KICK-STARTING YOUR MS OR PHD RESEARCH

SUGGESTIONS FOR MEMBERS OF THE BESSA GROUP

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Proefschrift

ter verkrijging van de graad van doctor
aan de Technische Universiteit Delft,
op gezag van de Rector Magnificus Prof. dr. ir. Tim van der Hagen,
voorzitter van het College voor Promoties,
in het openbaar te verdedigen op dinsdag 1 januari 2019 om 10:00 uur

door

Miguel BESSA

Werktuigkundig ingenieur,
University of Porto, Porto, Portugal,
geboren te Porto, Portugal.

Dit proefschrift is goedgekeurd door de

promotor: prof. dr. I. Richardson

Samenstelling promotiecommissie:

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Prof. dr. ir. T. van der Hagen,	Technische Universiteit Delft
Voorzitter,	
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Prof. dr. W.K. Liu,	Northwestern University
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Dr. M.A. Bessa heeft in belangrijke mate aan de totstandkoming van het proefschrift bijgedragen.

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A bit of creativity transforms minimum innovation into maximum results.
Imagine what a lot of creativity can do.

M.A.B.

SUMMARY

This document intends to establish a baseline for everyone in our research group. Hopefully, it will facilitate cooperation between all of us. As a computational group, we like Linux, Github and LaTeX. Therefore, this document provides a brief introduction to these basic tools.

SAMENVATTING

Samenvatting in het Nederlands...

CONTENTS

1

INTRODUCTION

THE introduction chapter should be short (1 to 3 pages). In the first paragraph, briefly refer the intent of this work and the main solution proposed. Then use the following paragraphs to provide the Big Picture[1], and discuss the main challenge(s) without presenting alternative solutions (that's for Chapter 2). The last paragraph typically contains the thesis' structure.

Parts of this chapter have been published in Computer Methods in Applied Mechanics and Engineering **320**, 633 (2017) [1].

[1] In other words: Why should we care? Including one figure motivating the thesis can be useful.

2

LITERATURE REVIEW

In our research group we do not publish literature review articles, and it will be difficult to convince me to change this policy[1]. We publish original research. This has consequences for this chapter of your thesis:

- Keep it short. My suggestion[2]: approximately 10 to 20 pages.
- Include lots of **relevant** references [1, 2] and briefly summarize the work.
- In general, do **not** include the details of the articles you cite. Some articles can (and should) be described in more detail, but only when they introduce essential knowledge to understand your work.
- Usually, an article can be summarized in one (or a few) sentences. Remember, the reader can always go to the original articles to understand the details of *someone else's* work!

This policy has a couple of consequences:

1. Your first paper will not be as easy as a literature review (sorry!)
2. You cannot use a large literature review as a scapegoat for not being original ;)

Note that this does not mean that a literature review is not important. On the contrary, knowing the literature well is usually the first step for good research. It is important for you to **know** the research well, but you don't need to teach the reader about past research. You just need to **guide** him/her through that maze in a coherent and helpful way...

[1] You can always try!

[2] As with everything I write here (or say...): use your judgment! Sometimes there are good reasons for having even shorter or longer literature reviews.

3

YOUR INNOVATIVE CHAPTER

THIS is the Chapter where the magic starts! Here you have to find a balance between providing enough detail and not disrupting the storyline of your work. This is usually achieved by a combination of two points:

- Strive for a concise writing style (write a first draft and then start shortening it progressively)
- In the chapters include only key figures and tables. Think about what is essential to understand your work
- Use the Appendix! You can include many details and additional results in the appendix. See Appendix A for a few more comments on this.

4

INTRODUCTION TO LATEX AND THIS TEMPLATE

THIS document is intended to be both an example of the TU Delft dissertation template for LaTeX, as well as a short introduction to its use. It is not intended to be a general introduction to LaTeX itself,[1] and we will assume the reader to be familiar with the basics of creating and compiling documents.

Instructions on how to use this template under Windows and Linux, and which LaTeX packages are required, can be found in `README.txt`.

