Engineering Master's thesis introductions

Aalto University

In **engineering**, although **research article** and **master's thesis** introductions show similarities in structure, the master's theses (Fig. 1) can require two additional elements: **Move 3 (Proposing a New Approach)** and **Move 4-3 (Thesis Scope)**.

Master's Introduction Chapters in Engineering (MICE)

Click on icons to view the video on that topic!

MOVE 1 CURRENT SITUATION (compulsory)
(What is the wider context of the topic studied?)

Step 1: Making a centrality claim
(Why is this topic area important or relevant?)

AND

Step 2: Making topic generalizations
(What features are important to know about this topic?)

AND/OR

Step 3: Reviewing previous research and solutions
(What earlier solutions or related work have been done in this area?)

MOVE 2 PROBLEMS (compulsory)
(What is wrong or missing from current solutions?)

Step 1: Indicating weaknesses
(What are the limitations or inadequacies of current solutions?)

AND/OR

Step 2: Identifying a gap
(What area remains unstudied or overlooked in current solutions?)

MOVE 3 PROPOSING A NEW APPROACH (optional)
(What new strategy could solve this problem?)

Step 1: Introducing a potential solution
(What new idea could work?)

AND

Step 2: Justifying the approach
(What are the advantages or benefits of this new approach?)

MOVE 4 YOUR SOLUTION (compulsory)
(How will your thesis overcome this problem or fill this gap?)

Step 1: Research Aims (required)
(What will the thesis achieve?)

Step 2: Methods (required)
(How will you use to develop and verify/validate your solution?)

Step 3: Thesis Scope (optional)
(How much of the topic / problem will you address in the thesis?)

Step 4: Describing the main outcome (optional)
(What are the features of your solution?)

Step 5: Overview of thesis structure (required)
(What are the aims and contents of the following chapters?)

Figure 1 Model for organizing master's thesis introductions in engineering (Pennington, unpublished), adapted from the CaRS Model for research articles (John Swales, 2004).

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In science and engineering, introduction chapters are organized based on two principles. First, information is presented in a **General-to-Specific** order, which progresses from discussing *general* aspects of the topic before slowly narrowing down the topic to the *specific* problem to be solved in the thesis. Second, in order to situate your topic into its wider context, thesis introductions typically follow a **Problem-Solution** pattern, which begins by describing the **current situation** (Move 1), followed by identifying a **problem** (Move 2) and then suggesting a **solution** (Moves 3 and 4), with the **evaluation** of this solution being the focus of the remaining chapters in the thesis.

MOVE 1: CURRENT SITUATION

This first move in the MICE model presents background knowledge necessary for the reader to understand the context for the problem and the solution offered in your thesis. Move 1 consists of three steps:

Move 1-1 Making a centrality claim 

Many writers find the first sentence to be a difficult one to create. To get an idea of what strategies are typically used in your own field, take a look at journal papers in your own field. Typical first sentences usually make a general claim about the topic in terms of its **(a) importance**, **(b) popularity**, **(c) applications**, or present a **(d) definition**:

(a) Model Predictive Control (MPC) **has become** one of the most studied and applied control techniques both in academia and in the process industries.

(b) **In recent years,** mobile ad hoc networks **have** **received** much attention **due to** their potential applications and the proliferation of mobile devices [1], [2].

(c) **In the recent past,** wireless sensor networks **have found** their way into a wide variety of applications and systems with vastly varying requirements and characteristics.

(d) A business process **is** a sequence of tasks carried out to achieve the business objectives of an organization.

With the exception of definitions, note that these claims typically consist of three elements: (1) a **time span**, (2) a claim in the **present perfect tense** [*has (been) done*] to stress the continued relevance and importance of the topic, and (3) a **reason** or **evidence** to support your claim. This step typically appears at the beginning of text and is rarely longer than 1-3 sentences.

Figure 2 Typical structure of first sentences in engineering introductions

Experienced writers in engineering typically use the following four **conventional sentence patterns** as the **"opening" sentence** in a text to stress the *popularity*, *importance* or *relevance* of the wider topic [Move 1-1]. See **Appendix 4** for the typical vocabulary used in these topic sentences.

1. {TIME} [TOPIC] has [VERB -ed] [INTENSIFIER] + attention + [REASON]

In the recent decade, chitosan **has received much attention because of** its extraordinary properties and for its inexpensive abundant resources.

2. {TIME} [TOPIC] has [VERB -ed] + [INTENSIFIER] + interest | in [FIELD] [REASON]

Over the last decade, hydrogen **has generated much interest due to** its potential use as an environmentally benign approach for energy generation, as well as its ease of transportation [1, 2].

