



TU Clausthal

Master Thesis

by

First name, middle names and family name

Title of Master Thesis

1st Supervisor: **TUC Supervisor I**

2nd Supervisor: **TUC Supervisor II**

Industry Supervisor: **if applicable**

A yellow scroll graphic with a brown border and a small brown circle at the top right corner.

Possible Industry
Logo

8th April 2020

Institute of Petroleum Engineering
Clausthal University of Technology

Declaration of Authorship

I have read and understood the guidelines of the Technical University of Clausthal and those published in the ITE bulletin, including those regarding the use of literature and other sources. I confirm that I have prepared this thesis independently by myself. Any information taken from other sources and being reproduced in this thesis is clearly referenced.

In terms of the general examination regulations, this work has not yet been submitted to any other examination division.

I hereby agree that my master thesis may be exhibited in the institute's library and kept for inspection. **Note: is not applicable if the thesis is rated as confidential in the companies agreement!**

Clausthal-Zellerfeld, 8th April 2020

Location, Date

First name and family name

Abstract

Depending on the scope of your thesis, describe the work you have performed in one or two pages.

Zusammenfassung

If you write your thesis in English (obligatory for master students), you have to hand in the abstract in German language, too.

Acknowledgements

If you have to say thank you, you can do it here. If you write your thesis in a company, it is often expected to thank them for their support etc. It is also a good chance to give credits to those, who helped you until this point like the assistant that supervised you, scientific staff, that did a lot of supporting work, friends, family

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List of Tables

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Abbreviations

CP	credit point
EOR	Enhanced Oil Recovery

Symbols

k	permeability
-----	--------------

Units

mD	millidarcy
cm	centimetre

1 Introduction

Here you usually discuss the motivation behind this work, the objectives as well as the outline of your thesis.

In the following sections, some background information for this template and style guides are given as well as the work flow from start of the thesis work until your defence.

1.1 Before the thesis work starts

1.1.1 Prerequisites

The following requirements are described separately in case of a bachelor and in a master student case. They comply with the study regulations for the Bachelor program “Energy and Mineral Resources field of study” “Petroleum Engineering” (AFB 6.10.52, 2015) and the Master program Petroleum Engineering (AFB 6.10.54, 2015). In exceptional

Table 1.1: Prerequisites to start Thesis

BSc Thesis / 12 CPs	MSc Thesis / 28 CPs
<ul style="list-style-type: none">• Proof of 150 CPs completed• Completion of the following modules¹<ul style="list-style-type: none">– Engineering Basics Modules: B1, 2, 3, 4, 5,6, 7, 10, 11– Fundamental Petroleum Engineering Modules: B 23, 24, 25, 26, 27– Seminar	<ul style="list-style-type: none">• Proof of 80 CPs completed• All the modules except the group project must be completed

¹ Other courses at supervisors request

cases after consultation and consideration of both supervisor and professor, particular M.Sc. candidates can be allowed to begin with the thesis work prior to achieving 80 credit points (CPs).

Once the prospective B. Sc. and M. Sc. candidates are close to fulfil the required scope of academic achievements (CPs), they can start to look either for potential thesis

topics, in-house (ITE) or from the appropriate external supervisors. Before moving to Step A.2., print out a copy of the actual “Notenspiegel” to approach a potential advisor.

1.1.2 Assignment of Thesis Topic

To be assigned to a prospective candidate a relevant topic proposal for the B.Sc or M.Sc thesis offered by a potential supervisor, who could be a teaching or research staff member at the Institute of Petroleum Engineering, a relevant facility of the Clausthal University of Technology, a partner university, as well as a qualified member of a partner petroleum R&D or service company, must be approved by one of the department heads of ITE responsible for the petroleum engineering degree-course or the field of study. Depending on whether the prospective B. Sc. or M. Sc. candidate would prepare the thesis with the external or internal supervisor, a thesis topic constructed and assigned by the industry is not allowed. Industry proposals are welcomed but each topic should be assigned by the ITE. At the end of this step, the thesis candidate holds a signed copy of the thesis declaration in hand, knows the thesis topic, the thesis advisor and is aware of the time duration for the work to be completed. From the date written on the declaration, the candidate has 16 weeks to register the thesis at the examination office. Note, that failure to register the thesis at the examination office will AUTOMATICALLY cause that the declaration document becomes invalid and the thesis topic is withdrawn.

