Presentation and Example Usage of Yet Another Thesis Template

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June 6, 2019

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Task

For: **Alex Povel** [666]

Topic: **Presentation and Example Usage of Yet Another Thesis Template** (Example Document)

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- First you are doing this,
- then another thing,
- lastly that.

You will be working on this a lot.

————————————————   ————————————————

Prof. Spam-Ham Eggs   *Place & Date*

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Declaration of Authorship

I, Alex Povel [666], hereby declare to be the sole, independent author of the Example Document submitted here. No other than the cited references have been used. Any content directly or indirectly obtained from external sources has been marked up as such. This thesis has neither been submitted to a second examination authority nor been published.

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Alex Povel

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Abstract

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- we found out this
- and also that!

Contents

Glossary

The most commonly used symbols are listed here, alongside their location of first occurrence. Symbols used but not listed here are clarified in their respective contexts.

Symbols

Greek	Description	1st Use	Unit
Ξ	wastegate position		–
α	flow angle in the absolute system		°, rad
β	flow angle in the relative system		°, rad
γ	ratio of specific heats		–
γ	mass fraction	3	–
ρ	density		$\mathrm{kg\,m^{-3}}$
τ	shear stress		$\mathrm{N\,m^{-2}}$

Roman	Description	1st Use	Unit
A	area		$\mathrm{m^2}$
$\mathbf{c}$	absolute velocity (magnitude)		$\mathrm{m\,s^{-1}}$
c_p	specific heat capacity at constant pressure		$\mathrm{J\,kg^{-1}\,K^{-1}}$
H	enthalpy		J
H	(specific) heating value	3	$\mathrm{J\,kg^{-1}}$
h	height		m
M	MACH number		–
m	mass		kg
p	pressure	2	Pa
r	radius		m
R	radius ratio		–
R	specific gas constant	2	$\mathrm{J\,kg^{-1}\,K^{-1}}$
T	absolute temperature	2	K
U	internal energy		J

v	specific volume	2	$m^3\,kg^{-1}$
ϑ	relative temperature		°C

Sub- and Superscripts

Subscripts

		in	inlet
		m	meridional
		out	outlet
air	air	**t**	throat
exh	exhaust	**T**	turbine
i	inferior	θ	tangential/circumferential/blade

Acronyms

Short	Description	Page
CI	Continuous Integration	28
HFO	Heavy Fuel Oil	23
IDE	Integrated Development Environment	4
IMO	International Maritime Organization	23
MDO	Marine Diesel Oil	23
PDF	Portable Document Format	5
RE	Rated Engine	18

Illustrative Elements

List of Figures

List of Tables

List of Illustrations

List of Code

Chapter **1**

Text Features

Let us first go through some of the textual features offered by LaTeX and used in this template.

1.1 Fonts

Using high-quality fonts is one goal. This includes the fantastic TeXGyre fonts, of which the *Palatino* (by Hermann Zapf) clone *Pagella* was chosen for this template. It comes with an accompanying math font of the same name. Using both font types in conjunction is made possible through the `unicode-math` package. As such, achieving a better match of text and math fonts is nigh impossible. Both fonts are vector fonts; if LaTeX yields any warnings about font size substitutions, that is bogus.

Not only do the fonts look fantastic on their own and together, they (just as important) also feature an immensely broad support for symbols and characters, as well as font shapes and weights and combinations thereof. The latter is demonstrated in Table 1.1.

Combine all that with `microtype`, and we have absolutely gorgeous typesetting. As Jeremy Clarkson would say, "Behoooold the magnificence":

> Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Etiam lobortis facilisis sem. Nullam nec mi et neque pharetra sollicitudin. Praesent imperdiet mi nec ante. Donec ullamcorper, felis non sodales commodo, lectus velit ultrices augue, a dignissim nibh lectus placerat pede. Vivamus nunc nunc, molestie ut, ultricies vel, semper in, velit. Ut porttitor. Praesent in sapien. Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Duis fringilla tristique neque. Sed interdum libero ut metus. Pellentesque placerat. Nam rutrum augue a leo. Morbi sed elit sit amet ante lobortis sollicitudin. Praesent blandit blandit mauris. Praesent lectus tellus, aliquet aliquam, luctus a, egestas a, turpis. Mauris lacinia lorem sit amet ipsum. Nunc quis urna dictum turpis accumsan semper.

Notice the balanced line endings? How it was incredibly easy on the eyes, therefore easy to read? Nothing gets in the way; there is nothing to stumble over, disturbing the

Table 1.1 / Examples for font features offered by the main roman font. Notice the small vertical white space after the fourth row, nicely separating content that is slightly dissimilar.

Feature	Sample Text
Regular	The quick brown Fox jumps over the lazy Dog 13 times!
Bold	**The quick brown Fox jumps over the lazy Dog 13 times!**
Italics	*The quick brown Fox jumps over the lazy Dog 13 times!*
Bold Italics	***The quick brown Fox jumps over the lazy Dog 13 times!***
SMALL CAPITALS	THE QUICK BROWN FOX JUMPS OVER THE LAZY DOG 13 TIMES!
BOLD SC	**THE QUICK BROWN FOX JUMPS OVER THE LAZY DOG 13 TIMES!**
ITALICS SC	*THE QUICK BROWN FOX JUMPS OVER THE LAZY DOG 13 TIMES!*

flow: letters and words are spaced out nicely horizontally, as are lines vertically. There is a minimal number of hyphens. That is how it is meant to be.

1.1.1 Math

What often does not occur at first glance is that many documents use text and math fonts that are very different from one another. As far as I know, Microsoft's Word has usable math typesetting and sensible default fonts for that. Yet, it cannot do what dedicated, fully-fleshed text and math fonts — different fonts, but meant for one another — can achieve. They provide a seamless transition, especially when using actual text in the math environment or vice versa, like when we go for $x \to \infty$ and then also do $\int_1^2 y^2 \, dy$ or maybe $a^2 + b^2 = c^2$ (the stuff you learn at university huh), all looking rather natural. Toggle the colors in the preamble, highlighting each different font family, to see all the differences. Some more examples follow.

$$pv = RT \tag{1.1}$$

$$e^{i\pi} + 1 = 0 \tag{1.2}$$

$$\lim_{x \to \infty} \frac{\pi(x)}{x/\ln(x)} = 1 \tag{1.3}$$

$$\sum_{k=0}^{n} \binom{n}{k} = 2^n \tag{1.4}$$

$$\left[M\frac{\partial}{\partial M} + \beta(g)\frac{\partial}{\partial g} + n\gamma \right] G^n(x_1, x_2, \ldots, x_n; M, g) = 0 \tag{1.5}$$

$$\Delta h_{\text{change}} = 1/2\left(c_{\text{exit}}^2 - c_{\text{entry}}^2 \right) \tag{1.6}$$

Symbols   Note how the symbols in Equation 1.1 are hyperlinks (leading to their definition in the glossary), courtesy of packages **hyperref** and the wonderful **glossaries-extra** working together. Having not specified anything else, they take hyper-link color. That is of course a bit unfortunate. In the final document, all links should be hidden, aka black. This is a given for print output, but I also encourage it for digital output. The visual noise introduced by colored links is quite immense. Their only point is to let users know there is something clickable — they likely figure that out themselves quickly.