3. {TIME} [TOPIC] + has emerged as a(n) + [INTENSIFIER] [SUPERORDINATE] [PURPOSE]

In recent years, graphene **has emerged as a promising material for** optoelectronic applications **due to** its special two-dimensional system and unique band structure.

4. {TIME} [TOPIC] + has been the focus of + [INTENSIFIER] [RESEARCH ACTIVITY]

In the past few years, the energy efficiency of communication networks **has been the focus of intense research**.

Move 1-2 Making Topic Generalizations 

Topic generalizations are text that **defines**, **explains** or **describes** a concept. As a rule of thumb, if you can insert into a sentence **adverbs of frequency**, (e.g. ***"typically"***, ***"generally"***, ***"usually"***, ***"often"***, ***"commonly"***, ***"always"***) or a phrase claiming **common knowledge** "*it is well known that*", then you can be sure that you are generalizing about your topic.

Topic generalizations represent accepted knowledge and therefore require the **simple present tense** (*do/does*), since they have the status of "eternal truths". Typical **functions** for generalizing about technical concepts include

- **Definitions**
- **Descriptions of technical features**
- **Applications**
- **Examples**
- **Classification / Division into sub-types or groups**

1 Introduction

Move 1-1

[1]With a massively growing population, natural and man-made disasters have become **increasingly** inevitable. [2]During these threats, a **need** for communication arises among people to cope with these emergencies and coordinate rescue operations.

Move 2-1

Move 1-2

[3]These rescue operations can only be supported by telecommunication networks, which are **commonly** referred to as Public Safety Networks (PSN). [4]PSNs have gained increased attention due to their ability to provide better control of systems and their support offered in perilous conditions. [5]PSNs are emergency services which require a wireless network to function. [6]They assist emergency services, such as fire trucks, ambulances and police cars, which need communications for increased efficiency. [7]PSN finds usage in applications requiring high performance characteristics in systems, such as connectivity on the move, high reliability in voice, increased efficiency and the capability of cooperating with other departments. [8]**However,** due to the requirements of higher bandwidth, the usage of PSN **has been limited** by present-day systems, resulting in the **need** to develop efficient solutions.

Move 2-1

Adapted from Saimanoj Katta Rokkaiah, "Public Safety Usage in Commercial Networks", Master's thesis, School of Elec. Eng., Aalto Univ., Espoo, Finland, 2018. This work is licensed under a CC BY-NC-SA 4.0 license.

Figure 3 Introduction extract showing Move 1-2 (Making Topic Generalizations)

As shown above in Figure 3, another typical feature of topic generalizations is that the text stays on topic. In other words, the idea that your text is "about" tends to be placed in topical position (before the verb) as **Given** information until a new subtopic emerges as **New** information (after the verb) to replace it as the topic (See Information Ordering).

Move 1-3 Reviewing items of previous research

When reviewing past solutions and research, the writer needs to relate ***what*** *has been done (or proposed)* with ***who*** *has done (or proposed) it*. However, before starting to list individual studies and their authors, it is important that you first introduce them in a **topic sentence**. For this purpose, good writers often use the following three topic sentence patterns as strategies for introducing an area of research. See **Appendix 5** to find out more about the vocabulary typically used in these topic sentences.

5. {TIME} [INTENSIFIER] [RESEARCH ACTIVITY] has [VERB -ed] | [TOPIC] [PURPOSE]

Recently, much research has been devoted to developing efficient routing protocols **for** marshall**ing** packets through the network [1-7].

6. {TIME} [INTENSIFIER] **progress has been** [VERB -ed] **in** [TOPIC]

In recent years, much progress has been achieved in the development of biodegradable products using agricultural materials.

7. {TIME} [QUANTIFIER] [RESEARCH ACTIVITY] have (been) [VERB -ed] | [TOPIC] [PURPOSE]

A number of METHODS have recently been described to measure this property, including the Tarr-Baker gelometer (Bender, 2009) and the Herbstreith Pektinometer (Zedler, 2013).

Also, note in Figure 4 how this move is signaled by the use of **citations**, e.g., [15], and the **present perfect tense** (*has/have –ed*) when referring to multiple studies or the current consensus in the field.

Move 1-3

[9]In recent years, **much work has been** devot**ed to** integrating commercial systems with PSN in order to mitigate the above issues **[15]**. [10]**Several studies have** survey**ed** the current state of PSN, its future trends and state-of-the-art research **[1][2][3]**.