1.2 During the thesis work

1.2.1 Thesis Preparation and Supervision Requirements

- The thesis work should be organized by a candidate in a close contact with the advisor and in accordance with the objectives and scope described in the “Declaration”
- At least monthly consultation with the advisor or/and other responsible persons at the ITE is required during the work on the thesis. Typically, more frequent meetings will improve the thesis quality and are suggested.
- To layout the thesis report, the candidates are required to use the provided template available in the ITE Bulletin under BSc./MSc. Template (link) (Merge: Layout of a report or thesis + How to prepare.). ITE also offers thesis template

for download. Content and the Structure of the thesis report is recommended in accordance with the guidance of the provided template.

- In order to support the candidates we require a midterm progress report (optionally presentation, written document, etc.).

Management of changes in title, content or deliverables: any deviation from the agreed thesis declarations are to be communicated and requires approval from the department head by signing an informal addendum to the thesis declaration which defines the approved changes. Unauthorized changes to the thesis title or content by the student may cause failure or non-acceptance of the work.

1.2.2 Is your thesis ready? Submit your final draft to Advisor

- This step is optional, but recommended – please agree with the advisor, if this step is for you! If not, go directly to section 1.3.
- Note that ALL theses will go through a plagiarism check. Doing the plagiarism check at this level through your advisor is beneficial for you – because it is without consequences.

1.3 Thesis Submission and Presentation

1.3.1 Thesis Submission

- Once the thesis work is complete, submit a digital copy of the work (PDF version) to advisor and professor. This version will be used to perform a plagiarism check with the Turnitin software. (NOTE: Only if the plagiarism check was successfully passed and after the thesis was submitted, the student must request/ register to an appointment for thesis presentation.)
- Submit three (3) printed and binded versions of the thesis to the examination office. An electronic copy of the thesis report and presentation, commonly on a USB stick (or CD), must be added and submitted with the thesis report.

1.3.2 Thesis Presentation

- The thesis must be presented at the colloquium of a respective department at the institute. Schedule and venue of the colloquium for a corresponding semester

period (WS: September-December; SS: April-July) will be announced by the departments.

- The presentation dates are to be scheduled for Tuesday afternoons by the secretary offices of the department of Reservoir Engineering (Jessica Lürer) and the Drilling & Production (Marion Bischof). The presentation announcements will be posted at the foyer entrance area and it will be available on the website.
- The candidates are recommended to use the ITE PowerPoint presentation template. The duration of the thesis presentation must not exceed 20 min. The thesis presentation and the results are discussed thereafter. The total duration including discussion can take up to 60 min.
- A copy of the final presentation must be sent prior to the presentation date to the thesis advisor.

2 Styleguide and L^AT_EX manual

The original template was written with L^AT_EX. At first, it seems difficult and complex, but it makes writing large documents very easy. You can also write your thesis with Word or similar open access programs, but you have to insert many things manually. Therefore, we provide this template with detailed explanations on how to use L^AT_EX and insert many examples you can directly use with slight modifications. It is still advisable to get familiar with the basics of L^AT_EX. Fast help and many easy tutorials can be found on the world wide web.

In the following sections, we will apply many methods that L^AT_EX offers for you to see in the output 00Thesis.pdf file to directly compare with the commands used in the %.tex files. If any problems occur, there is numerous literature in the library. Due to fast changes and current development of usepackages it is recommended to ask the internet.

For Word users: The following sections are also an useful example, how to nicely organise your document. Sadly, you will have to do most of the formatting manually and as many of you might already experienced, that can be a very laborious business, if you try to apply some fast changes. Please use a serif font with 12pt font size like Times New Roman. The spacing should be set to one and a half for easy reading.

2.1 Installation

First you need to install a TeX distribution on your system. You can install either MikTeX (<https://miktex.org/download>) or TeX live (<https://tug.org/texlive/acquire-netinstall.html>). MikTeX has the advantage, that instead of installing the whole available package of TeX programs as TeX live does, it installs a basic setting and updates needed programs on the fly. However, you need a working internet connection when using new usepackages.

In the second step, you install a TeX editor. There are many editors available like TeXmaker, TeXStudio, TeXworks, TeXlipse ...Choose one and install. For an easy start, TeXStudio, which automatically recognises your MikTeX installation, or TeXmaker are recommended.