Math highlighting   In a very unintrusive yet also not ambivalent way, we can highlight important results, as is done in Equation 1.3. This feature is a natural part of **tcolorbox**, a very powerful package for anything color and boxes!

Chemical Reactions

Closely related to purely mathematical equations are chemical ones, as shown in Equation **R** 1.1.

$$C + O_2 \longrightarrow CO_2 \qquad\qquad [\mathbf{R}\,1.1]$$

This functionality is still very basic and probably poorly executed in parts. We can also use chemical compounds invoking \chcpd, as demonstrated in Equation 1.7.

$$\frac{H_{\text{i}}}{1 \times 10^6} = 35\gamma_{\text{C}} + 94.3\gamma_{\text{H}} + 10.4\gamma_{\text{S}} + 6.3\gamma_{\text{N}} - 10.8\gamma_{\text{O}} - 2.44\gamma_w \qquad [1.7]$$

1.1.2 Sans-Serif

Having taken care of the main/roman font, we turn to the others. Fontin is a decent sans-serif font. Quite importantly, and in contrast to almost all other free sans-serif fonts, it comes with all the bells and whistles required for stunts, see Table 1.2. This even includes small-capitals support.

1.1.3 Mono-Spaced

Wanting to display any sort of code in the document will have you looking for a mono-spaced aka typewriter font. Inconsolata, provided by Google, will be our pick here:

```python
@something
def get_metadata(table, data_start: int) -> dict:
    """Get some metadata"""
    metadata = {}  # metadata found in file header

    for i, row in enumerate(table):
        if i >= data_start:
```

```
        break
    lrow = row.lower()

  return junk
```

with Python syntax highlighting taken from this GitHub repository. Note that comments are really meant to be *italics* shape (or *slanted*), but Inconsolata does not deliver that. If you don't care, Inconsolata will be good enough. Still, Consolas is much preferred: it has *true* italics and bold italics. As far as I know, it is shipped with Windows but not free; I cannot share it here, but you will be able to get your hands on it rather easily.

So what?

If you don't care for *any* of this, don't quit just yet. The features of LATEX will do their work silently in the background for you. You won't have to worry about any of this ever again, but can rest assured it is taken care of. **Focus on your content and impress others that way** (**yet still bedazzling them with your sexy-ass documents**).

1.2 References

Note that using the package `cleveref`, we only ever issue \cref{label} commands. The package does the heavy lifting and puts the float type in front, also with correct plural forms if required (see Table 1.1 and Figures 2.3 and 2.8 ← all of that was done automagically). Doing it any other way is just way too laborious and error-prone.

For added convenience, add some info on the type you are attaching the label to, *e.g.* \label{fig:hello}. This helps for auto-completion in your Integrated Development Environment (IDE)[1] of choice.

1.2.1 Bibliography

The second most likely need for references are the bibliographical ones. Examples are spread throughout this document. At their basis, they rely on **biblatex** and its back-end **biber**. Forget about **natbib** and similar. Using \autocite{bibid}, we can reliably cite sources and have a whole range of features delivered for free. We do not have to worry about the specific citation style (in parentheses, as a superscript, ...) — \autocite{bibid} takes care of that, we can then manage its behavior globally.

As such, we can have citations that look like this: [DH14, p. 23; Aun00, pp. 29 sqq.; Jap85, pp. 2–9; Kur11, pp. 89 sq.; Pam82]. We can add a note to each; if this note is an integer number, it is automatically taken to be the page number. If a following page

---

[1]Here, gls was used to print this abbreviation from the glossary. *Never, ever **don't*** do that: when there is an abbreviation, put it into the glossary system and have it handle that. You will regret not doing it and end up scratching together all wild, spread-out, manually typed abbreviations. Your document might suffer from inconsistencies.

Table 1.2 / Examples for font features offered by the sans-serif font.

Feature	Sample Text
Regular	The quick brown Fox jumps over the lazy Dog 13 times!
Bold	**The quick brown Fox jumps over the lazy Dog 13 times!**
Italics	*The quick brown Fox jumps over the lazy Dog 13 times!*
Bold Italics	***The quick brown Fox jumps over the lazy Dog 13 times!***
Small Capitals	The quick brown Fox jumps over the lazy Dog 13 times!

is to be included in the citation, append \psq. Otherwise, \psqq for "this page and the following ones". Using \autocites{}, we can then chain together as many as we want.

Dixon and Hall [DH14][1] do not claim anything, this is just an example for a \textcite, used to implement a citation to be a readable part of the sentence. There is also a plural form available.

Language　All of this is incredibly convenient, for there is minimal manual work and a lot of elevation. Importantly, this is language-agnostic, and `biblatex` will make use of `polyglossia` (the LuaLATEX replacement for `babel`) and `csquotes`. Therefore, through changing the desired document language for just these packages, all others including `biblatex` will quickly adjust automatically.

backref　Taking a look at the bibliography in the back matter of this document reveals the feature backref: the pages where a reference was cited occur after its entry. This is helpful in print, but amazing in digital format, for these page numbers are also links. Your readers will thank you tenfold for allowing them to very swiftly navigate and jump within your document.

Try it out by clicking this reference: [Brä15], leading you to the bibliography. It will say this page's number (Page 5) at the end of its entry, done by `biblatex`. Clicking it will land you back here exactly.

Manager　To generate the *.bib file, from which LATEX pulls the info, in the first place, a citation manager is a good tool. Zotero is a decent pick, but it ultimately does not matter much. Just use *some* manager to keep your actual documents/Portable Document Formats (PDFs) and the automatically derived *.bib files in one place, named and structured consistently.

1.3 Lists

In technical publications, using lists (either bullet points or enumerations) is highly encouraged. They should *always* be preferred over doing the same thing in a block of text. Just consider this example list:

- The presented approach is more complex than the previous one:
  1. more time was spent doing computations,
  2. less was spent effing about,
  3. features were added.
- At the same time, the following simplifications were made:
  1. went from continuous- to discrete-time simulations,
  2. threw out some superfluous stuff.

Processing the very same information from a text block would suddenly be much more challenging. Note the block-like itemize symbol (∎)² , and the fact that enumerate numbers are part of the sans-serif family and **bold**. That is totally cool and stuff, because it's... different? This was specified and may be changed in the **enumitem** package options.

1.4 Censoring

> I am a TODO note from **todonotes**. I am also specially highlighted in many editors.

Let me tell you a huge secret: ███████████████. You can also censor float contents, as illustrated in Figure 1.1.

1.5 Glossaries

The package **glossaries-extra** is an absolute beast. For this document, it is used with its back-end **bib2gls**. This (Java) tool comes with installations of TeXLive and Miktex. You should already have it.

In a format similar to normal bibliographies, we now manage all abbreviations, symbols *etc.* using *.bib files. You can see them in a sub-folder for this project as well. Each entry is processed by **bib2gls** and put into an auxiliary file. From it, it reads and inserts all contents when we use \gls and its many siblings to insert glossary data. The framework for all of that, also printing of the glossary/nomenclature, was already done for this project.