Move 2-1

[11]**Unfortunately,** the telecommunication system built for the social community used by commercial users operates on a **different** infrastructure. [12]**Moreover,** the existing PSN systems present in various countries operate on **different** frequencies, thus **hinder**ing the inter-dependability of these systems.

Move 1-3

[13]Nevertheless, **researchers** are working to make the coexistence on a single platform a reality **[11]**. [14]**Recently, much progress has been** achiev**ed in** the development of various solutions for integrating the PSNs and Commercial networks through multiple models, proposals and approaches, resulting in higher efficient usage of these systems **[4][5]**.

Adapted from Saimanoj Katta Rokkaiah, “Public Safety Usage in Commercial Networks”, Master’s thesis, School of Elec. Eng., Aalto Univ., Espoo, Finland, 2018. This work is licensed under a CC BY-NC-SA 4.0 license.

Figure 4 Extract showing Move 1-3 (reviewing items of previous research)

MOVE 2: PROBLEM

As a thesis writer you need to show the "motivation" for your study. One way to do this is by showing that the previous research history or current solutions are not complete. In other words, that there are aspects of the research field or solution still needing further investigation.

Move 2-1: Indicating weaknesses

The most common way of achieving this is to present a ***negative evaluation*** of some feature of **Move 1**. This is often signaled by words expressing a ***contrast*** or ***negative evaluation***:

CONTRAST	QUANTITY	VERBS		ADJECTIVES	
However	~~a~~ few	fail	limit	difficult	ineffective
Unfortunately	less	ignore	restrict	laborious	inconclusive
Although	~~a~~ little	neglect	hinder	limited	uncertain
Despite	no	overlook	hamper	restricted	unclear
but	none	impede	deter	inefficient	time-consuming
yet	not	prevent	prevent	unreliable	unsatisfactory

Figs. 3 and 4 above show typical examples of how **Move 2-1** can be used as a strategy to make a smooth transition between different solutions by pointing out the deficiencies in each earlier solution. This strategy is often used in science and engineering to review the literature in **"cycles"** of **Move 1**-**Move 2**, **Move 1**-**Move 2**, **Move 1**-**Move 2**, ending when the writer finally reaches his/her own solution by announcing the **Research aims (Move 4-1)**, as can be seen in Fig. 5.

Move 1-2

[3]**Traditionally,** forest areas and farms have been mapped using images taken by either satellites or manned airplanes. [4]**However,** these images are

Move 2-1

expensive, can**not** be easily **nor** frequently updated, and are **limited** by low resolution. [5]These **problems have been overcome by** us**ing** unmanned aerial

Move 1-2

vehicles (UAVs). [6]UAVs are **widely** used today in **many** application areas because of its low cost and ease of operation. [7]UAVs are **increasingly** used in construction fields for improving productivity [1], in forest and farms for health monitoring [2], [3], and for disaster management [4]. [8]Current UAVs can operate autonomously. [9]**However,** using autonomous UAVs to optimally cover a given

Move 2-1

terrain is a **less** explored area, and most use cases **require** that the area mapped be already available in Google Maps or other mapping applications. [10]**Moreover,** the path taken by the UAV may **not** be optimal. [11]**Therefore, the**

Move 4-1

aim of this thesis is to design, implement and test a software system in a semiautonomous quadcopter drone for mapping and measuring a given area of land, consisting of either agricultural field or forest stand.

Adapted from **Issouf Ouattara,** "Semiautonomous Drone System for Mapping and Measuring of Agricultural Fields and Forest Stands," Master's thesis, Elec. Eng., Aalto University, Finland, 2018. This work is distibuted under a CC BY-NC-SA 4.0 license.

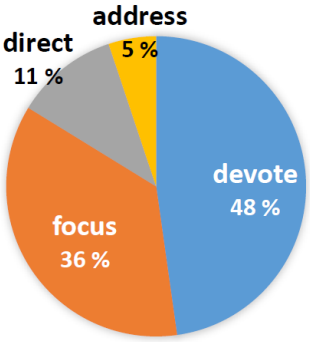
Figure 5 Extract showing cycling of Move 1 and Move 2, leading to Move 4-1

Move 2-2: Identifying a gap

When very little or no research is available on your thesis topic, another common strategy is to first describe those research areas in your field that have received attention (Move 1-3), and then go on to claim that **no** studies/research, **little** research, or **few** studies have proposed solutions to the problem that you aim to solve in your own study (Move 2-2). Note that the structures and vocabulary presented as **Topic sentence type 5** in Appendix 5 are often used to establish a gap by replacing the *positive* quantifiers with *negative* ones, such as **no**, **none**, **less**, **few** or **little**.