4.1. DOCUMENT STRUCTURE

Since a dissertation is a substantial document, it is convenient to break it up into smaller pieces. In this template we therefore give every chapter its own file. The chapters (and appendices) are gathered together in `dissertation.tex`, which is the master file describing the overall structure of the document. `dissertation.tex` starts with the line

```
\documentclass{dissertation}
```

which loads the dissertation template. The template is based on the LaTeX `book` document class and stored in `dissertation.cls`. The document class accepts several comma-separated options. By default, hyperlinks are shown in cyan, which is convenient when reading the dissertation on a computer, but can be expensive when printing. They can be turned black with the `print` option. This will also turn the headers dark gray instead of cyan. Moreover, it will add a 3 mm bleed around the page including crop marks. This will help the printer with the thumb indices, since they run right up to the

[1] We recommend http://en.wikibooks.org/wiki/LaTeX as a reference and a starting point for new users.

page borders. Finally, the `nativefonts` option can be used to override the automatic font selection (see below).

A dissertation is a big document, which makes it easy to miss warnings about the layout in the LaTeX output. In order to locate problem areas, add the `draft` option to the `\documentclass` line. This will display a vertical bar in the margins next to the paragraphs that require attention.

The contents of the dissertation are included between the commands `\begin{document}` and `\end{document}`, and split into three parts by

1. `\frontmatter`, which uses Roman numerals for the page numbers and is used for the title page and the table of contents;
2. `\mainmatter`, which uses Arabic numerals for the page numbers and is the style for the chapters;
3. `\appendix`, which uses letters for the chapter numbers, starting with 'A'.

The title page is defined in `title.tex` in the `title` folder and included verbatim with `\include{title/title}`,[2] (see below). Additionally, it is possible to include a preface, containing, for example, the acknowledgements. An example is in `preface.tex`. The table of contents is generated automatically with the `\tableofcontents` command. Chapters are included after `\mainmatter` and appendices after `\appendix`. For example, `\include{chapter_1/chapter_1}` includes `chapter_1.tex`, which contains this introduction.

4.2. TITLE PAGE

THE title pages are defined in `title/title.tex`, which you will have to modify according to your needs. Note that these pages are subject to the requirements of the *promotieregelement* and cannot be changed at will. Apart from the names and dates, most of the Dutch text is dictated literally.

Since the thesis title and name of the author appear several times throughout the document (on the title page, but also in, *e.g.*, the preface and cv), special commands are provided so they only have to be specified once. The title (and optional subtitle) can be specified with

```
\title[Optional subtitle]{Title}
```

The name of the author is specified with

```
\author{First name}{Last name}
```

Note that the first and last name are separate arguments, since they may be printed in different font shapes. The `\title` and `\author` commands also ensure that the title and author appear in the metadata of the final PDF.

[2] Note that it is not necessary to specify the file extension.

See `title/title.tex` for detailed documentation on the comment and layout of the title pages. Logos of institutes that have contributed financially to the dissertation may be included on reverse side of the title page. A few example logos can be found in the `title/logos` folder.

4.3. CHAPTERS

EACH chapter has its own file. For example, the LaTeX source of this chapter can be found in `chapter_1.tex`. A chapter starts with the command

```
\chapter{Chapter title}
```

This starts a new page, prints the chapter number and title and adds a link in the table of contents. If the title is very long, it may be desirable to use a shorter version in the page headers and the table of contents. This can be achieved by specifying the short title in brackets:

```
\chapter[Short title]{Very long title with many words which could
not possibly fit on one line}
```

Unnumbered chapters, such as the preface, can be created with `\chapter*{Chapter title}`. Such a chapter will not show up in the table of contents or in the page header. To create a table of contents entry anyway, add

```
\addcontentsline{toc}{chapter}{Chapter title}
```

after the `\chapter` command. To print the chapter title in the page header, add

```
\setheader{Chapter title}
```

If (parts of) the chapter have already been published elsewhere, it is customary to add a reference. This can be done with the special unnumbered footnote command `\blfootnote`. For example,

```
\blfootnote{Parts of this chapter have been published in Annalen
der Physik \textbf{324}, 289 (1906) \cite {Einstein1906}.}
```

generates the footnote at the beginning of this chapter. Because this footnote is unnumbered, the `hyperref` package may throw a warning, which safely be ignored.