Using **glossaries-extra** and its many features also for symbols is a fabulous tool. It is absolutely counter-intuitive, for now we have to write \gls{temperature} instead

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²This is also a regular Unicode character. When copy-pasting old or outdated LATEX documents, ever noticed all the funny business going on? A good example is copying German "Umlauts" like Ä, Ö, Ü. They might turn into " ¨ A", since LATEX only ever put two random dots over the regular ASCII letter A. With **unicode-math** (building onto **fontspec**) and LuaLATEX, we are fully Unicode! Copy-paste anything correctly: $\delta\sigma \int_1^2 y$.
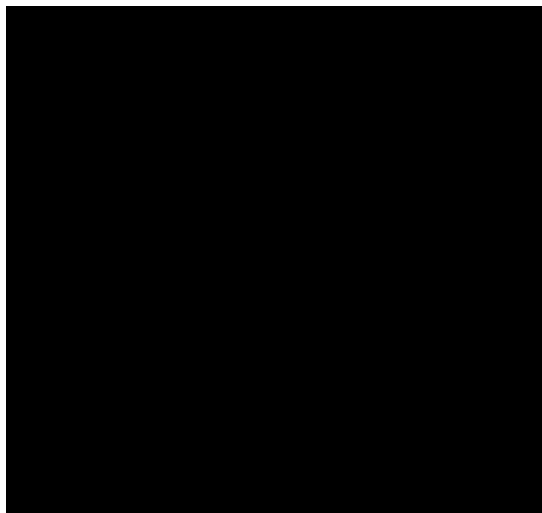
Figure 1.1 / Example for a censoring box.

of just T. This makes the source code obfuscated and hurts legibility. The advantages are probably worth it: never worry about consistency again. You have one central repository for all data, and any changes there are immediately forwarded to the entire document (provided you are persistent in using \gls *etc.*). We can then also go ahead and add a billion other features, like cross-referencing, hyperlinking, additional explanations and much more.

1.6 Indices

For the index at the end, we currently use **splitidx**. It splits the single index LaTeX expects, allowing for multiple indices. In the future, all of this should be replaced by **glossaries-extra**. For now, we can add people like EINSTEIN and FEYNMAN to the index. Terms, like machine learning and artificial intelligence (so hip), may be added as well. We can also nest entries with \term{parent!child} .

These are implemented as a custom commands and are vastly inferior to using **glossaries-extra**. For example, these are simple links with no descriptive texts *etc.*

Lastly, we will have to run the tool splitidx on our main *.tex file/its *.aux file. This is another step in the process that could be circumvented using **glossaries-extra**.

1.7 Code

As previously seen in Section 1.1.3, we have a special code-block environment for code between paragraphs (*i.e.*, not a float). Its big brother Floaty McFloatface is illustrated in algorithm 1.1. Notice how you can very easily select and copy[3] said code without

---

[3]steal

Code 1.1 / This is an example for a floating code environment with some interesting LATEX stuff. The actual code is likely crap, you be the judge.

```python
def value_cleanup(raw_in) -> float:
    """Turn dirtied string(s) (e.g. ",233 kg") to float(s)."""
    if isinstance(raw_in, (int, float, datetime)) or raw_in is None:
        return raw_in  # A useless note: x² ≠ x
    elif isinstance(raw_in, list):
        clean_list = []
        for substr in raw_in:
            clean_list.append(value_cleanup(substr))  # Recursion
        return clean_list
    elif not isinstance(raw_in, str):
        raise TypeError(f"Expected type 'str', got '{type(raw_in).__name__}'.")
    else:
        dotted = raw_in.replace(",", ".")  # Decimal representation
        cleaned = dotted.strip()  # Remove surrounding whitespace
        numeric = '0123456789-.'  # Include negatives/decimal sep. in search
        position = None  # Initialize to throw error just in case
        # Append space for search to work
        for position, char in enumerate(cleaned + " "):
            if char not in numeric:
                if position == 0:  # Didn't even start with numerical char
                    return None  # This is interesting
                break
        # Up to just before found nun-numeric char
        return float(cleaned[:position])  # −1.5 × 10⁻² is also a float
```

having to worry about line numbers. The line numbers can even be referenced, *e.g.* we find a **return** statement on Line 4. This requires escaping the \label with the previously specified special command, back-ticks: `escaped LaTeX`.

Inline code goes like so: y = [file_patterns[x] **for** x **in** ["send", "help"]].

1.7.1 Matlab/Simulink

The basis for this template was laid by a thesis concerned with MATLAB®/Simulink®. As such, we have nice commands like MATLAB®, Simulink®, MATLAB®/Simulink® and Symbolic Math Toolbox™ to print, in a consistent manner, all the different names and also add them to the index. Further, there are funny little vector symbols available, referencing various things MATLAB®/Simulink® has to offer:

Inputs: ☑ *Step-Function*   ☑ *Step-Functions*
Data Dictionaries: 🗄 *Data Dictionary*   🗄 *Data Dictionaries*
Workspaces: ⊞ *Base Workspace*   🖳 *Model Workspace*   🖳 *Model Workspaces*
Models: 🖳 *Model*   🖳 *Models*   ☐ *Referenced Model*   ☐ *Referenced Models*   ✏ *Library Model*   ✏ *Library Models*   🖳 *Library*   🖳 *Libraries*
Data processing: ☂ *Data Logging*
Look-Up Tables: ✒ *Look-Up Table*   ✒ *Look-Up Tables*
Settings: ⚙ *Configuration*
Variables: ⊞ YourVar   ⊞ *Struct*   ⊞ *Structs*   ⊞ *Table*   ⊞ *Tables*   ⊞ YourStruct   📦 YourObj   📦 *Bus*   📦 *Buses*

These can probably be improved by handling plural cases/commands automatically. Since plural forms and all that jazz are often not as straightforward as appending an "s", and regarding the countless exceptions one would have to take into account, automating LaTeX macros that deal with language is a much harder task than what it might seem at first.

1.8 Landscape

Pages in landscape format are rather straightforward to implement. Note that not only are these in landscape orientation; they are also recognized as such by supporting PDF viewers, rotating the page for you and keeping it legible.

Float Features

In Figure 1.1 and Table 1.1, we have already seen examples for floats. These are handled by packages **caption** and **floatrow**. A notable feature is the capability for captions the same width as the float they are attached to. This tends to look much prettier, *cf.* Figures 2.1 and 2.2.

2.1 Multiple floats

Other possibilities are rather arbitrary arrangements of sub-figures and -captions. For this, see Figure 2.3, which contains two sub-figures Figures 2.3a and 2.3b. Multiple sub-tables are also possible, see Table 2.1.

2.2 Side-Captions

Lastly, on occasion figures and their captions might look disproportionate in combination. In these cases, placing a side-caption might relieve the situation, as shown in Figure 2.4.

2.3 Caption Positioning

Note that the caption of Table 1.1 occurs *above* the table no matter the **caption** command's position. Per convention, figure captions should appear below, table captions above their bodies. This is also handled by **floatrow**. Also note that there is neither a fullstop nor *any* character (no space, no empty line) behind the last caption line in the source code, since dots are managed globally by the **caption** package.