5. {TIME} [INTENSIFIER] [RESEARCH ACTIVITY] has [verb -ed] + [TOPIC]

Uncountable noun	No Little Less	research work effort	has been DEVOTED to has FOCUSED on has been DIRECTED toward/ at has ADDRESSED (the issue of)
	Little Less	attention interest	has FOCUSED ON has been DIRECTED toward/ at
Countable noun	No Few	efforts studies papers investigations	have been DEVOTED to have FOCUSED on have been DIRECTED toward/ at have ADDRESSED (the issue of)



Although much work has addressed [closely related topic], **no** / **few studies** have focused on [your topic].

Despite the large number of studies investigating [closely related topic], **less** / **little work** has focused on [your topic].

Move 1-2

[21]An important component in the cloud service-provisioning ecosystem is the service orchestrator. [22]The orchestrator automates some of the repetitive tasks and coordinates the end-to-end service delivery process, ensuring appropriate service levels and configurations [9]. [23]As the service is ordered, the orchestrator translates high-level service description into multiple provisioning requests, coordinated across multiple resource domains.

Move 2-1

[24]**However,** setting up an orchestration engine involves **costs** in terms of integration and set-up time.

Move 2-2

[25]**Although** numerous studies **have** investigat**ed** the performance aspects of orchestration in service delivery, **few of these have** focus**ed** on it from a techno-economic perspective.

Move 4-1

[26]**Therefore, the aim of this thesis is to** evaluate the economic feasibility of adopting an orchestrator for service delivery processes used in a highly virtualized data center environment that leverages SDN and NFV.

Adapted from **Anonymous Master's thesis, School of Electrical Engineering, Aalto University, Espoo, Finland.** This work is licensed under a CC BY-NC-SA 4.0 license.

Figure 6 Extract exemplifying Move 2-2 (Identifying a Gap)

MOVE 3: Proposing a New Approach

Because the task of engineering is to create new solutions to problems, **Move 3** is a common strategy used in engineering, especially in those master's theses that aim to ***evaluate the feasibility*** of applying a new technological approach for either solving a problem or improving a current solution. Therefore, it is important that a **"problem**," **Move 2-1** (Indicating a problem) or **Move 2-2** (Identifying a Gap), has been introduced in the previous sentence(s). In Fig. 7, note also how this move uses the **conditional voice** (*would, could*) to indicate that at this point in your thesis, you can only *speculate* on whether your approach *might* work, since it is not until the end of your thesis that your *results* will either confirm or disprove the feasibility or efficacy of this new approach.

Move 3-1: Introducing a potential solution

This step is typically signaled using the following language structures:

One **A(n)**	promising potential possible interesting	**solution** **approach** **strategy**	**for**	overcom**ing** tackl**ing** address**ing** solv**ing** avoid**ing** mitigat**ing**	this **problem** this **issue** this **challenge**	**would be to** [do what?]

This	**problem** **issue** **challenge**	**could** be	overc**o**me tackl**ed** address**ed** solv**ed** avoid**ed** mitigat**ed**	**by**	adopt**ing** us**ing** **…ing**	[approach]

Move 3-2: Justifying the approach

Step 2 *defines*, *evaluates* and *justifies* the new approach proposed in Step 1 (Fig. 7).

[15]**Despite** the significant amount of work focusing on integrating PSN into commercial systems, **few studies have** attempt**ed** to improve the performance of these systems by prioritizing users through the use of schedulers [10]. **Move 2-2**

[16]**One possible approach to** achieve even higher performance **would be** to provide courteous priority [15] to PS users during emergency situations when sufficient resources are available. [17]Because commercial and public safety users can be blocked during lower availability of resources, the Courteous Bandwidth Constraints Allocation Model (CAM) was introduced to improve the performance of lower classes of traffic [16]. **Move 3-1**

[18]CAM has **the advantage** that it **would allow** integrated systems to have less packet loss, higher throughput and less delay. **Move 3-2**

Adapted from Saimanoj Katta Rokkaiah, "Public Safety Usage in Commercial Networks", Master's thesis, School of Elec. Eng., Aalto Univ., Finland, 2018. This work is distributed under a CC BY-NC-SA 4.0 license.

Figure 7 Extract exemplifying Steps 1 and 2 in Move 3.