2.2 Start writing

L^AT_EX offers many advantages like automatic numbering, positioning of tables and figures, easily referencing chapters, sections, tables and figures and automated citation. First of all, it is hardly possible to make any spacing typos. It does not matter, how many spaces you have between your words, L^AT_EX takes only your text input. Furthermore, you can easily reread your written words, because you can put each sentence in a new line, which means if you insert your corrections, you can easily find the sentences by their first words.

New paragraphs are formed by skipping one line and the first sentence is automatically intended. How it looks like in the source file? Like this:

```
First of all, it is hardly possible to make any spacing typos.
```

```
It does not matter, how many    spaces you have between your words, \LaTeX takes only
Furthermore, you can easily reread your written words, because you can put each sente
```

```
New paragraphs are formed by skipping one line and the first sentence is automatically
How it looks like in the source file? Like this!
```

L^AT_EX sets the spacing in justifications automatically as Word does, but it also executes the hyphenation on its own. However, this automation has some disadvantages. For example it will insert the larger spacing after a “.” also after dots for other purposes like abbreviations. Here you have to insert the forced spacing “~” like in Prof. Dr. X or f. e. This forced spacing can also be used to avoid line break in those wordgroups, that have to be printed in one block like nameprefixes or referenced objects like Figure Y.

To avoid line breaks in units, use either “\,” or utilise the `siunitx` package to set a smaller protected spacing between the value and the unit: 10 g or 10 g. This package has more to offer, if you are having more complex units like the gravitational force 9.81 m s^{-2} . To find out, what this package offers and which units are provided, you should read its package documentation (this goes for other L^AT_EX packages, too). You can also define your own units to add missing ones like Darcy with `\DeclareSIUnit\Darcy{D}` in the preamble.

L^AT_EX offers many formatting tools like **bold**, *italic*, underline, *emphasizing*, various **colours** (A list of L^AT_EX colours can be found by a simple internet research). Here we already defined some additional colours with `\definecolor{text}{model}{color-spec}` like the TUC **green**, **red**, dark grey, light grey or the **Word blue**. Also you can write text in

^{superscript} or _{subscript}. With some easy commands you can also vary the **Textsize** if needed in special occasions. The standard font size should remain `\normalsize` with 12 pt.

2.3 Structuring your thesis

In bachelor and master theses it is not recommended to have more than three structure layers (you are not writing a book!). If you need more layers in one chapter, you should rethink your structure. Obviously, one of your sections is significant enough to get its own chapter.

The document class in L^AT_EX is `scrreprt`, which offers chapters as the highest structuring element, then sections, subsections, subsubsections and paragraphs. However, you should not go lower than subsubsections, which are already excluded from the table of content, do not have a numbering (in this template, usually everything is numbered until paragraph) and are might used to give a large subsection a tidier order.

Each chapter starts with a new page and in case of L^AT_EX users with a new `.tex` file. This chapter page does not have a heading, all following pages have the heading with the number and title of the current chapter (*sorry, no idea how to do that in word manually or if it is even possible*). In L^AT_EX you can write as many single files as you want and simply insert them with either `\include{}` (for whole chapters, because it starts a new page) or `\input{}`, which inserts the written text without interruption (if you want to insert larger texts or very big tables separately). This is another advantage of L^AT_EX: you can write your thesis in small bits and put them together instead having one endless document which makes you scroll through forever.

You should always refer to you tables and figures in your texts and number them according to their appearance. It is recommended, to use the number of the chapter and then start counting figures and tables separately for each chapter. This comes in handy, if you have many tables and figures included in you thesis, for smaller reports it is not necessary. In L^AT_EX, the numbering is done automatically and you can refer to figures and tables (as well as equations, chapters, sections,...) by giving them a label `\label{key}` and use this as a reference with `\ref{label}`. In subsection 1.2.2 we already used this to refer to section 1.3. You should use reasonable label keys with prefixes for what you label. This makes the search for your labels much easier, because many L^AT_EX editors like TeXstudio are suggesting already used keys while writing so you only have to chose from the list by clicking on one suggestion. In this template, we used `\label{tab:}` for tables, `\label{fig:}` for figures, `\label{ch:}` for chapters, `\label{sec:}` for sections

and `\label{subsec:}` for subsections. If you have any other questions, have a look at Table 2.2.