Float Footer   We also have a \floatfoot command for all floats. This is used to place additional info underneath the caption, primarily used for references, *cf.* Figure 2.3.
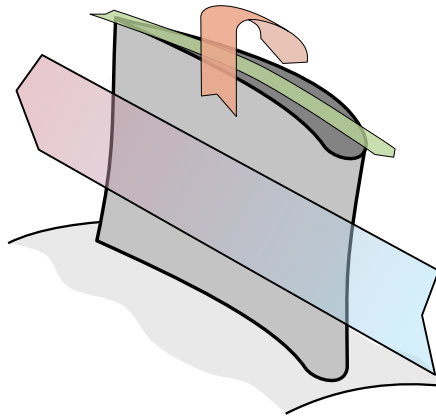
Figure 2.1 / Example for a regular caption, spanning the whole width since it is so long.
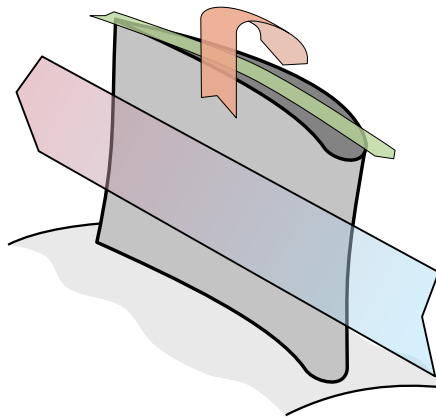
Figure 2.2 / Example for a new caption, spanning the just the width of the float it is attached to.

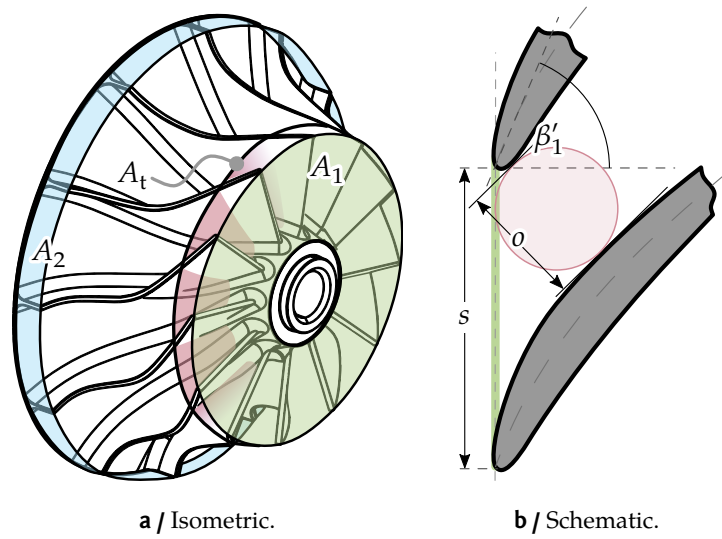**a /** Isometric. **b /** Schematic.

Figure 2.3 / Inducer throat created by geometric constraints as an example for sub-figures.
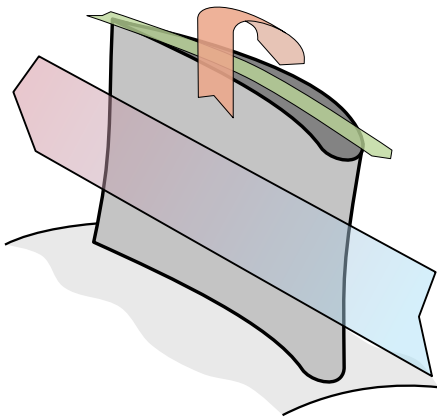
Adapted from [Sha15; WB90, p. 99; HSU85, p. 535].

Figure 2.4 / A side caption, which may also span multiple lines like demonstrated in this rather long caption right here.

Table 2.1 / Works on zero- and one-dimensional turbocharger and engine modelling.

a / Using Maps.

Author & [Work]	Comment
Bozza and De Bellis [BD11]	—
Bozza et al. [Boz+13]	—
Bozza et al. [Boz+90]	**Nozzles**
Burke [Bur14]	—
De Bellis and Bontempo [DB18]	—
Berndt [Ber09]	—
Chesse et al. [Che+00]	—
Cornolti et al. [Cor+13]	—
Eriksson [Eri07]	—
Grigoriadis [Gri08]	—
Kech and Klotz [KK02]	—
Lee et al. [Lee+09]	—
Leufvén and Eriksson [LE11]	—
Shaaban et al. [Sha+06]	—
Wahlström and Eriksson [WE11]	—
Watel et al. [Wat+10]	MATLAB®/Simulink®
Yang and Zhu [YZ10]	—

b / Computing Maps.

Author & [Work]	Comment
Beckey, Hartfield, and Carpenter [BHC11]	using algorithms
Bergqvist [Ber14]	from CFD
Bohn et al. [Boh+02]	—
Bolz [Bol14]	—
Elkamel et al. [Elk+11]	—
Ewert [Ewe13]	—
Freeman [Fre11]	MATLAB® script
Hänsch [Hän10]	—
Harley et al. [Har+14]	—
Lüddecke [Lüd14]	—
Kurzke [Kur11]	—
Schwarz [Sch14]	—

c / Physical (0- & 1D).

Author & [Work]	Comment
Aungier [Aun95]	—
Casey and Robinson [CR13]	Calibrating with Maps
Chen and Winterbone [CW14]	Turbine
Erickson [Eri08]	FORTRAN
Ewert [Ewe13]	—
Gong and Chen [GC14]	—
Gutiérrez Velásquez et al. [Gut+10]	FORTRAN, 1D and 3D
Japikse [Jap09]	Overview
Kamaleshaiah, Venkatrayulu, and Ramamurthy [KVR88]	—
Kessel [Kes02]	1- & 3D
Lee et al. [Lee+08]	dual-stage; **Simulink®, maps**
Nakhjiri et al. [Nak+18]	—
Okhuahesogie et al. [Okh+14]	Differential Evolution
Pelton [Pel07]	—
Pixberg [Pix13]	**Reservoirs; Nozzles** (p. 42)
Sakellaridis et al. [Sak+15]	—
Schiffmann and Favrat [SF10]	—
Schur [Sch13b]	Simulink®
Serrano et al. [Ser+08]	**Reservoirs; Nozzles**
Shaaban [Sha04]	Diabatic; Extrapolation
Stuart et al. [Stu+14]	cites [Har+13]
Taburri et al. [Tab+12]	**Reservoirs; Nozzles**
Uchida [Ucho6]	—
Whitfield [Whi90]	Preliminary Design
Xu and Amano [XA12]	—
Zahn [Zah12]	—
Zhuge et al. [Zhu+09]	—

d / Loss Modelling.