MOVE 4: Your Solution

Move 4-1: Research Aim(s)

It is important that the purpose statement is placed towards the end of your introduction, after explaining the relevance/importance of the topic, current research in the field, and the specific problem motivating your study. The purpose statement should not only be presented as providing a solution to this previously stated problem but should also arise as the only logical conclusion that can be drawn based on your description of that problem. Therefore, the wording of your purpose statement should directly reflect what you have stated as **a problem** in the sentence(s) coming immediately before the purpose statement.

1. What is your contribution?

Instead of simply describing your topic area or making a knowledge claim, your purpose statement should be to emphasize the **contribution** of you work by highlighting the main **outcome** or **product** of your study. To accomplish this, you need to identify the concrete outcome(s) of your study. What will your work specifically offer to the reader?

A. Will you offer your readers a new **theory**, **framework** or **model** to **describe** a phenomenon or system, which you will then ***test*** and ***validate*** using pre-defined criteria or requirements?

B. Are you going to **design**, **develop** and **prototype / implement** a new **tool**, **device**, **method**, **protocol** or **process** to carry out specific tasks or functions?

C. Will you **improve** or **optimize** a current solution by ***adapting*** or ***applying*** a new technology, followed by its ***evaluation*** and ***comparison*** to an existing solution.

D. Will you ***evaluate*** and ***test*** a new technology to **determine** the **feasibility** (i.e., possibility, potential, suitability) of implementing the technology in a specific context?

E. Or will your contribution be a **recommendation** based on ***identifying*** relevant *options,* followed by ***comparing*** and ***evaluating*** these options in terms of particular *criteria* or *requirements*?

F. Or will you **identify** or **determine** specific **parameters**, **characteristics** or **features** of a current solution or phenomenon to aid later in its further development or the creation of a new solution.

Typical “contributions” in engineering are listed alphabetically in Table 1, with the most common ones highlighted in yellow.

Table 1 Typical research contributions in engineering

Algorithm	Framework	**Model**	System
Approach	Heuristic	Procedure	**Scheme Solution**
Architecture	Materials	Process	**Technique**
Design	Mechanism	Protocol	Technology
Equation	Measure	Scenario	Theory
Extension	**Method**	**Strategy**	Tool
Formula	Metric	Structure	

2. Elements of Purpose statements

Effective purpose statements can consist of four elements:

1. The **contribution** (**What** *outcomes*, *products* or *new knowledge* will emerge?)
2. The **rationale/motivation** (**Why?**)
3. The **method** (**How?**)
4. The **scope** (**Where?** In what *context*, *system* or *environment?*)

Note in the examples below how much clearer the purpose is when the focus is shifted from a focus on the writer's problem to that of the **contribution** of the study.

Poor: **[how?]**
The aim of this thesis is **to find out how** interpolating scaling functions can be used
[why?]
to solve optimal control problems.

Better: **[What contribution?]** **[why?]**
The aim of this thesis is **to develop** computational algorithms **for solving** the optimal
[How?]
control problems **using** interpolating scaling functions.

Poor: **[what?]**
The aim of this thesis is **to find out whether** geothermal production is sustainable
[how?]
by developing sustainability indicators and **by applying** these to a geothermal system
[why?]
under production **in order to test** their effectiveness.

Better: **[What contribution?]**
The aim of this thesis is **to identify** sustainability indicators and **to test** their effectiveness
[how?] **[where?]**
by applying the indicators **in** a geothermal production system.

3. Structure of Purpose statements

The following sentence patterns are typically used to express the purpose of a thesis.

The	purpose aim goal objective	of **this**	thesis study work	is **to**	develop determine identify model optimize	[your contribution]	**in order to** …[why?] **for –ing** …[why?] **that /which can**… **by –ing**… [how?] **using**… [how?] **in** … [where?]
Therefore, **In order to… ,**		**this**	thesis study work		develops models	[your contribution]	**for –ing** …[why?] **in** … [where?]
					determines assesses evaluates	the feasibility of… the potential of…	

Move 4-2: Describing Methods

This step comes immediately after **Move 3-1** (Research aims) and is generally kept short and only broadly outlines **"how"** you will **develop** and **verify/validate** your solution.

In order to **To**	accomplish achieve	**this**	**aim,** **goal,** **objective,**	**the thesis**	**will** compare *(future tense)* compare**s** *(present tense)*
	develop	**this**	**solution,**	**the thesis**	

For this purpose, **the thesis**	**will** compare *(future tense)* compare**s** *(present tense)*

This	**aim** **goal** **objective**	**will be** **is**	**accomplished** **achieved**	**by** compar**ing** **using**

One effective **"bridge"** for smoothly moving from discussion of the purpose and contribution of your thesis to introducing the methods is to use a **purpose clause** (**"*In order to* + verb"** or simply **"*to* + verb")**, as shown in the following two examples.

