Master Thesis Guide

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TO DO

- [ ] Link to info to graduation procedure (+ procedure on graduation day itself)
- [ ] Presentation guidelines [Timo]

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Contents

1. Introduction

1.1 Who is this guide for?

This document has been written for master students intending to graduate at the section Human-Robot Interaction, of the department Cognitive Robotics (Faculty 3mE, TU Delft). Typically, these include MSc students from: BioMechanical Engineering (specialisations BioRobotics or Haptic Interfaces) and Vehicle Engineering, and (from academic year 2020-2021) the new MSc Robotics. Occasionally, we supervise students from other backgrounds as well. A previous version of this guide has gone 'viral', so it may be of use to people not graduating in our section as well! Note that, the guide has been written with students of the Human-Robot Interaction group in mind, who need to perform at least some kind of human factors experiment. Nonetheless, the guide contains a lot of general tips and tricks that can be applied in other domains.

1.2 Why did we write this guide?

As supervisors, we found that many questions we received concerned the *process* of the thesis project, as opposed to the content. This document covers the process part for the second year of your MSc, ranging from finding a thesis supervisor and topic, to tips for your final presentation.

Note that an MSc thesis project is not a straightforward affair to which a step-by-step 'manual' can be applied. As such, this guide is no more than a guide, it provides a structured approach, examples, and helpful tips & tricks, but that does not mean this is the only way to go about your thesis project. Please also make use of other guides, tips, tricks, conversations with students & staff, and of course your own creativity and common sense.

2. General information

2.1 Graduation process overview

The second year of your MSc consists of three main parts, illustrated in the figure below. The three parts are:

- *Internship*: The internship gives you the chance to explore academia or industry outside TU Delft, although you can also do a research assignment within the department. The topic doesn't need to align with the rest of your thesis project. You will be graded by a short report (10 pages), with a pass or fail.
- *Literature study*: During the literature study, you will need to define a relevant research question that can be answered with literature only, and answer it. This requires you to read and analyze scientific literature, thereby refining your literature research question. You will be graded on a literature report, typically 30-50 pages.
- *Master thesis*: The master thesis is your final project at the TU Delft. During the project you will define your own research question and use the proper scientific methods to answer it.

The literature study and the final thesis project preferably concern the same field of research. This gives you a chance to really dive into the subject. Each part is separately described with more detailed information and tips & tricks. Please be sure to read these chapters before you actually start that specific part!

TO DO
For the formal rules, guidelines and forms that are applicable to the master process, please check graduation website of 3ME, and the Procedure Form.

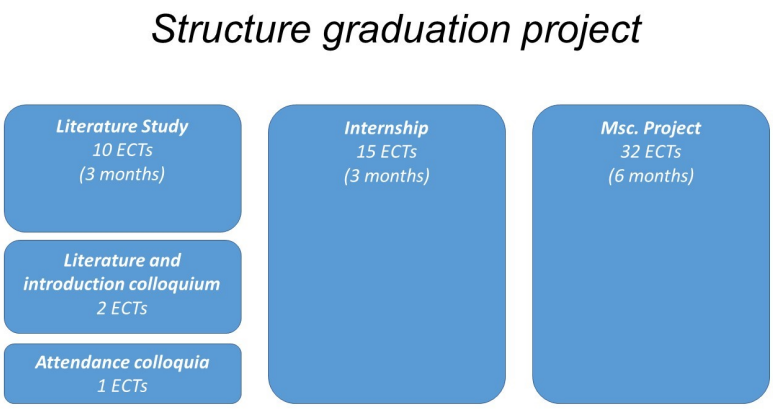


Figure 2.1: Overview of the graduation project.

2.2 Thesis guide overview

This document is complemented by a `Starter_pack.zip`, which contains some useful literature, thesis examples, and MATLAB-code for you to use. The .zip contains the following folders:

- `01 Literature` – The must-reads for every human-interaction researcher, grouped per topic.
- `02 Literature reports` – Examples of good literature reports.
- `03 Data analysis` – Step-by-step explanation of the process of data analysis.
- `04 MSc. reports` – Examples of good MSc. reports.
- `05 MSc. presentations` – Examples of good MSc. presentations.
- `06 MSc. data template` – Template of folders to store your experiment data.

Note that the starter pack is only available to the students of the Human-Robot Interaction group because some of its contents cannot be shared to a larger audience for a number of reasons.

> **TIP**
> When you are about to start a new part of your project (e.g., literature report), take your time to browse through the examples and see how the students before you did it. This will help you get a good idea what you will be working towards.