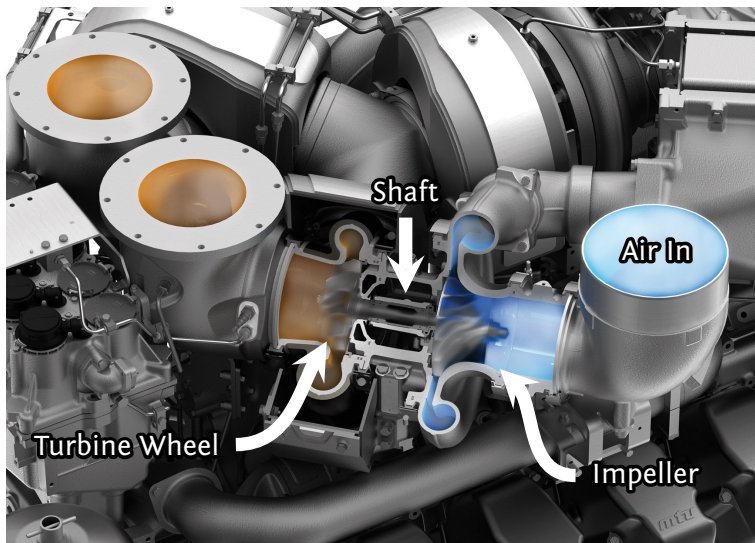| Author & [Work]	Comment
Aungier [Aun95]	—
Doustmohammadi, Hajilouy Benisi, and Mojaddam [DHM13]	—
El-Maksoud, Bayomi, and Rezk [EBR12]	—
Galvas [Gal72] and Galvas [Gal73]	—
Gülich [Gülo3]	Disk Friction
Gutiérrez Velásquez [Gut17]	—
Harley et al. [Har+13]	Recommends [OYC97]
Mohtar [Moh10]	—
Nakhjiri et al. [Nak+11]	—
Oh, Yoon, and Chung [OYC97]	—
Tacconi [Tac18]	Cites [Har+13]; recommends [Gal73]
Schneider et al. [Sch+15]	2D
Solaesa [Sol16]	—

Figure 2.5 / Digital renders have to be implemented as bitmaps. You can actually vectorize images like this one, too, with decent success. However, the resulting file will contain an absurd number of paths and can be multiple megabytes in size. We can draw onto bitmaps using Tikz. .

Adapted from [Rol11]. In the current `*.bib` file, this reference was automatically generated by Zotero as `@artwork`. While that is okay, **biblatex** will throw a warning that there is no driver for such a type. It falls back to `@misc`, which works just fine.

2.4 Tikz and pgfplots

Packages **tikz** and **pgfplots** offer an absolutely scary plethora of features. A select few are presented here.

2.4.1 Drawing over Bitmaps

When having to rely on bitmaps, once might still want to add additional info. This can be done directly in LaTeX, profiting from all the usual features. In the example here, this is of course the retaining of the text font, but also usage of the wonderful **contour** package to draw legible black-on-white (or vice-versa) text. An example is shown in Figure 2.5.

2.4.2 Direct plotting

If you rely on tools like `matlab2tikz`, maybe this is for you. We can plot *directly* into LaTeX, without having to import outside data in the form of `*.csv`-files or automatically generated Tikz-pictures. Still, anything more than polynomials is probably still too much. While the functionality is limited, it may still save a lot of time and headaches.
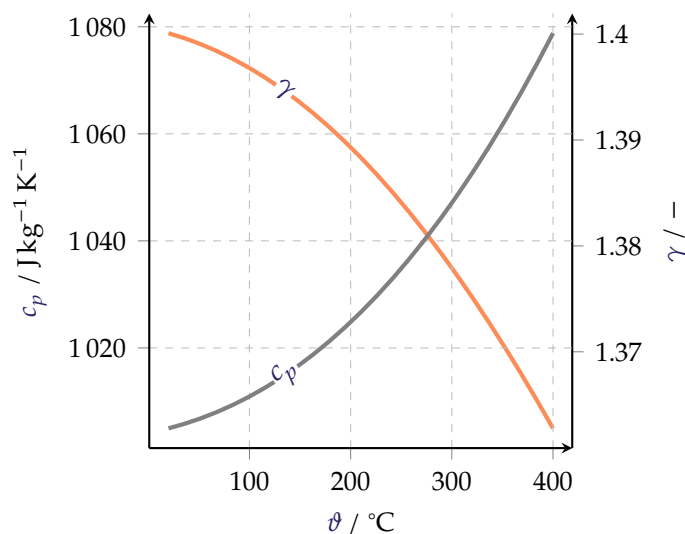
Figure 2.6a / Caloric parameters of air. **Avoid legends** and put info where it belongs, improving legibility (less back-and-forth for the eye).

See [DH14, p. 15].

This is demonstrated in Figures 2.6a and 2.6b.

2.4.3 Plotting from files

As discussed, often we'd want to plot data from files. The better behaved the CSV file is (meaningful headers, no junk rows), the easier that is. In Figure 2.7, we only have to specify *e.g.* y=M and the column corresponding to that header is automatically chosen, with no confusion about indices/numbers.

2.4.4 Tikz and Text

We can also draw tikz content into text content using \tikzmark. This, and also how to use \foreach in tikz, is illustrated in Equation 2.1. There, usage of chemical compounds as \chcpd is also shown.

$$\gamma_C + \gamma_H + \gamma_S + \gamma_O + \gamma_N + \gamma_{H_2O} + \gamma_{ash} := 1. \qquad [2.1]$$

Carbon
Hydrogen
Sulphur
Oxygen
Nitrogen
Water
Ash

2.4.5 Regular Tikz pictures

Tikz really is *not* meant for drawing. The more free-form images shown here were created in InkScape. Still, "drawing" in Tikz is much preferred and nicer when the images are somewhat programmatic, aka there's a lot of 90° corners, equal distances, and everything is a bit "block-like", repetitive. Then, your chances of success using
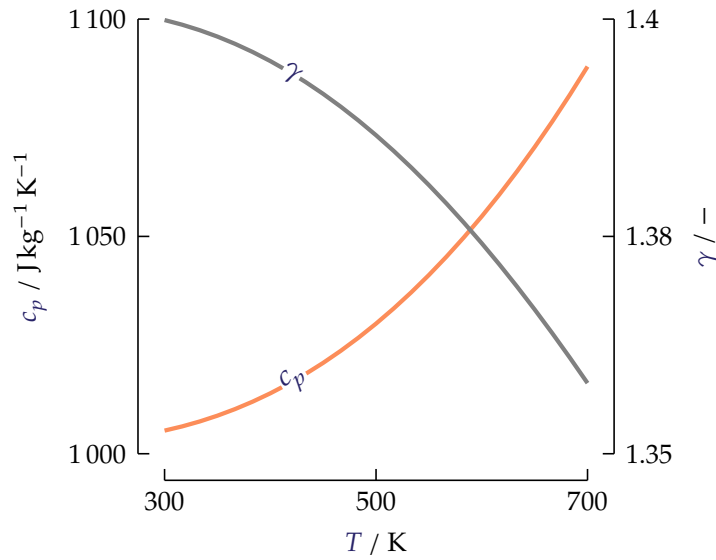
Figure 2.6b / Same as Figure 2.6a in hip and "*Tufte*-like". I think it looks gorgeous. For more info, refer to its namesake, TUFTE. Note how this is a *continued* float.
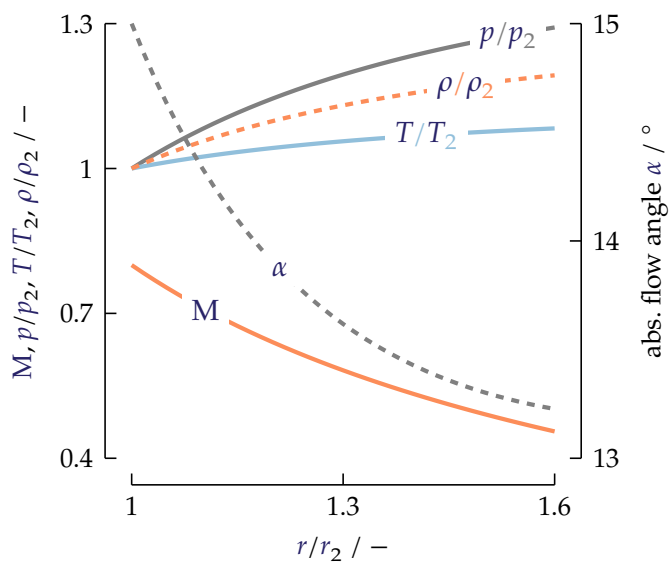

Figure 2.7 / A plot from CSV data for a diffuser.