Move 1-3
Move 2-1
Move 4-1
Move 4-2

[49]**In most cases,** this challenge is handled by complex software security assurance processes. [50]**Furthermore,** as every large software house has its own internal ways of working, it would be **difficult** to create a standardized, common VMS for all use cases. [51]**Although** many companies offer VMS services, these have had only **limited** success. [52]Some of the reasons for this include the confidential nature of the processed information, with **few** companies being willing to share this information with external parties; the need for integrity protection; expectations concerning the availability of the system; and integration with existing infrastructure. [53]**Unfortunately,** these requirements can**not** be fulfilled using current off-the-shelf VMS products. [54]**Therefore,** the **objective** of **this thesis is to** design the **architecture** for a vulnerability management system to be incorporated into the software development and maintenance life cycle. [55]**To accomplish this task,** the thesis **will compare** a number of existing VMSs **in order to evaluate** their usefulness **in terms of** the confidentiality, integrity, availability and usability of the system.

Andon Nikolov, "Vulnerability management service for product life cycle," M.Sc. thesis, School of Electrical Engineering, Aalto Univ., Espoo, Finland, 2017.

Move 4-1
Move 4-2

[33]**Thus,** the **aim** of this thesis is to design and develop a working **prototype** of a bio-waste bin for collecting household bio waste in urban Finnish environments. [34]**In order to develop this solution,** the thesis **will use** an ethnographic method **to find drivers** for the design of the bio-waste bin as well as benchmarking against similar currently available household solutions. [35]**To ensure the usefulness of the design,** the thesis **will identify** the practical factors that either inhibit or facilitate the sorting of bio-waste in urban Finland. [36]This **will be accomplished by observing** and **interviewing** people in their own households while doing activities involving bio waste.

Lilli Mäkelä, "Design for discardables - Exploring household biowaste practices in Finland," Master's thesis, School of Arts, Design and Architecture, Aalto Univ., Espoo, Finland, 2017.

In science and technology, two main language structures, **Result-Means** and **Means-Purpose**, have been shown to comprise 40% of the methods statements in research articles [1].

Means-Purpose

1a. The simulation results	**were** compar**ed** **are** compar**ed**	with field test data	**to** validate **in order to** validate	the model.
2a. FEM simulation	**was** us**ed** **is** us**ed**	**to** verify **in order to** verify **for** verify**ing** **in** verify**ing**	the analytical results.	

Result-Means

1b. The model **was** validat**ed** **by** compar**ing** the simulation results and field test data.

2b. The analytical results **were** verif**ied** **using** FEM simulation.

A common grammatical mistake made by Finnish writers is to use "**with**" rather than "**by**" when describing the means used to carry out procedures and methods:

1b. The model **was** validat**ed** ~~**with**~~ compar**ison** of the simulation results and field test data.

1b. The model **was** validat**ed** **by** compar**ing** the simulation results and field test data.

Note in the examples above how these two patterns can be used to move the topical focus from the **result** (outcome) to the **purpose** of the methodological step, and vice versa, in order to maintain cohesion between sentences:

2a. The analytical results **were** verif**ied** **using** FEM simulation. **[Result-Means]**

2b. FEM simulation **was** us**ed** **to** **verify** the analytical results. **[Means-Purpose]**

In addition to being used for describing methods, these two patterns also play an important role in

- **Chapter overviews and summaries** (See **Appendix 1**) to *justify* your research process,
- **Move 4-4 (Describing the main outcome)** in the introduction chapter to *describe* how your solution works, as well as
- The **Results chapter** (Module 3) to *explain* and *justify* the procedures used to obtain and analyze measurements and experimental results.

[1] Ian Bruce, 2008. "Cognitive genre structures in Methods sections of research articles: A corpus study." **Journal of English for Academic Purposes**, vol. 7, pp. 38-54.

Move 4-3: Scope 

Many novice writers confuse ***scope*** with the ***aim*** of the thesis. However, these two are not the same thing. Whereas the *aim* describes **what** your thesis will do to solve the problem, the *scope* defines the **extent** of the problem area that you will deal with in your thesis. In other words, which aspects of the problem will you **include** and what will you **exclude** from the thesis?