2.4 Tables

For a tidy table layout, avoid vertical and double lines. Vertical lines often interrupt reading a row and lead easily to skip lines or columns when searching for data. Writing table in L^AT_EX is often a laborious business an one of its disadvantages, but the results are simple and well-arranged as you can see in Table 2.1. The font is slightly reduced with `\footnotesize` or 10pt for Word users. The captions of figures and tables are 10pt, too. How tables and other float objects like figures are positioned in L^AT_EX, is explained in section 2.5!

Table 2.1: Laboratory data

Chemical	T [°C]	p [bar]	k [mD]
H ₂ O	70	1.5	256
NH ₃	60	3.0	512
Brine	80	1.6	1024
2-Propanol	50	1.8	2048

After `\begin{tabular}` you define the alignment of your columns in the bracket `{}`. `c` for center, `l` for left, `r` for right and `pwidth` for a column of fixed width, but without alignment. In this document we defined three extra alignments: `C`, `L` and `R` that align like before, but you can fix the width of the colums. You use this, if you have long texts in your tables as we had in Table 1.1. Fixing the length causes automatical line breaks. Otherwise the table will just expand to the length of the text. You can use `cm`, `em`, `pt` or `ex` as a unit for lenghts or fractions of pageparameters like `0.5\textwidth` or `0.1\textheight`. With `@{\hspace{width}}` between the column alignment paramters you can insert a space for optical optimisation, f.e. if the automated space appears to be to narrow.

If you have very long tables with relevant lab data, L^AT_EX offers the `longtable` environment, that generates tables over more than one page and gives automated subcaptions. With `threeparttable` you can even use footnotes limited only to your table as used in the very helpful Table 2.2.

To make things a little bit easier, you can utilise online tools. They come in very

Table 2.2: Helpful table

Number	Value	Data	Description
1	Answer	42	Asked the question ¹
2	None	— ²	Help!

¹ What was the question?² No data available. Sorry...

handy if you have multirows or multicolumns. https://www.tablesgenerator.com/latex_tables#

2.5 Figures

A for tables, figures are captioned with 10 pt font size, if the default font size is 12 pt. Captions are positioned below figures, caption of tables above them. In L^AT_EX figures are inserted into a document with the command `\includegraphics[keyvals]{imagefile}`. By changing the parameter in the angular brackets, you can choose the height/width of your figure. In the following brackets you give either the name of your file, if it is located in the same folder as your `.tex` or you need to add the filepath as we do it here, because our images are located in the folder labelled “Pictures”.

Here we use `\includegraphics` in an environment, as we did with the tables (see Figure 2.1). This makes them float to the position L^AT_EX thinks is the best and results in a nice and clean layout. This is what `[htbp]`, which stands for here, top, bottom and next page, does: Tries to position the object in this order at the best place. If you do not agree, you can use only one of the placements or force it to the position where you wrote it in the `.tex` file with `!h`.

2.6 Math environment

You can write mathematical equations with the formula editor in Word. In L^AT_EX you use `$...$` to write variables or short equations in a text like temperature T , the differential pressure Δp and more. For larger equations L^AT_EX offers the `equation` environment. For a good and short explanation, how to use the math environment and how to display multiple equations you can go to <https://www1.cmc.edu/pages/faculty/aaksoy/latex/latexthree.html>.

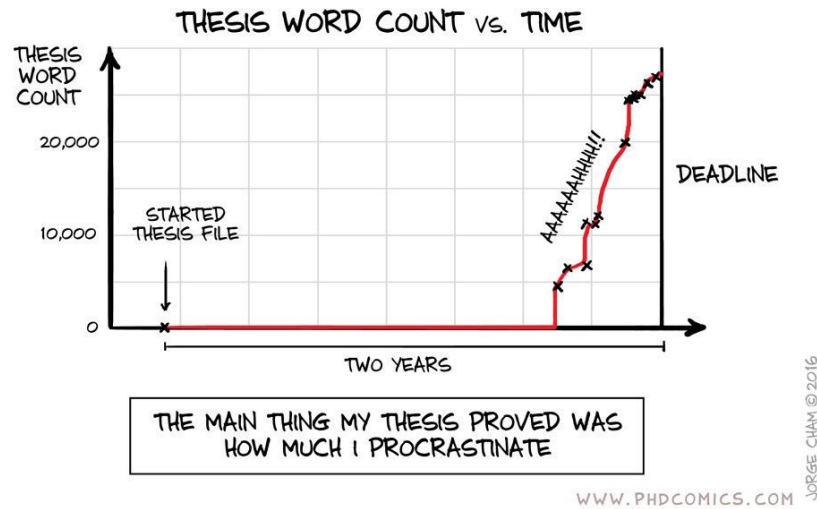


Figure 2.1: Progress of thesis writing (*Time and word range to be adjusted to the scope of your work*)