$\dot{m}_{\mathrm{exh}}$

$\dot{m}_{\mathrm{T}}$

$\Xi(\tau)$

$p_{\mathrm{in}}(\tau)$

$p_{\mathrm{air},RE}$

$0.1 \leq u \leq 1$

$1 - u$

$\frac{KTs}{z-1}$

$1 - u$

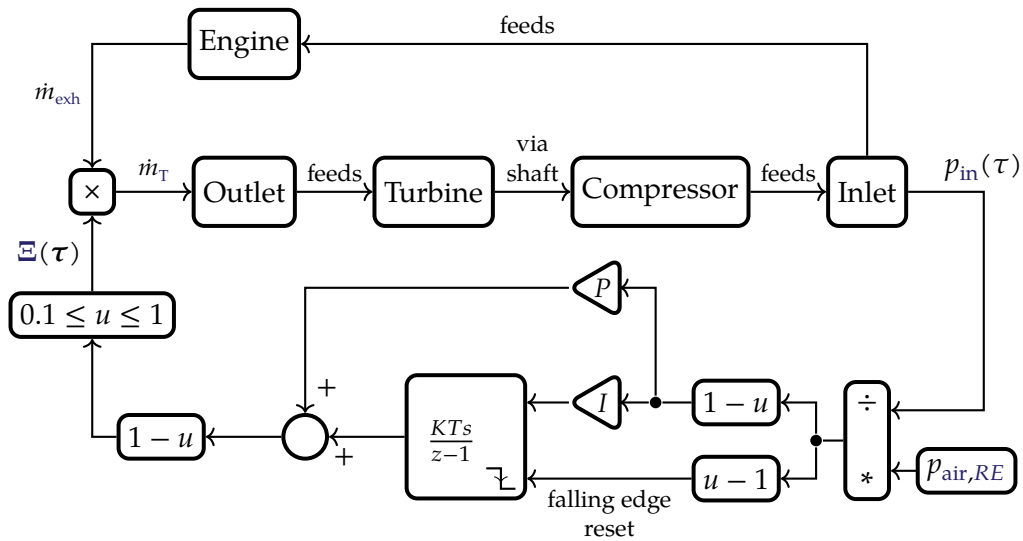$u - 1$

falling edge reset

via shaft

Figure 2.8 / Wastegate implementation in a feedback-loop in Simulink® as an example for a Tikz diagram.

Tikz are much improved, for it is suited well then. For example, a small file structure diagram:
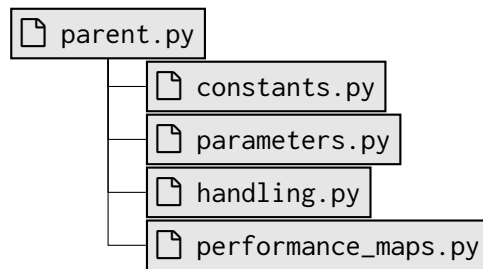
Note how `tikzpicture` environments don't have to be contained in floats. A second example is shown in Figure 2.8.

2.4.6 InkScape

Having seen what Tikz is good for, Figures 2.9a and 2.9b are good examples for when InkScape might be the better choice: 3D drawings with curves. Figure 2.3a is a bitmap turned vector; InkScape can detect edges/contrasts in bitmaps and replicate those lines in a vector graphic. While InkScape is really awkward to use at times, and severely lacking behind its commercial competitors (which is fine), it has 3D perspective tools that can also handle these cases. That being said, Tikz is always the preferred method if so feasible.

InkScape will let you create freely scalable vector graphics (*.svg). They may then be exported as *.pdf; now, that is only half the story. The vector graphic's text part is
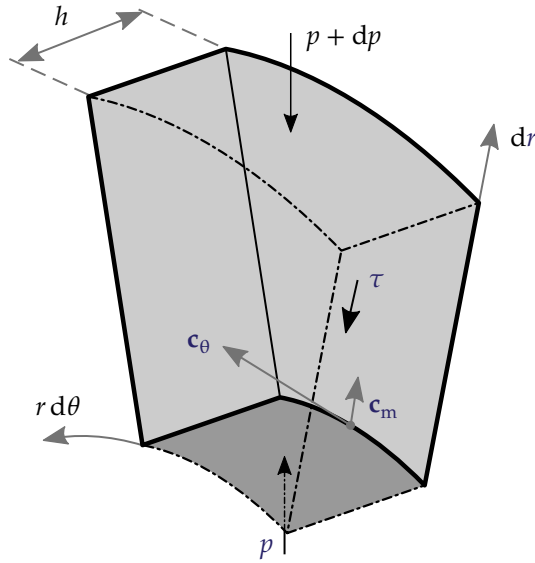
Figure 2.9a / InkScape is likely a better choice for images like this one.

Adapted from [Sta52, p. 47].
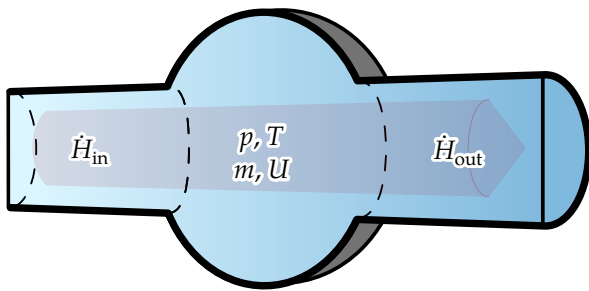
Figure 2.9b / Another example for InkScape usage.

Adapted from [GO10, p. 30].

exported to a plain text (*i.e.* TEX) file, as `*.pdf_tex`. On the latter, we then call `\input` within LATEX, and that file in turn embeds the previously created `*.pdf` file.

Single-Page PDFs   If you aim to reuse just the `*.pdf`, without the text, outside of LATEX, perhaps on your website, then you will want it to really only contain *one* page. However, InkScape may create multi-page files. Selecting all text elements in the `*.svg` file and moving them to the top-most layer (press POS1) will ensure that the generated `*.pdf` will have just one page containing the entire image.

2.5 Illustrations

As a special gimmick, there is an environment for illustrations. It may be useless now, but you can alter it to suit your needs; the skeleton is there for you. It mainly behaves like the other floats: it...floats (if you allow it to) and also has its own list. For an

example, see Section 2.5.