If multiple people have contributed significantly to this chapter, they can be lister with the `\authors` command. This can be followed by a quotation using `\epigraph` as shown in the beginning of `chapter_1.tex` (most was commented out). Finally, there is also the option to include an abstract in the beginning of a chapter (except perhaps the introduction). This can be accomplished with the `abstract` environment (an example is also found in `chapter_1.tex`). In the case that you want to create an abstract for the chapters it should be followed by `\newpage` to start the chapter text on a new page.

Chapters are subdivided into sections, subsections, subsubsections, and, optionally, paragraphs and subparagraphs. All can have a title, but only sections and subsections are

numbered. As with chapters, the numbering can be turned off by using `\section*{...}` instead of `\section{...}`, and similarly for the subsection.

4.4. SECTION TITLE

This is an example of a section. Table 4.1 is an example of a simple table, while Figure 4.1 is a simple figure that is in the middle of the text.

Table 4.1: Example table

First column	Second column
parameter	1
parameter	2

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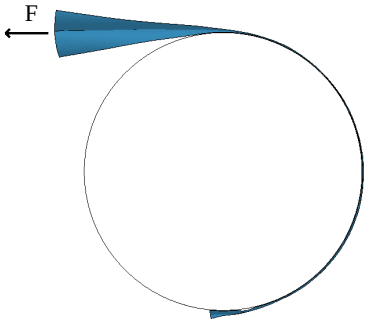

Figure 4.1: Example figure.

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ANOTHER SECTION BUT WITHOUT BEING NUMBERED

Regular figures without subfigures are easy. See Figure 4.2.

Table 4.2 is a slightly more complicated table. You can use the command `tabular` or `tabularx` (Google it!).

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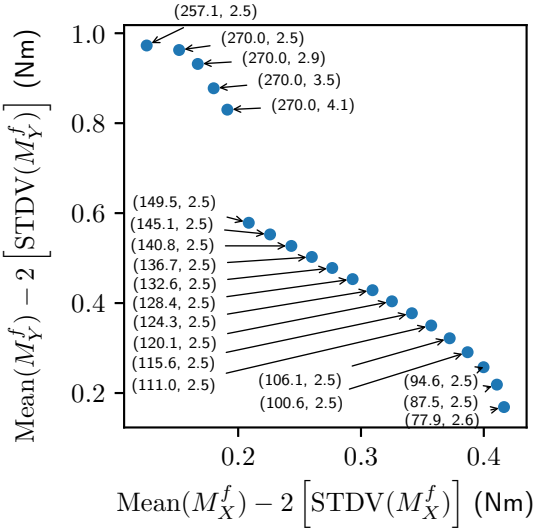

Figure 4.2: Pareto frontier [2].

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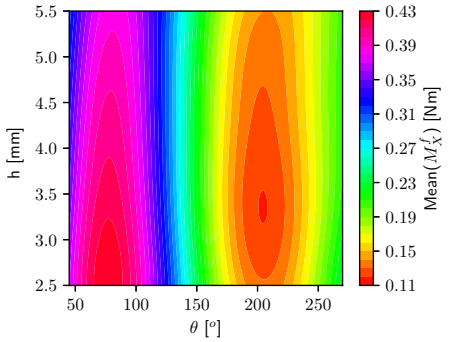
Table 4.2: Examples of pattern detection applications.

Field	Application	Input	Output
Bioinformatics	Sequence analysis	DNA sequence	Known types of gene
Data Mining	Finding meaningful patterns/relations	Points in multi-dimensional space	Clusters/Predefined Values
Speech recognition	Chat-bots	Soundwave	Spoken Words
Image analysis	Face recognition	Pixels	Personal Identity

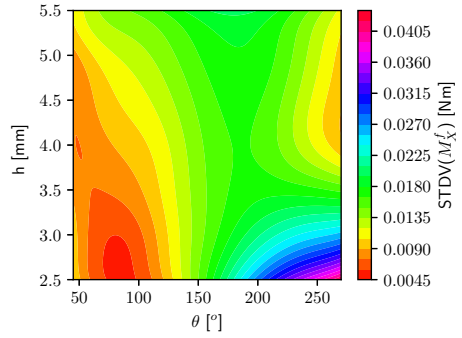
4.4.1. SUBSECTION TITLE

A figure with multiple subfigures is shown next. You can refer to each subfigure individually, for example look at Figure 4.3c.