3. Finding a thesis topic and supervisor

We believe that defining an interesting and relevant research topic is an important part of the graduation project. So, we do not predefine and distribute graduation projects a priori, but we try to find a topic that is interesting for both you and your thesis supervisor.

> **TIP**
> To get a feeling of all the topics and areas, please browse the Delft Haptics Lab website.

Topics of interest & link to website profiles:

- Timo Melman: Driver adaptations to guidance.
- Luka Peternel: Physical human-robot interaction control, exoskeleton control, human motor control and computational neuroscience.
- Michaël Wiertlewski: Design of tactile interfaces for reproducing realistic tactile sensations and the psychophysical study of human perception.
- Arkady Zgonnikov: Modeling driver behavior, traffic interactions between autonomous vehicles and human drivers
- Niek Beckers: Adaptive human-robot cooperation, responsible human-robot interaction, haptic human-human interaction.
- Past topics

3.1 The role of the supervisor

Once you found a topic that interests you, set up an appointment with the relevant persons for an initial meeting to get to know each other.

Daily supervisor (choose wisely): Have **regular progress meetings** (every 1-2 weeks), discuss the small problems you face. The daily supervisor guides you through the process, and is the one you should go to first with problems. So, the daily supervisor points out the devil in the details.

Supervisor (David): Have progress meetings (roughly monthly) and discuss fundamental problems. So, meeting with David is all about the **bigger picture**.

TIP
It is good practice to prepare every meeting with your supervisors in advance. Make a **short overview** of your work in progress (e.g., on paper or in Powerpoint) of your progress since your last meeting. Write down **items** you want to discuss, for example **problems** you have (and how you think they can be solved), and the **next steps** you are planning to take. If possible, send this to your supervisors a day before the meeting, so that they have time to go over them. See `Example_Agenda.pdf` and `Example_WorkInProgress.pdf` in the starter pack for a good example of a progress meeting preparation.

4. Internship

TO DO
See the website of the International Office at 3mE for a checklist of the general steps you need to take for your internship. Here you can also find an overview of the forms that need to be filled out by your supervisor.

4.1 When do you start?

The internship is the first part of your second MSc year. If you are studying nominally, that means it takes place in Q1 (Sept-Oct). You can start at another time too, although this may complicate planning of coursework or holidays. Note that it usually takes around 3 months to arrange an internship, and up to 6 if you do it abroad and need to arrange housing.

4.2 What do you need to start?

You need to have performed most of your first year course work by the time you perform your internship (preferably all of it).

You need to find an internship supervisor who needs to give his/her approval. This involves signing a form (see TO DO box) before you go. The internship supervisor must be a staff member (not a PhD or postdoc) who will be there to help you with any questions, and who will assess your internship report. The internship supervisor will typically not advise you on the content of your internship, and does not have to be your thesis supervisor.

But most importantly, you need to find a place where to perform your internship.

4.3 Where do you perform your internship?

You do your internship either in academia (Netherlands or abroad) or industry/start-ups (Netherlands or abroad).

We recommend Dutch students who have always stayed in Delft to undertake their internship abroad. It is a great experience to get out of your comfort zone! Note that the faculty will sometimes support student initiatives for studying abroad, for example you can apply for scholarships or grants.

4.4 Some of our own contacts

We listed below some companies that are in close contact with researchers from our section, and that have hosted our students before.

4.4.1 International Academia

- Computational Biological Learning Lab, University of Cambridge – The United Kingdom (sensorimotor learning).

- ASpire Centre for Rehabibilitation Engineering and Assistive Technologies (CREATe), University College London – The United Kingdom (surgical robotics).
- Lab of Franck Mars, University of Nantes, France (automotive).
- BioRobotics Lab, Scuola Superiore Sant'Anna – Italy (soft robotics, surgical robotics).
- Lehrstuhl für Ergonomie, Technical University of Munich – Germany (cooperative driving and automation).
- Re-Touch Lab Yon Visell, University of California in Santa Barbara – USA (soft haptics).
- ISIR Sorborne Université – France. (robotics / Teleoperation with the micro-world).
- Lab of Ingvars Birznieks Neura / University of New South Wales – Australia (neuroscience of touch).
- Art&Métiers – Lille,France (collaborative robotics).