Illustration 2.1: I am a useless box

There can be pretty much any content in here. Math works, as we can see

$$1 = 1!\qquad\qquad [2.2]$$

still holds true after all these years. Inserting other floats in here will cause LATEX to have a massive fit. We circumvent this by setting the [H] flag, saying "Oh hell yeah, we do want this float right here". **In any other context, setting any such flag is considered poor style.** Well, by me at least. You **will** be setting these flags prematurely and then run into countless issues of placement and **very poor** spacing. For the love of God, let LATEX do its job in placing the floats. Truth be told, they will on occasion not be placed where you need or want them. Keep working. At the very end, when all is done, go ahead and change the few misplaced floats manually, by shoving them about in the source code (still not using htb! flags). Then, you're done, with minimal pain and maximum usage of LATEX spacing/placing capabilities. Here is such a float within a float:
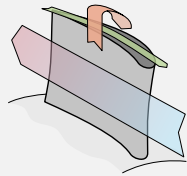
Figure 2.10 / Side-captions are still possible. So are labels.

This box even breaks across pages if so required. Should this turn out ugly, some manual action is certainly required.

Style

These are just random thoughts on style and design of documents, primarily technical publications of all kinds. They are a collection of experience, but also aspects taken from various literature on the topic. The available literature is positively exhausting, so there is no point digging into that here. Take to it if you are truly interested; the content presented here is on a beginner level.

Of course, anything is subjective here. When one speaks of "rules" in style and design, of course what they are really saying is "99 % of people agree on this". Many people make an effort to be the other 1 % (guilty!). Chances are, it will not come out looking right and you'll be back to the drawing board anyway.

3.1 Conventions

Less is more: hack and alter as little as possible. Armies of professionals have arrived at today's conventions over centuries. One example that breaks with what is usually found in documents are the page headers of this document. The header height is increased beyond its standard (using the fabulous `koma-script`) and a vertical rule was inserted. I like it: a touch different and modern, yet not in the way of anything. If you don't, feel free to tear it down in the preamble.

Less is more: use the least ink possible to get your point across. Any more is only noise. For this, compare Table 1.1 with its not-so-blessed twin, Table 3.1. Another observation there: **if in doubt, left-align**. If you don't have an *actual reason* to center or right-align, just don't.

An example for a larger table is shown in Table 3.2. One key aspect there: column-types provided by `siunitx`. These automatically apply \num to each entry, which in turn allows easy printing of things like "-3.23×10^{-5}". Use *x{y} to print column-type y (*i.e.* c) x times. No need for tedious repetition. Decimal places are accounted for and aligned by.

Table 3.1 / Awful version of Table 1.1.

Feature	Sample Text
Regular	The quick brown Fox jumps over the lazy Dog 13 times!
Bold	**The quick brown Fox jumps over the lazy Dog 13 times!**
Italics	*The quick brown Fox jumps over the lazy Dog 13 times!*
Bold Italics	***The quick brown Fox jumps over the lazy Dog 13 times!***
Small Capitals	The quick brown Fox jumps over the lazy Dog 13 times!
Bold SC	**The quick brown Fox jumps over the lazy Dog 13 times!**
Italics SC	*The quick brown Fox jumps over the lazy Dog 13 times!*

Table 3.2 / Compositions and properties of fuels, as used in Eq. 2.1.

Name	Mass fraction γ [–]							ρ $[\mathrm{kg\,m^{-3}}]$	H_i $[\mathrm{MJ\,kg^{-1}}]$
	C	H	S	O	N	H_2O	Ash		
Diesel[a]	0.8600	0.1320	0.0060	0.0020[b]		n.a.	n.a.	840	42.7
Oil EL[a]	0.8570	0.1310	0.0100	0.0020[b]		n.a.	n.a.	840	42.7
Oil H[a]	0.8490	0.1060	0.0350	0.0100[b]		n.a.	n.a.	980	40.0
MDO[c]	n.a.	n.a.	0.0150	n.a.	n.a.	0.0030[d]	0.0001	900	n.a.
HFO[e]	n.a.	n.a.	0.0350[f]	n.a.	n.a.	0.0050[d]	0.0015	1010	n.a.
Light[g]	0.8600	0.1320	0.0060	0.0010	0.0010	0	0	840	Eq. 1.7
Medium[g]	0.8530	0.1269	0.0150	0.0010	0.0010	0.0030	0.0001	900	Eq. 1.7
Heavy[g]	0.8460	0.1025	0.0350	0.0050	0.0050	0.0050	0.0015	1010	Eq. 1.7

[a][BK16, p. 634]; see also [DGF07, p. L70] and [MT07, p. 97].
[b]Given as a sum $\gamma_\mathrm{O} + \gamma_\mathrm{N}$.
[c]MDO, max. values of specification *DMB*, [Int17].
[d]Given as a volume fraction, assumed equal to mass fraction.
[e]HFO, max. values of specification *RMK*, [Int17].
[f]IMO level prior to 2020.
[g]Derived, *virtual* fuels for simulation.

3.2 Sectioning

3.2.1 Explanation

Between any two sectional commands (from \part down), there always has to be *some* content. Anything else looks off, *cf.* Sections 3.2 and 3.2.1. At least, tell the reader what the following hierarchical level contains for them.

Further, three numbered levels of hierarchy are enough. In **koma-script** reports (scrreprt), these are chapters, sections and subsections.

Deeper!

Deeper sectioning is fine, but it should not be numbered or occur in the table of contents. Notice how, without specifying anything, **koma-script** abides by that automatically. This is despite using \subsubsection{Deeper!} as opposed to \subsubsection*, its explicitly unnumbered counterpart.

Also notice how between \section{Sectioning}, which produced Section 3.2, and \subsubsection{Deeper!}, there was no sub-section. Usually, you would want a clean cascade with no jump in the hierarchy levels. If you catch yourself jumping, it is also a sign there is something off with your actual content structure and thought process. That being said, I sometimes still do it because of reasons. Your call, just be aware.

Amazingly, LaTeX has many ways where it does not let you do something easily, or where commands look off. **Never fight LaTeX** in that; you will lose, it will win. When something is awkward to do or requires a lot of manual labor, you are probably doing it wrong and there will be an easier way. Most often, that comes in the form of packages. Being a fully-fleshed programming language under the hood, *any* repetition in LaTeX should make you stop for a second and wonder about another way. That may lead to you discovering sub-optimal approaches and code. Just as often, it won't lead anywhere and trying to force minimum code and maximum optimization will not be economical.

Paragraphs   They are a nice touch, introducing a new, distinct paragraph/idea/thought without being too loud about it.

That being said, leave a blank line in the source code for regular paragraphs. Use either vertical spacing between paragraphs or indentation (like here). Do not use both.

Each new train of thought should go into its own paragraph. This paragraph is not indented, as was intended by manually calling \noindent. In regular text and documents, there are very few reasons that should ever occur. Again, let LaTeX do its thing. Again, if you find yourself typing \noindent all the time, there will be something wrong.

3.3 Other stuff

This section is about auxiliary stuff. Notice `\lcnamecref` in the previous sentence: it references (in *lower-c*ase) the name of the thing you are passing it. If this section ever changes to something else (chapter, ...), it is updated automatically.

Now for the stuff:

- Small spaces are produced by the usual back-slash, followed by an actual space: `\ `. Much like physical quantities produced by **siunitx** (30.2×10^2 N) and its small spaces, they are nice to have. When LaTeX sees any dot . with a space behind it, it sees that as the end of the sentence. When it isn't, like for Prof. Very Important, we use an explicit small space instead.