(a) Mean ultimate buckling moment in X

(b) Mean ultimate buckling moment in Y



(c) Standard deviation of ultimate buckling moment in X

(d) Standard deviation of ultimate buckling moment in Y

Figure 4.3: Distribution of mean and standard deviation of the ultimate buckling moments obtained by bending the structure around X and Y [2].

A SUBSUBSECTION TITLE

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An highlighted paragraph Lorem ipsum dolor sit amet, consectetur adipisicing elit, sed do eiusmod tempor incididunt ut labore et dolore magna aliqua. Ut enim ad minim veniam, quis nostrud exercitation ullamco laboris nisi ut aliquip ex ea commodo consequat. Duis aute irure dolor in reprehenderit in voluptate velit esse cillum dolore eu fugiat nulla pariatur. Excepteur sint occaecat cupidatat non proident, sunt in culpa qui officia deserunt mollit anim id est laborum.

4.5. REFERENCES

References in this template are treated in the standard way, i.e. using only one file (here named: `references.bib`) that is called after the conclusion chapter (Chapter 6). This makes it simple to compile the document with a standard Latex editor, e.g. TeXstudio.

The original TUD latex template allows to put the references at the end of each chapter (instead of putting them all together at the end of the thesis). If you want to do this, see Appendix B. The bibliography style is specified in `dissertation.bst`, which is a modified version of `apsrev4-1.bst` (from REVTeX) designed to also display the titles of referenced articles. The template will automatically generate clickable hyperlinks if a URL or DOI (digital object identifier) is present for the reference. Although it is possible to manage the bibliography by hand, we recommend using EndNote (available from Blackboard) or JabRef (available from http://jabref.sourceforge.net/).

4.6. FONTS AND COLORS

THE fonts used by this template depend on which version of LaTeX you use. Regular LaTeX, *i.e.*, if you compile your document with with `latex`, `pslatex` or `pdflatex`, will use Utopia for text, Fourier for math and Latin Modern for sans-serif and monospaced text. However, if you want to adhere to the TU Delft house style, you will need to use XeLaTeX, as it supports TrueType and OpenType fonts. Compiling with `xelatex` will use Bookman Old Style for titles, Tahoma for text, Courier New for monospace and Cambria for math. If you want to use XeLaTeX, but do not want to use the TU Delft house style fonts, you can add the `nativefonts` option to the document class.

This template supports the use of drop caps, a large colored initial at the beginning of a chapter or section, via the `\dropcap` command:

```
\dropcap{L}{orem} ipsum...
```

The first argument is the capital that will be printed on two lines (in the title color), and the second argument is the rest of the word. Depending on the font, the latter may be printed in small caps.

The corporate colors of the TU Delft are cyan, black and white, available, respectively, via `\color{tudelft-cyan}`, `\color{tudelft-black}` (which differs slightly from the default `black`) and `\color{tudelft-white}`. Apart from these three, the house style defines the basic colors

- tudelft-sea-green,
- tudelft-green,
- tudelft-dark-blue,
- tudelft-purple,
- tudelft-turquoise and
- tudelft-sky-blue,

as well as the accent colors

- tudelft-lavendel,
- tudelft-orange,
- tudelft-warm-purple,
- tudelft-fuchsia,
- tudelft-bright-green and
- tudelft-yellow.

5

DISCUSSION

HAVING a chapter for the discussion of the results is not mandatory, but it is usually very useful. Again, unfortunately most people will not read the entire thesis[1]. They will read the abstract (summary), see the figures and then read the Discussion and Conclusions. Only if the findings are worthwhile, then they may read part or all of the content.