4.4.2 Dutch companies

- Heemskerk Innovative Technology B.V. (care robotics, automation, tele-manipulation).
- Sea-tools B.V. (tele-manipulation).
- Philips (automation).
- ESA (space robotics, tele-manipulation).
- MOOG, Inc. (motion control hardware).
- Ampelmann B.V. (motion control for offshore applications).
- Huisman B.V. (offshore equipment, cranes and drill designs).
- Cruden (Moving-base driving simulator manufacturer).
- TNO (haptics/human factors)
- Senseglove (force feedback glove for VR)

4.4.3 International companies

- Nissan Motor Corporation – Japan (automotive).
- VTI, Transportation Research – Sweden (automotive).
- Audi AG, Automated driving department – Germany (automotive).
- Continental Automotive, Automated driving division interior – Germany (interface design).
- Actronika – Paris, France (vibrotactile solutions)
- Force Dimension – Lausanne Switzerland (Force feedback)
- Lofelt – Berlin, Germany (vibrotactile solutions)
- Syntouch – Los Angeles, USA (robotics touch sensors)
- Tanvas – Chicago, USA (surface haptics)
- Ultraleap – Bristol, UK (Mid-air haptics)
- Oculus/Facebook Research – Seattle, USA (VR headset + human factors).

4.5 Assessment

At the end of the internship you are asked to write **a short report** (5-10 pages) where you justify the work you have done and to prove that you have not been used as cheap slave labor. The following aspects will be important: Was the work at the MSc level? Did you work on a coherent project? Please include this in the report. Finally send your report to David Abbink (D.A.Abbink@tudelft.nl).

5. Literature study

Your graduation project at the Delft Haptics Lab - just like any other Mechanical Engineering thesis project - starts with writing your Literature Report (ME51010, 10 ects). For the first time, you alone will be responsible for a large self-defined project. It involves creating a research question that can be answered by literature, **finding and analyzing** the right literature, and **writing** a solid report about it. It can seem like an overwhelming, open-ended challenge at times. To some extent, this is exactly the point... but of course there are also certain pitfalls we can help you avoid!

This chapter aims to give guidelines and suggestions to help you in writing your literature report. Typically the report writing takes **three months** and can roughly be divided into three phases, each requiring approximately one month's work:

1. Orientation & exploration.
2. Structured literature search.
3. Literature documentation.

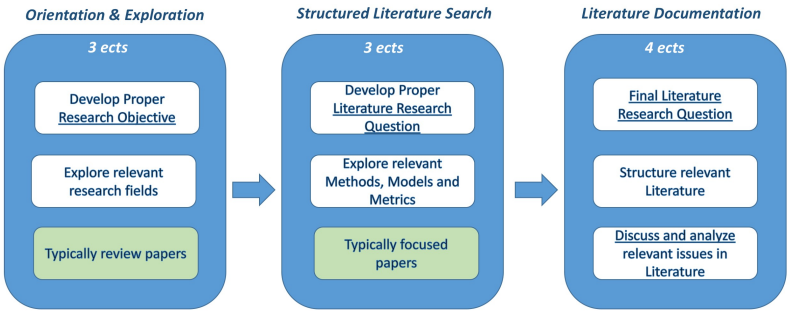


Figure 5.1: Overview of the literature study.

5.1 Step 1: Orientation & exploration

Input:	A rough idea about an interesting topic
Process:	Iterative process of searching relevant literature and refining your literature research question
Output:	Preliminary research question and better understanding of the domain.

You first need to **define your research question**. Remember, the Literature Report is not simply a literature survey, but it should use literature to answer a research question. You should be able to answer your research question with literature, which will help you understand the field (existing solutions, open questions, etc.). You may also include sub-questions that address different aspects of your main question. Do not worry about coming up with the perfect research question at the beginning - you won't be able to do that. Formulating a good research question is an iterative process; it will **evolve and be refined** as you learn more about the field through literature.

TIP
Examples of a good literature research question:
What methods in literature can be used to improve driver-automation interaction by adapting automation to the driver?

Poor research question (too broad):
Can haptic shared control help people drive better?

Poor research question (too specific):
Which assistance technology can result in better lane changing performance for elderly drivers: haptic shared control or visual augmentation?

How to start?
Before diving into the literature, it is helpful to map out your research field. Identify the following to provide some direction before beginning your search:

- Key terms / topics: e.g., haptic guidance, driver models
- Leading researchers / research institutes
- Important journals / conferences: e.g., Transactions on Haptics, Transactions on Human-Machine Systems, Worldhaptics, Eurohaptics and Haptics Symposium
- Seminal articles: David and your daily supervisor can help you get started here. See also the starter pack for several articles that we think might be useful when you start at Delft Haptics Lab

Starter pack: literature
The literature folder (`01 Literature`) in the starter pack contains a good amount of must-reads concerning automation in general, haptics, statistics, etc.