Here some examples from the link:

$$\int_{\alpha}^{\beta} f'(x) dx = f(\beta) - f(\alpha). \quad (2.1)$$

We can use the fundamental theorem of calculus to say that $\int_2^3 x^2 dx = \frac{3^3}{3} - \frac{2^3}{3} = \frac{19}{3}$. Also note that $\int_2^3 x^2 dx = \frac{3^3}{3} - \frac{2^3}{3} = \frac{19}{3}$. We can also give this equation its own line.

$$\int_2^3 x^2 dx = \frac{3^3}{3} - \frac{2^3}{3} = \frac{19}{3}.$$

2.7 Enumerations

Enumerations should be avoided in a thesis. You should express your thoughts and ideas in a written text. Bullet points are for presentations. In some cases it is feasibly reasonable to use a list, here some examples, how do do them in L^AT_EX. [Word users](#) simple press the right button in the menu header, type and press enter for the next bullet point.

- Maybe
- I
 - should

- write
 - * this
 - * in
 - one
 - sentence.
1. Pour the acid into the water.
 2. Stir for 40 minutes at 60 °C

2.8 Glossaries

First you need to define your glossary entries in the associated `GlossarX.tex` files.

2.8.1 Units/Symbols

To make units and symbols appear in the glossary, you need to reference them in the text with the `\gls{label}` command like: The length is 10 cm. Or you write: The permeability k is 30 mD and use `\glsadd{label}` to add the unit to the glossary.

2.8.2 Acronyms

The acronym is displayed full the first time it is referenced. For example CP is written in its short form, because we already used it in subsection 1.1.1. However, Improved Oil Recovery (IOR) is referenced for the first time and any further mention of IOR will lead to the display of its short form. The commands and their correct use are listed below:

`\gls{label}` This command prints the term associated with `<label>`.

`\Gls{label}` This command prints the singular form of the term with the first character converted to upper case.

`\glspl{label}` This command prints the plural of the defined term if defined or simply add an “s”.

`\Glspl{label}` Same as before with upper case.

`\glsadd{label}` Adds the glossary entry without reference in the text.

`\acrfull{label}` Gives the full acronym with abbreviation.

`\acrlong{label}` Prints the long version of an acronym without the abbreviation.

`\acrshort{label}` Prints only the abbreviation.

...

More informations can be found at <https://en.wikibooks.org/wiki/LaTeX/Glossary>.

2.9 References

Please keep your citations style consistent. There are many citation styles available. For example, SPE prints first the author names directly followed by the year whilst many scientific journals print the publishing year at the close. Therefore you should never simply copy the citations you find in your sources, but write your references in your own consistent and reasonable way. Do not change it mid-work and also consider some guidelines by cited papers. Some journals have to be cited in a specific way and some, like the *Angewandte Chemie* are publishing in two languages, english and german. Here you have to cite the international version alongside the german one or, if only referring to the english version, clearly state it is the international version.^[1] A good guidance can be the SPE style guide you can find at https://www.spe.org/authors/docs/SPE_Style_Guide_2019.pdf and especially for references: https://petrowiki.org/Help:Citing_references. The correct abbreviations in references are listed here: <https://libguides.murdoch.edu.au/APA/abbreviation>

For references in L^AT_EX it is recommended to use BibTeX (https://de.overleaf.com/learn/latex/Bibliography_management_with_bibtex) and the natbib usepackage (https://www.overleaf.com/learn/latex/Bibliography_management_with_natbib). You can collect your references in the `Literature.bib` file and cite them with `\cite{label}`. However, you are limited to the citation styles offered by L^AT_EX.