Therefore, you want to devote a lot of time to the parts that are most important: Abstract, Discussion and Conclusions. Of these 3, the "Discussion" is perhaps the most difficult because you need to demonstrate that you have good critical reasoning about the work you did:

- What is the general impact of your work?
- What do the results mean?
- Compare your results with the literature (in a concise manner, and only if applicable).
- Be specific about the improvements you made (whether there is prior literature or not), but also discuss the limitations of your work.
- Highlight unexpected results (if any).

You need to be short but extremely on point. One strategy is to start general (to increase the relevance of your work), but then to be very specific in order to demonstrate that your work is truly useful to solve a particular problem.

[1] But do not worry: I will.

6

CONCLUSION

This is a concluding chapter explaining the scientific and technical implications for society of the research findings in considerable detail.

REFERENCES

[1] M. Bessa, R. Bostanabad, Z. Liu, A. Hu, D. W. Apley, C. Brinson, W. Chen, and W. Liu, *A framework for data-driven analysis of materials under uncertainty: Countering the curse of dimensionality,* Computer Methods in Applied Mechanics and Engineering **320**, 633 (2017).

[2] M. Bessa and S. Pellegrino, *Design of ultra-thin shell structures in the stochastic post-buckling range using bayesian machine learning and optimization,* International Journal of Solids and Structures **139-140**, 174 (2018).

A

A NICE APPENDIX

Nowadays, a smart use of the appendix is becoming more and more important. People do not have enough time to read long documents anymore (that's the truth...). So, the best journal articles (Nature & Science) adopted a format where there is a short "main body" and then there is a long "Supporting Information" (which is the Appendix of a thesis).

My general advice is for you to do the same. Write concisely the essential information that you put in the main body. Focus on the main message and the key storyline. Then, leave to the appendices all supporting results, modeling details, secondary arguments, etc.

B

REFERENCES AT THE END OF CHAPTERS

Some people like to have the references at the end of chapters, instead of at the end of the thesis. However, compiling the document becomes a little less convenient and I do not see the benefit of doing this. Anyway, in case you want to do that then you need to edit the `dissertation.cls` file by uncommenting the `chapterbib` package and including `sectionbib` in the `natbib` package. Then, you have to include the special command `\references{references}` at the end of **each** chapter (for example, at the end of `chapter_1.tex`). Note that the references are included in the file `references.bib`.

Also note that if you want to have references at the end of chapters you need to run a command like `bibtex chapter_1/chapter_1` for each chapter. For convenience, a "Makefile" is also available (although you need to edit it), so you can run this file and compile the entire document such that references are put at the end of each chapter. Again, my recommendation is to just ignore this completely, and use the standard format of references at the end of the thesis.

Curriculum Vitæ

Miguel Bessa

14-03-1879	Born in Ulm, Germany.

Education

1892–1896	Grammar School Luitpold Gymnasium, Münich (1892–1895) Aurau, Switzerland (1895–1896)
1896–1900	Undergraduate in Mathematics & Physics Eidgenössische Polytechnische Schule Zürich
1905	PhD. Physics Eidgenössische Polytechnische Schule Zürich *Thesis:* Eine neue Bestimmung der Moleküldimensionen *Promotor:* Prof. dr. A. Kleiner

Awards

1922	Nobel Prize in Physics
1925	Copley Medal
1929	Max Planck Medal
1999	Time magazine's person of the century

List of Publications

4. **A. Einstein**, *Ist die Trägheit eines Körpers von seinem Energieinhalt abhängig?*, Annalen der Physik **18**, 639 (1906).

3. **A. Einstein**, *Zur Elektrodynamik bewegter Körper*, Annalen der Physik **17**, 891 (1905).

2. **A. Einstein**, *Über die von der molekularkinetischen Theorie der Wärme geforderte Bewegung von in ruhenden Flüssigkeiten suspendierten Teilchen*, Annalen der Physik **17**, 549 (1905).

1. **A. Einstein**, *Über einen die Erzeugung und Verwandlung des Lichtes betreffenden heuristischen Gesichtspunkt*, Annalen der Physik **17**, 132 (1905).