5.2 Step 2. Structured Literature Search

Input:	Preliminary research question & better understanding of the area.
Process:	Find, read, and organize literature; Explore relevant methods/models/metrics.
Output:	Refined research question & structured organization of relevant literature.

The papers you read during Step 1 should give you a good starting point for finding more literature. Previously, you may have focused on broader review articles to get an idea about the field, but now you will need to read more detailed, focused papers to help answer your research question. Here are some general tips about how to perform your literature search:

Where to look for papers?
There are different search engines (**Google Scholar, IEEE Xplore, PubMed, Scopus, Web of Science**) available. Some are more multidisciplinary (e.g., Google Scholar), while some are more focused (e.g., IEEE Xplore for engineering). Thus, some papers may be in one database and not the other. Generally, Google Scholar is a good place to start.

How to find focused papers?
We start the focused literature search with a preliminary research question. It can be that this main question is too broad to answer in one go. If this is the case, you can build a mind map that includes all sorts of associations and aspects of the main question. With this mind-map you can refine your question further with sub-questions. These sub-questions can then be formulated to search queries. The search queries can be formulated from questions as follows:

> I want to find information about developments within the automotive industry concerning the use of different fuels to improve air quality.

Here we have an example that is not related to haptics or driver modelling, however if we have a question on driver modelling, synonyms for driver modelling could be: human steering dynamics,

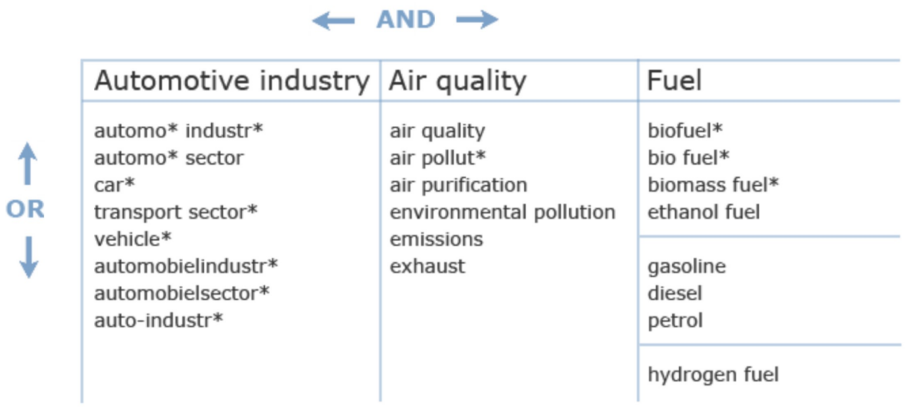


Figure 5.2: An example of combinations of search terms.

cybernetic steering model, human-like driving model, optimal control driver model, etc. Search using the key terms you identified. If you have read a good paper, look up other papers that it cited (past), as well as other papers that it was later cited by (future).

Should I read this paper?
You will come across a lot of papers, but how do you decide if you should spend time reading it? First, does the title sound relevant? If yes, does the abstract seem relevant? If yes, it is probably worth reading. After reading the introduction, you should have an even better idea about how relevant this paper is to your research question, and to what depth you should read and understand the details of the paper.

> **TIP**
> See How to read and understand a scientific paper for a website with helpful tips.

How to judge a paper?
On first sight, people often judge a paper based on the number of times it has been cited, how well known the authors are, and/or how respected the journal is. Note that papers recently published will typically have less citations. While these are of course indicators of good research, you should be the ultimate judge of a paper's quality - think critically about the methods, results, and explanations.

For your literature report, it is always a good idea to cite papers from preferably more than one institution. Of course we do good work, but if your thesis paper has 90% of citations from TU Delft, that is not so good. You may also search work in the TU Delft repository for PhD theses and master theses, for background information.

Organization
Practically speaking, we recommend using Mendeley or Zotero to organize and keep track of the papers you have found. Create a **group folder/library**, which you can share with your advisor(s). This way, your advisor(s) can easily add and share papers with you.

To organize your thoughts, and to see how the papers you have read relate to one another, it can be helpful to create the following (which can later be used in your report):

- Table: Categorize the papers you read based on some parameter(s) (e.g., approach, methodology, results). Provides organization and can help identify gaps in literature.
- Schematic diagram: Helps visualize the bigger picture and can show how papers relate to one another.

5.3 Step 3: Literature Documentation

Input:	Refined research question & structured organization of relevant literature.
Process:	Analyze and write down your findings; Revise based on feedback from supervisors.
Output:	Literature report.