With the extension bibulous, you can generate customised bibliography entries. Here, we wrote our own style based on the citation style used by most scientific papers and you can add your own templates in the `TUen.bst` file. You can also use the `SPE.bst`, which has the SPE style included and automatically shortens the list of authors to a maximum of three and adds “et. al.” if more authors or editors are present. How to install and use the bibulous add on is explained in the beginning of the main L^AT_EX file `00Thesis.tex`.

Below we listed the entry typed that are defined in the `SPE.bst` style file:

- SPE references
 - `petrowiki`^[2]
 - `proceedingsSPE`^[3]
 - `articleSPE`^[4]
 - `bookspe`^[5]
- Non-SPE references
 - `article`^[6]
 - `book`^[7]
 - `inbook`^[8]
 - `inproceedings`^[9]
 - `wikipedia`^[10]

The result can be viewed at the end of this template in the “References”. Below we listed the entry typed that are defined in the `TUen.bst` style file:

`book`^[7] Books

`inbook`^[11] Chapter/section in a book

`article`^[6] Journal article

`angewandte`^[1] Bilingual journal article of *Angewandte Chemie*

The result is shown in Figure 2.2

References

- [1] Pujari S. P., Scheres L., Marcelis A. T. M., Zuilhof H. *Angew. Chem.* **2014**, *126*, 6438–6474; *Angew. Chem. Int. Ed.* **2014**, *53*, 6322–6356. DOI: 10.1002/ange.201306709.
- [2] Sheng J. J. *Modern Chemical Enhanced Oil Recovery: Theory and Practice*. Gulf Professional Publishing, Burlington, MA, **2010**.
- [3] Somasundaran P. Interfacial Chemistry of Particulate Flotation. In *Advances in Interfacial Phenomena of Particulate/Solution/Gas Systems*, Somasundaran P., Grieves R. B. (eds.). American Institute of Chemical Engineers, New York, **1975**, chap. 1, pp. 1–15.
- [4] Lin Y., Wan L., Krumpfer J. W., Watkins J. J., McCarthy T. J. *Langmuir* **2013**, *29*, 1329–1332. DOI: 10.1021/la303963q.

Figure 2.2: References generated with the TUen.bst style file

3 Title of Chapter 1

This is usually called “Theoretical Background” and illustrates topics of your thesis and the State-of-the-Art.

4 Title of Chapter 2

5 Title of Chapter 3

6 Conclusion

7 Outlook

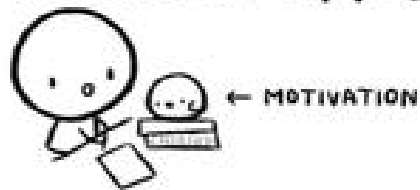
References

- [1] Pujari, S. P., Scheres, L., Marcelis, A. T. M., et al. 2014. Kovalente Oberflächenmodifikationen von Oxiden. *Angew. Chem.* 126, 6438–6474; *Angew. Chem. Int. Ed.* 53, 6322–6356. DOI: 10.1002/ange.201306709.
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- [7] Sheng, J. J. 2010. *Modern Chemical Enhanced Oil Recovery: Theory and Practice*. Burlington, MA: Gulf Professional Publishing.
- [8] Somasundaran, P. 1975. Interfacial Chemistry of Particulate Flotation. In *Advances in Interfacial Phenomena of Particulate/Solution/Gas Systems*, ed. Somasundaran P. and Grieves R. B., Chap. 1, 1–15. New York: American Institute of Chemical Engineers.
- [9] Hauhs, F., Födisch, H., Hincapie, R., et al. 2017. Novel Application of Foam and Air Flooding in Glass-Silicon-Glass Micromodels. In *DGMK-Tagungsbericht 2017-1*, 249–259, Hamburg: German Society for Petroleum and Coal Science and Technology.

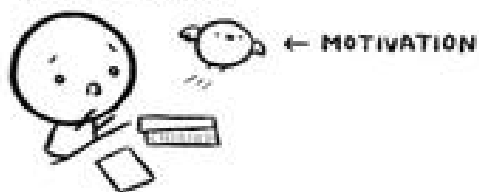
- [10] Wikipedia. 2019. LaTeX. (25 September 2019 revision). <https://de.wikipedia.org/wiki/LaTeX> (accessed 28 October, 2019).
- [11] *Warning: citation key “Particulate Flotation” is not in the bibliography database.*

Appendix

time to start my project!



wait noooo!



CHIBIRAD

Figure A1: Is there hope?