Typical language:

~~**The scope of this thesis is**…~~

[**+**] This thesis **is limited to** / **is restricted to** / **is confined to**…
This thesis **focuses only on**… / will (only) **focus on**…

[**--**] …**remain**(s) **beyond** / **outside the scope of** this thesis…
…**is**/**are excluded from** this thesis**, as** / **since**…
…will **not be considered / is not considered** in this thesis**, as** / **since**…

> **1.3 Scope**
>
> The scope of the thesis **will be limited to** typical simply supported short to medium span timber-concrete composite road bridges. Short to medium span refers to typical TCC bridges with span l = 10…25 m. The sub-structures **are excluded from the scope**, since they have only a small effect on the behavior of the superstructure, at least when simply supported bridges are considered. Moreover, detailed design of the bridge, i.e. reinforcements, connector design or detailing of the bridge, **is not considered**.
>
> *Joonas Jaaranen, "Analysis methods for short to medium span timber-concrete composite bridges," M.Sc. thesis, School of Engineering, Aalto Univ., Espoo, Finland, 2016.*

Move 4-4: Describing the main outcome 

Here, the writer describes the main features of the outcome (e.g., device, algorithm, model or method) developed in the thesis. This step is most common in Mechanical engineering.

> **The proposed system consists of** a laser source, an electrooptic phase modulator (EOPM), a fiber Bragg grating (FBG), and a photodetector (PD). The light source **is phase modulated by** an electrical Gaussian pulse train via the EOPM. The optical phase modulation to intensity modulation conversion **is achieved by reflecting** the phase modulated light at the slopes of the FBG that **serves as** a frequency discriminator. Electrical monocycle or doublet pulses are obtained at the output of the PD by locating the wavelength of the optical carrier at the linear or the quadrature slopes of the FBG reflection spectrum.

Move 4-5: Overview of thesis structure 

First, the writer introduces the structure with a **topic sentence**:

> The **rest** / **remainder** of this **thesis** is divided into five chapters.
> The **rest** / **remainder** of this **thesis** / **work** is organized as follows.
> This **thesis** is structured as follows.

Next, the writer has three alternative structures that can be used to describe each **Chapter** (in theses or dissertations):

> **Chapter 3** *describes* the framework used to... **(Text as actor)**
> **Chapter 4** *presents* the model used to...
>
> ~~*In Chapter 3,* **I** *describe* the framework used to...~~ **(Author as actor)**
> ~~*In Chapter 4,* **we** *present* the model used to...~~
>
> *In Chapter 3*, **a framework** *is described* that... **(Content as subject)**
> *In Chapter 4*, **a model** *is presented* for …

A quick-n-dirty analysis revealed the following 21 verbs to be common in electrical engineering:

analyze	**discuss**	**introduce**	**report**
assess	**evaluate**	**outline**	**review**
define	**examine**	**present**	**summarize**
derive	**explain**	**propose**	**survey**
describe	**explore**	**provide**	**validate**
			verify

Thus, a typical **Step 5** in a master's thesis would look similar to the following, with the first sentence serving as a **topic sentence** and one sentence usually being allotted for describing each *chapter*.

> [1]**The rest of this thesis is divided into five chapters.** [2]**Chapter 2 outlines** the methodology used in this thesis. [3]**Chapter 3 reviews** the literature on the various tools and concepts used during the thesis. [4]**Chapter 4 describes** the development of a small-signal model including the core loss parameters. [5]**Chapter 5 provides** the results of the thesis, including core losses and their associated resistance values, as well as admittances calculated using the small-signal, and DC step voltage test results. [6]**Chapter 6 concludes** the thesis by discussing the accuracy of the models and the convergence characteristics of the algorithms.

Headings in Thesis Introductions

Aalto University

Some thesis supervisors at Aalto University offer their students a template describing the content and possible **section headings** that can be included in the introduction chapter for a master's thesis. Although most thesis introduction chapters at Aalto are not divided into sections, analysis of earlier student's theses reveals that the introduction can be divided into as many as **nine sections**, each introduced by a short, numbered **heading**:

1. **Background**
2. **Motivation** (Problem Statement)
3. **Purpose** (Thesis aims/ objectives/ goals)
4. **Methods** (Methodology, Experimental)
5. **Scope**
6. **Client**
7. **Author's Contribution**
8. **Contribution of the thesis**
9. **Structure of the thesis** (Outline)

Note that some of these sections can also be combined. For example, some theses combine *aims* and *scope* to form a section called **"Objectives and Scope",** or *aims* and *methods* to create **"Goals and Methods"** as a section heading. These nine potential headings are described with examples below.