Begin with an outline

Before starting to write, it is helpful to first make a Table of Contents (outline). What will the main chapters be about? What will the sub-sections within the main chapters be? How will the papers you read fit into this outline? Make sure that you have sections that will discuss and analyze the literature that answers your main research question, methods/models/metrics and your respective sub-questions (if applicable). In making this outline, you may discover that more literature is needed to adequately write a section.

Write the content

A typical Literature Report includes the sections outlined below. It can be helpful to start with the introduction. The main objective of introduction is to introduce and motivate the literature research and present the reader with an overall big picture. However, since the introduction is usually one of the more difficult sections to write, it can help to start with a main chapter, just to begin writing.

1. Table of contents
2. Abstract
   A brief, **stand-alone summary** of your Literature Report. A typical abstract is about 500 words long and consists of a short motivation and problem statement, explains the scientific method used, and reports the most important results and conclusions.

   TIP
   See How to Write an Abstract for a one page checklist with tips.

3. Introduction
   This section provides **the motivation and background** behind your research question. What is the context of your research? Why is it relevant/important? Why should people care? At the end of the introduction, clearly state your research question. To increase its salience, you can put it on a separate line and/or in bold. Briefly describe the following chapters that will be necessary to answer your research question (and sub-questions). There are many topics that might potentially be relevant to your research question, however, you have to limit your study to a few specific areas. Motivate the selection of chapters and their respective topics. In addition, motivate the exclusion of any other potentially relevant topics.
4. Main chapters
   There are typically three main chapters (although this is not fixed), each focusing on a distinct sub-topic related to your research question. Do not simply list and summarize the papers, but **interpret and analyze** their methodology, results, and/or conclusions. At the end of each main chapter, list important conclusions from this chapter. Remember, these conclusions should always relate back to your research question (and sub-questions)!
5. Discussion and Conclusions
   Discuss your findings in the context of your research question. Perhaps you have **identified weaknesses** or gaps in literature that need further investigation, or can make **recommendations** about applying particular methods/techniques/solutions to your problem. Do not simply summarize, but try to make recommendations. Note that if a particular paper is not worth discussing or mentioning in Discussion, it is probably not worth being explained in detail in the main chapters, and should be only mentioned briefly in Introduction.

6. Future work
   Briefly describe ideas for your upcoming MSc thesis and how findings from your Literature Report influence the design choices of your future work.

7. References
   This is the list of literature that you cite throughout the report. There are different styles to reference the work of others, for example IEEE (i.e., [1]), or APA-style (i.e., Abbink et al., 2017). It usually differs per field of research which reference style is preferred. For your report it does not matter which reference style you choose, but you need to be consistent in your choice.

TIP
See the following websites for the two most used style guides in the field:

- American Psychological Association (APA)
- Institute of Electrical and Electronic Engineers (IEEE).

Note that these guidelines do not concern references only, but the entire layout of the manuscript. For the report, it is only important that you are consistent in the use for references.
Reference managers, like Zotero, Mendeley, or Endnote, often provide a plug-in for Microsoft Word and LaTeX, which make inserting/managing references easy. They sometimes even extract information, like authors names, from the PDFs automatically. Be aware that (like with all automation) these systems still need a human to check if they function properly!

How many pages should the Literature Report be? How many papers should I read?
There is no required number of pages or references - whatever is sufficient to answer your research question. However, too many or too few may indicate that your research question is too broad or too specific. We have attached a couple of good examples of literature reports in the starter pack.

5.4 Step 4. Evaluation by your supervisors

During the evaluation of the report the following items are especially considered.

- **Content**
  - Clear and relevant research question.
  - Sufficient coverage of relevant fields/topics.
  - An insightful discussion concerning the research question.
  - A clear conclusion.
- **Process**
  - A structured and transparent method to analyze the literature.
  - Independence of the work
- **Report**
  - Logical structure of the report.
  - Grammatical correctness.

TIP
The literature report grading sheet available from the 3mE website outlines the grading criteria in more details

Note that the content itself is only as good as your ability to convey it through a good writing style. A general recommendation to organize the main chapters is to start with the big picture at the beginning, which can be easily understood, and outlines/motivates the rest of the chapter. If the concept is hard to express or hard to understand, use simple and easily understandable examples or analogies. After you establish the big picture of the chapter at the beginning, then you can proceed with details and more complex explanations throughout the rest of it.