  A second important application would be abbreviations, *i.e.* ← these little things. **In the name of all that is holy, never type units, numbers or quantities out by yourself, manually.** Use **siunitx** for that. It will insert a small space between the number and the unit. No spaces or full spaces are wrong and painful to read. Lastly, even numbers should always go into `\num`. Compare 47 sheep versus 47 sheep. Different fonts are used: the regular text font, for which we specified `OldStyle`, *i.e.* hanging numbers, the the math font. Other features are global control over decimal and group/thousands separators, how to handle scientific notation (1×10^1) and *much* more. As always, the manual will be your reference and friend.

- Use `---` in the source code to have an em-dash—perhaps even without surrounding spaces? That is probably up to your choice. What is not, because it is largely agreed on, is to use `--` – an en-dash – instead. It is reserved for number ranges. Lastly, a single hy-phen is reserved for just that — hyphenation.

- A generally important concept in LaTeX: **write what you *mean*, not what produces the desired output**. Do *emphasized* text and *emphasized*, but in italics, text look the same? They certainly do, usually.

  Yet, what did we *mean* to be doing? We *mean* to *emphasize*; italic text is just what it happens to look like now, but it is not the *meaning*. For example, we could later decide to redefine emphasized text to bold. If you previously did not differentiate strictly enough between `\emph` and `\textit`, you are in for a bad time.

- Indices are upright! They are text. If text occurs in math mode, that is also actual text. Consider

$$MEAN_{sample} \neq 2, \qquad [3.1]$$

which looks stupid. What Equation 3.1 really says is "$M \cdot E \cdot A \cdot N$": slanted characters are variables, and not specifying any operator implies multiplication. This example might be pedantic, but it is easy to imagine such an issue evolving into real ambiguity, which would be a serious error. Since multiplication is implied by doing nothing, leaving out `*` aka `\cdot` altogether often looks best. We can `\DeclareMathOperator{\examplemean}{MEAN}`, then use `\text` for the subscript:

$$\mathrm{MEAN}_{sample} \neq 2. \qquad [3.2]$$

- In Equation 3.2, and anywhere else, the equation is part of the sentence. It is just another language, which can and will be read as a natural part of the surrounding text. As such, it should contain punctuation marks. So that now, having considered that we have the amazing result of

$$1 \neq 2 \, , \qquad\qquad [3.3]$$

we have achieved better overall reading flow. Notice the small spaces \, before the commas and dots in equations.

Implementing these as \eqcomma and \eqend ensures consistency. Note that \eqend was previously \eqdot, but that is reserved by **unicode-math**. Other than consistency, the punctuation can then also be switched off globally if your requirements demand so.

Chapter **4**

Technical Aspects

TₑX being TₑX, there are countless of technical aspects to pay attention to. The most important one are collected here, in a random fashion.

4.1 Building the document

The most important part! In Chapter 1, we looked into why we are using LuaLATₑX. Reasons are:

1. `unicode-math` aka `fontspec`
2. `contour` works (it does not with XᴇLATₑX)
3. it allocates as much memory as it happens to need. The ancient limitations of TₑX are easily reached with `tikz` and `pgfplots` functionalities. Circumventing that either feels hacky or actually is hacky. `tikzexternalize` is a decent module, but has a long list of caveats. Using LuaLATₑX, we do not have to worry about any of that: hit compile, wait, done (the waiting part might be a bit longer than what you might be used to from pdfLATₑX).

With that out of the way, the building process — starting from scratch — looks roughly like this:

1. **LuaLATₑX** — build first version, generating the auxiliary files. At this point, references or anything else will not yet be correct.
2. **biber** — it will take the specified `*.bib` file and build the bibliography auxiliary files.
3. **splitindex** — invoke it as `splitindex NAME`, where NAME is your main file's name, such that all the auxiliary files bear names like `name.aux` *etc.*
4. **bib2gls** — also invoked as `bib2gls NAME`,
5. **LuaLATₑX**,
6. **LuaLATₑX**.

This list is no guarantee however. If anything fails, try running it again in different orders, or run LuaLATₑX again. You can also look into deleting auxiliary files (they can always be regenerated freely) if you are seeing really cryptic error messages.

4.1.1 latexmk

A much more user-friendly tool is `latexmk`, also provided in most TeX distributions. Therefore, you should already have it available and on your PATH.

The tool knows about all the different auxiliary files and will run your compiler of choice as many times as needed. It will know when to stop by checking the auxiliary files: if they do not change anymore between runs, we must have hit a "steady state" and the produced document will be ready.

Since it does not natively do well with either **glossaries-extra** or **splitidx**, this project contains a file `latexmkrc` in its root. It is a configuration file written in Perl, letting `latexmk` know about the auxiliary files of those two packages and what to do with them. The tool will look for its configuration file in the project root and find it there.

Now, you can start from absolute scratch, with no auxiliary files generated yet at all. All you need is a TeX distribution and Java (for **bib2gls**)! I recommend TeXLive: in its full installation, it ships with all the required tools.

Then invoking **`latexmk yourfile`** will run the entire pipeline, giving you the fully-done end product.

4.1.2 Version Control

LaTeX is well suited for a version control system, specifically Git. Using GitHub or GitLab, you can also have your document built automatically, on servers specified (and perhaps paid for) by you. You could be editing LaTeX source code on your phone, push it to the remote repository, and download the compiled document.

If using Git, each text line should also be on its own line of code. Should you bunch multiple text sentences into one line of code, diffing will be harder.

Continuous Integration

If you are on GitLab, you can configure your runner with the YAML file found in the project root (the runner will expect it there anyway). The runner you need to provide yourself; perhaps, your university has one. I do not yet have an analogous Travis-CI configuration for GitHub.

Docker The Continuous Integration (CI) configuration for GitLab relies on a docker image found here:

https:
//cloud.docker.com/u/alexpovel/repository/docker/alexpovel/javalatex

Its `Dockerfile` does `apt-get update -y texlive-full` and as such, will download a *massive*, full TeXLive distribution. That is still worth it and nice to have, so we do not have to specify packages manually ourselves. The file's second important part is of course Java for **bib2gls**.

Metadata   In the project root, you will notice a file `gitmeta.txt`. This is my pathetic approach of breathing some dynamic metadata printing into the produced document. You can see the result of that on of this document, right after the title page. LaTeX is made to read the contents of that `gitmeta.txt` file and implements it. The text file's default contents are printed if we do not involve it in our building process.

We could change the `*.tex` contents directly using the `sed` commands from the `.gitlab-ci.yml` file, but I reckoned going for an external file would make the `*.tex` file more robust and stand-alone.

You can will the file out manually (highly discouraged and besides the point) or have it, as is configured for GitLab in `.gitlab-ci.yml`, done by the building process on your runner.

That way, you will never lose track of your finished versions either. Usually, you won't be able to tell what commit or tag a generated PDF belongs to once it is in circulation. But hard-printing that, we can always go back to the very specific commit it belongs to.

4.2 Random Thoughts

- If you don't intend to allow `\par` in your custom macros, use the starred variant of `\newcommand`.
- Put `{braces}` around anything where it is applicable. That includes sub- and superscripts that consist of only one character. `x^2` will work, but `x^{2}` will ensure nothing breaks down the line, *e.g.* when automatically replacing stuff. Superfluous braces don't hurt, but their lack can bite you.

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