\Acute{A}}	$\bar{\bar{A}}$	\Bar{\Bar{A}}
$\breve{a}$	\breve{a}	$\check{a}$	\check{a}	$\breve{\breve{A}}$	\Breve{\Breve{A}}	$\check{\check{A}}$	\Check{\Check{A}}
$\ddot{a}$	\ddot{a}	$\dot{a}$	\dot{a}	$\ddot{\ddot{A}}$	\Ddot{\Ddot{A}}	$\dot{\dot{A}}$	\Dot{\Dot{A}}
$\grave{a}$	\grave{a}	$\hat{a}$	\hat{a}	$\grave{\grave{A}}$	\Grave{\Grave{A}}	$\hat{\hat{A}}$	\Hat{\Hat{A}}
$\tilde{a}$	\tilde{a}	$\vec{a}$	\vec{a}	$\tilde{\tilde{A}}$	\Tilde{\Tilde{A}}	$\vec{\vec{A}}$	\Vec{\Vec{A}}

10 Array environment, examples

Simplest version: `\begin{array}{`*cols*`}` *row*$_1$ `\\` *row*$_2$ `\\` $\ldots$ *row*$_m$ `\end{array}`
where *cols* includes one character [`lrc`] for each column (with optional characters `|` inserted for vertical lines) and *row*$_j$ includes character `&` a total of $(n-1)$ times to separate the n elements in the row. Examples:

```
\left( \begin{array}{cc} 2\tau & 7\phi-frac5{12} \\
          3\psi & \frac{\pi}8 \end{array} \right)
\left( \begin{array}{c} x \\ y \end{array} \right)
\mbox{~and~} \left[ \begin{array}{cc|r}
     3 & 4 & 5 \\ 1 & 3 & 729 \end{array} \right]
```

$$\left(\begin{array}{cc} 2\tau & 7\phi-\frac{5}{12} \\ 3\psi & \frac{\pi}{8} \end{array} \right) \left(\begin{array}{c} x \\ y \end{array} \right) \text{ and } \left[\begin{array}{cc|r} 3 & 4 & 5 \\ 1 & 3 & 729 \end{array} \right]$$

```
   f(z) =     \left\{ \begin{array}{rcl}
         \overline{\overline{z^2}+\cos z} & \mbox{for}
         & |z|<3 \\ 0  & \mbox{for} & 3\leq|z|\leq5 \\
         \sin\overline{z} & \mbox{for} & |z|>5
                \end{array}\right.
```

$$f(z) = \left\{ \begin{array}{rcl} \overline{\overline{z^2}+\cos z} & \text{for} & |z|<3 \\ 0 & \text{for} & 3\leq|z|\leq5 \\ \sin\overline{z} & \text{for} & |z|>5 \end{array}\right.$$

11 Other Styles (math mode only)

Caligraphic letters: `$\mathcal{A}$` etc.: $\mathcal{A B C D E F G H I J K L M N O P Q R S T U V W X Y Z}$

Mathbb letters: `$\mathbb{A}$` etc.: $\mathbb{A B C D E F G H I J K L M N O P Q R S T U V W X Y Z}$

Mathfrak letters: `$\mathfrak{A}$` etc.: $\mathfrak{A B C D E F G H I J K L M N O P Q R S T U V W X Y Z a b c 1 2 3}$

Math Sans serif letters: `$\mathsf{A}$` etc.: $\mathsf{A B C D E F G H I J K L M N O P Q R S T U V W X Y Z a b c 1 2 3}$

Math bold letters: `$\mathbf{A}$` etc.: $\mathbf{A B C D E F G H I J K L M N O P Q R S T U V W X Y Z a b c 1 2 3}$

Math bold italic letters: define `\def\mathbi#1{\textbf{\em #1}}` then use `$\mathbi{A}$` etc.:
$\boldsymbol{A B C D E F G H I J K L M N O P Q R S T U V W X Y Z \quad a b c \quad 1 2 3}$

12 Font sizes

Math Mode:

$\displaystyle \int f^{-1}(x-x_a)\,dx$ `${\displaystyle \int f^{-1}(x-x_a)\,dx}$`

$\textstyle \int f^{-1}(x-x_a)\,dx$ `${\textstyle \int f^{-1}(x-x_a)\,dx}$`

$\scriptstyle \int f^{-1}(x-x_a)\,dx$ `${\scriptstyle \int f^{-1}(x-x_a)\,dx}$`

$\scriptscriptstyle \int f^{-1}(x-x_a)\,dx$ `${\scriptscriptstyle \int f^{-1}(x-x_a)\,dx}$`

Text Mode:

`\tiny` = tiny
`\scriptsize` = very small
`\footnotesize` = smaller
`\small` = small
`\normalsize` = normal
`\large` = large
`\Large` = Large
`\LARGE` = LARGE
`\huge` = huge
`\Huge` = Huge

13 Text Mode: Accents and Symbols

ó	`\'{o}`	ö	`\"{o}`	ô	`\^{o}`	ò	`\`{o}`	õ	`\~{o}`	ō	`\={o}`	ọ	`\d s`
ȯ	`\.{o}`	ŏ	`\u{o}`	ő	`\H{o}`	o͡o	`\t{oo}`	o̧	`\c{o}`	o̱	`\d{o}`	s̊	`\r s`
o̲	`\b{o}`	Å	`\AA`	å	`\aa`	ß	`\ss`	ı	`\i`	ȷ	`\j`	s̋	`\H s`
ø	`\o`	s͡	`\t s`	š	`\v s`	Ø	`\O`	¶	`\P`	§	`\S`		
æ	`\ae`	Æ	`\AE`	†	`\dag`	‡	`\ddag`	©	`\copyright`	£	`\pounds`		