A good writing style involves a clear story that is followed throughout the chapter. Each paragraph should convey one important point. Two consecutive paragraphs should naturally connect each other to carry the story; the first sentence of a paragraph should ideally continue with the point made in the last sentence of the previous paragraph. For example, if a paragraph ends with "However, this method lacks robustness to external perturbations.", the next paragraph can continue with "To solve the robustness issues, researchers proposed a new method that...". You should strive to establish such natural flow also between individual sentences within each paragraph.

6. Master thesis

In your MSc project you will complete your own scientific research project. In collaboration with the supervisors, you will define a research question and answer it using the proper scientific methods. Generally, a MSc project involves a human factors experiment, however every project is different and therefore there is no manual how-to-perform-a-master-thesis set in stone. Nonetheless, below we provide a general guide with some tips and tricks that usually apply.

6.1 Step 1. Exploratory phase

Even if you performed your literature study at the Haptics Lab and had regular meetings with your supervisors, it is good to make an appointment to brainstorm about the topic of your master project. The goal of this meeting is to brainstorm about the objective of the project, and to find a direction that is interesting for both you and your supervisor. It is very well possible that during the first meeting you will not be able to make a decision on the topic yet. It probably takes some more deliberation, (re)reading of papers, and discussion before you can really settle on a topic.

6.2 Step 2. Analysis phase – Research proposal

Research objective and question
A good way to start your report is to write down your research objectives. This is usually done in a research proposal. In a research proposal you introduce a problem, motivate why it is important, and define your research objective.

Consider the research proposal as a living document, meaning it is best to update it as you go. It will start out as a draft and you can edit sections as you make progress. That is, during your thesis, you will be able to identify the problem you are investigating more specifically, which means you can make your introduction more focused, which in turn means you can delineate you research question, which determines your approach. A well updated research proposal can serve as a useful guide for your supervisory meetings. Moreover, when you will start writing your thesis, you will find that the proposal is a basis for your introduction and method section.

TIP
A good source for doing research is "the Human Subject Research for Engineers – A Practical Guide" by Joost de Winter and Dimitra Dodou. (The reader of the Experimental design, statistics & the human; course code BM41045.

A proposal usually contains the following:

1. Introduction (motivation and background)
    - Why is your research relevant?
    - Report state-of-the-art literature
    - Specify a problem according to the literature
    - What is your proposed solution?
    - Identify a literature gap
2. Research question
3. Research approach / methodology
4. What scientific methods will you use to answer your questions? (e.g., modelling in Simulink)
5. Planning

Hypotheses

Every experiment starts with well-defined hypotheses. A hypothesis is an educated prediction of your experiment results. A good hypothesis is based on solid argumentation. Hypotheses can be based, for example, on previous literature or the results of a (small) Simulink modelling study.

TIP
Hypotheses should be clearly and unambiguously defined.

A bad hypothesis:
Humans will drive better with continuous shared control than without.

A good hypothesis:
When drivers are supported by continuous haptic feedback on the steering wheel, performance (in terms of mean lateral position and SDLP) will increase and control effort (in terms of mean steering wheel reversal rate) will decrease, whereas physical workload (in terms of steering wheel torque) will increase, compared to manual driving.

TO DO
Introductory Colloquium:
Roughly half way in to the project, students give an introductory presentation in which the project goals, methodology and the research plan are presented.

Methodology

The scientific methods that you will use during the master project are mostly dependent on the objective. If your project is focused on design you will probably use a different approach than a thesis focused on analysis.

Initially, the approach will be a general description of the methods that you will use. For example, "To answer the sub-question 1, I will model the novel controller in Simulink in order to predict its behavior". However, when your project progresses this section will become more specifically defined and will become more like the method section of a scientific paper.

6.3 Step 3. Design and perform an experiment

Like all the previous steps, designing an experiment is an iterative process. At the end of your analysis phase you will have a rough idea of the experiment you will be performing. Now is the time to hammer out the details:

1. **Make a rough plan** of the number of participants, which (in)dependent measures you will use, time the experiment will take etc.
2. **Start to set-up the experiment**. You will probably come across matters that will influence your experiment design. Meanwhile you specify the experiment in more detail.
3. **Do pilot studies**, which you will use to test the experiment design and gather some preliminary data.
4. **Perform the experiment**.

> **TIP**
> Consider the following experimental documents:
>
> - **Consent form**: This is obligatory in experiments involving human participants. Each participant needs sign an informed consent and agree that you will use their data.
> - **Ethics approval**: At the TU Delft an experiment involving human participants requires an ethics approval. See the HREC website for more information
> - **Protocol**: Describes the procedure of the experiment. You could send this to your participants in advance so they are informed about the details of the experiment (duration, instructions etc.)
> - **Checklist**: A checklist helps you conduct the experiment in exactly the same way for every participant.
> - **Experiment log**: Keep notes (in a physical book or on your computer) in which you can write down moments during the experiment that might be of importance later. These might include comments from participants or unexpected events (e.g., simulator failures).

6.4 Step 4. Data Analysis

Now that the experiment is done, the next step is to start analyzing your data.

1. **Extract the raw data**: Raw data is the data is it output by the experimental setup, without any alterations. You will need to extract the data in such a format that you can analyze it. We advise you use plain-text formats (like .csv), so you are not restricted to MATLAB for analysis. After you have extracted all the raw data, you should start to explore it and investigate if your data looks as you expected. That is, data was recorded correctly, there are no data sets missing, values are within the expected range, etc.
2. **Create a meta data file**: A metadata file specifies how the data was collected (i.e., setup details) and includes a description of the raw data so that readers can understand the raw data (a sort of code book, **what** is stored **where** and **how**).
3. **Transform into analyzable data**: Now start to create analysis data, which is restructured and processed raw data that you can easily analyze. Meaning, you separate your raw data in analyzable parts, for example repetitions and road sections (e.g., straights and curves) and

you apply the appropriate processes (e.g., filters, sign reversals). Structure your data in such a way that it is easily transformed into statistical data.

Again, check your data and visualize it to make it easier to interpret. This data should start to give you an idea whether your hypotheses will hold or not.

4. **Transform into statistical data**: The last step is to transform your data into data which is used for your statistical analysis. For the statistical analysis you can use either MATLAB, R, Python (or alternatively SPSS).

TIP
In the starter pack folder we have included a MATLAB folder, which gives you a general example of data analysis. You can run the code (except, step1_ExtractRawData, because we did not include the raw data in order to save disk space). We advise you to go through the MATLAB-files. It is extensively commented, and provides a structured approach for data analysis

TODO
In order to make your code understandable for other people too, explain the calculations and processes in your code using comments and self-explanatory names for your variables. There is no such thing as too many comments (as long as you do not put your entire life story in there...). A good guide on naming variables is available here.

TODO
When you hand in your thesis you will also be required to hand in a copy of all data and related documents. See Chapter 7 on data management for more information about how to set up your data management.

6.5 Step 5. Writing report

The general approach within the Delft Hapticslab is to write it in the form of a paper, with additional background information in separate Appendices.

The paper is usually somewhere between 10 – 12 pages long. At first it might seem easy to fill these pages, but it is not about meeting the minimum amount of words. It is about conveying the most important message of your research, while providing the right amount of details. Consequently, condensing 6 months of work into 12 pages is actually pretty hard. Generally, a paper consists of the following sections:

- Title
- Abstract
- Introduction
- Methods
- Results
- Discussion
- Conclusion
- References
- (Author biographies)

TIP
Examples of MSc theses can be found in the TU Delft Repository. We have also included a couple of good examples in the starter pack (see `01 Literature`).

This paper provides an excellent set of principles and tips of how to structure and write your paper. Highly recommended!

This other link provides useful tips and tricks for writing a paper and presenting figures and tables. Note that some tips are very specific for publishing in journals, these can be ignored.

Use a decent spelling and grammar check on your report (especially before handing it in). Grammarly is a good choice (the paid version has additional checks, but the free version works fine too).

6.6 Step 6. Final presentation and defence

In a 20-25 minute presentation, you present your main findings to your parents, classmates, and committee. A scientific presentations consists of the following parts:

1. **Title slide**: The first slide contains the title, name, date and (optional) your committee members.
2. **Introduction**: Why did you investigate the problem?
   Start by motivating the problem you investigated by introducing it in a larger context. A good introduction starts broad and narrows it down until the research question you investigated.
3. **Method**: How did you investigate the problem?
   In the method you explain the details the research approaches you used. The trick is to present the most important details of your work, while still keeping it understandable for your audience.
4. **Results/Discussion**: What did you find?
   Show the most important results here and highlight interesting findings. Again, balance is key in present your results with enough detail, so that your conclusions make sense, but avoid losing the key message in graphs and tables. Do not only present the results, but discuss what they mean in light of your research question.
5. **Conclusions**: The conclusions summarize the findings of your study for the audience. What is important for the audience to remember?
6. **Future work**: So now what?
   Place your MSc project in a larger context. What does your work and your conclusions mean for the field and how should future research use it?
7. **Take home message**: (optional) End your presentation with a nice take home message. The last part of the presentation is often what the audience will remember, so make it last.

TIP
It is a good idea to practice your presentation several times before you have to present the final presentation. There are two options to practice your presentation:

- Organize it yourself. Reserve a room at the service desk and ask a couple or peers to attend. We encourage you to practice your presentations with a couple of lab members (i.e., students, PhDs, and post-docs) in attendance. They can provide your feedback on your presentation and ask relevant questions, which might prepare you for the defense.

- You can ask for a spot in the joint supervision meeting. This is a weekly meeting with all the MSc students that are affiliated to the Haptics lab. Topics/presentations are usually determined a couple of weeks beforehand, so be sure to ask the person responsible for a spot well in advance.

This link, and this link provide a couple of tips and tricks for common problems with Powerpoint presentations. We also provided a couple of good examples of presentations in `05 MSc presentations`

6.7 Step 7. Evaluation by your supervisors

After the defence, the supervisors will grade the following aspects of your thesis work on the scale of 1 to 10

- Content
  - Theoretical knowledge
  - Generation of new *knowledge* or development of new *design*
  - Creativity, skills
  - Research/design significance
- Communication
  - Quality and usefulness of report
  - Quality of presentation and interaction with audience
  - Handling questions in defence
  - Level of English
- Process
  - Contact with supervisor
  - Responsibility in work and writing, time management
  - Performing experiments/simulations (if applicable)
  - Critical attitude
  - Open mindedness

TIP
The thesis grading rubric available from the 3mE website outlines the grading criteria in more details

7. Data management

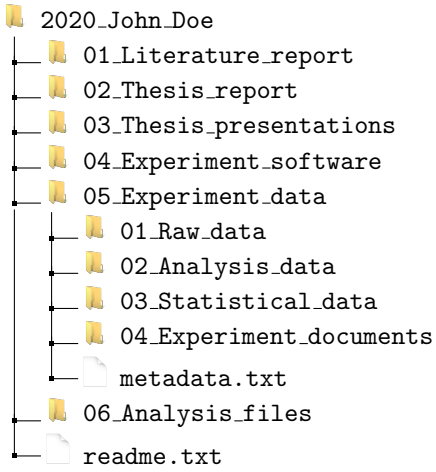
During your MSc thesis project, you will accumulate a lot of downloaded papers, write a couple of reports and gather a bunch of data. These data will include anything important related to your work, from simulation results and reports you wrote to data from experiments that involve testing human participants. Regarding all your data, we ask you to do two things:

1. To make sure that your data is easily accessible for future studies, we ask you to hand in a copy of all your data, analysis scripts and other related documents when you hand in your thesis. Please do this according to the guidelines provided in Section 7.1.

2. If your project involves any data related to human participants (questionnaires, demographics, behavioral data, ...), you need to particularly be careful with your data (during and after your thesis)! See Section 7.2 for more information.

7.1 Data folder structure

When you hand in your thesis you will also be required to hand in a copy of all data and related documents. We urge you to apply the structure as presented below, as it makes the understanding and handling of data by future students and employees a lot easier.



See the folder 06 MSc data template in the starter pack for a detailed manual, a template for the required folder structure and required files.

> **TIP**
> It's a good idea to use our folder structure from the start of your project, or at least keep it in mind *during* your project (to make your life easier when you need to hand all data in).

TODO
To reiterate, in order to make your code understandable for other people too, explain the calculations and processes in your code using self-explanatory variable names and comments. There is no such thing as too many comments (as long as you do not put your entire life story in there...).

7.2 Working with research data

Because we often work with experiments with humans, we need to be extra careful with the way we protect our data. Some of the guidelines and things you need to keep in mind are already covered in the HREC website, but we will reiterate some of the important things here.

- All data that are stored on your computer's hard drive or an external hard drive *need* to be deidentified or anonymous. There should be absolutely no way that someone can trace back who 'participant 1' was, except for the people involved in the study (note that these people all need to be on the ethics approval form).
- Any documents with a participant's name on it should only exist in paper form (such as the consent form; do *not* put the participant's identifier on the consent form). Do not scan these documents. Store these papers in a secure place. Please hand these documents in to your supervisor once you are done.
- Especially if you use an external hard drive to store your data, use an encryption if possible (BitLocker is freely available for most Windows 10 versions).
- If you are concerned about how to keep your data secure, talk to your supervisor or the 3mE Data Steward.
- You can find more information on many data storage-related questions here.