1. Background

Of these nine possible sections, a section entitled **"1.1 background"** seems *unnecessary* and *redundant* in view of the fact that the very idea of an "introduction chapter" is to provide enough background that the reader can understand the motivation, relevance and context for the whole thesis. I would suggest that you omit this as a section heading. However, if you choose to include a section called "background," then let it be *short* and *non-technical*; describe the wider setting, the *social implications*, *importance* and *relevance* of this topic. Remember that the introduction should understandable even to your **grandmother**! In other words, let it be the *scene-setting* part that describes the *bigger picture* or context into which your work fits. Avoid going into technical details here. Many students mistakenly feel that they need to give all the theoretical detail here. Save it for the theory or literature review chapter!

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2. Motivation

This section, often also entitled “Problem statement”, should describe the **problem** or **“gap”** that will be solved by your solution, which you will later describe in your thesis purpose statement.

1.1 Problem statement

Regarding Internet of Things data, a big question is how to manage the data system in an efficient and cost-effective way. That depends on a proper planning on which DBMS is used to store the concerned data and how it is configured to provide adequate performance. As mentioned before, a variety of databases are currently available, including SQL and NoSQL databases. **However,** which model and solution best fit IoT data is still **an open problem**. As far as we know, there **has not been much research on** a general database solution for IoT data that provides a practical, experimentally-driven characterization of the efficiency and suitability of different databases, especially in the cloud environment. Hence, the thesis addresses **this problem** and looks for a solution that can provide the best performance for the various types and the large amount of IoT data.

Thi Anh Mai Phan, “Cloud Databases for Internet-of-Things Data,” M.Sc. thesis, Dept. of Informatics and Mathematical Modelling, Technical University of Denmark, Denmark, 2013.

3. Purpose

The thesis purpose statement is one of the most important and difficult part of the introduction chapter. It should immediately follow and show a clear link back to the problem statement. Think of the purpose statement as a promise; your thesis will be evaluated based on how successfully you fulfill this promise. So, be careful to not promise too much or too little!

1.2 Goals

The main purpose of the thesis is to find analysis methods suitable for analyzing TCC bridges **and to** evaluate their applicability for practical design. The analysis methods means in the thesis a method for determining deformations, stresses and connector forces, so they can be used in the design for dimensioning the structure according the codes considering effects of the permanent and variable loads, inelastic strains due to environmental variations and concrete shrinkage. The method should be applicable in typical bridge design scenarios, including possibility for un-shored or shored construction, and it should be simple enough for practical design, but offer adequate accuracy of the results. As the result of the work a proposal for applicable method and its use was to be given.

Joonas Jaaranen, “Analysis methods for short to medium span timber-concrete composite bridges,” M.Sc. thesis, School of Engineering, Aalto Univ., Espoo, Finland, 2016.

5. Scope

Many novice writers confuse ***scope*** with the ***aim*** of the thesis. However, these two are not the same thing. Whereas the *aim* describes **what** your thesis will do to solve the problem, the *scope* defines the **extent** of the area that you will deal with in your thesis. In other words, what will you **include** and what will you **exclude** from the thesis?

1.3 Scope

The scope of the thesis **will be limited to** typical simply supported short to medium span timber-concrete composite road bridges. Short to medium span refers to typical TCC bridges with span l = 10…25 m. The sub-structures **are excluded from the scope**, since they have small effect on the behavior of the superstructure, at least when simply supported bridges are considered. Also, detailed design of the bridge, i.e. reinforcements, connector design or detailing of the bridge, **is not considered**.

Joonas Jaaranen, "Analysis methods for short to medium span timber-concrete composite bridges," M.Sc. thesis, School of Engineering, Aalto Univ., Espoo, Finland, 2016.

6. Client / Project

In theses that are written for a client *company* or a *university project*, it is natural that the introduction would briefly describe the client's/ project's context and motivation for wanting the study. However, avoid filling your introduction with a detailed description of the client company/project, its environment and reasons for commissioning your study. You should also consider where would be the most appropriate place to put this information: Should it be put into its **own section**, or into a section describing the **motivation** (i.e., the problem)? The **thesis aims**? The **scope** section? Would the company prefer to remain **anonymous**? Or is this simply **background** information that provides the context for your work, as shown in example below?

1 Introduction

Eniram Ltd focuses on optimizing the performance of marine vessels and fleets in various ways. **The fleets in question consist of** a wide variety of vessels from large cruise ships to tankers. The optimization is achieved by analyzing data that is collected on board the vessels from, for example, the vessels' integrated automation systems (IAS), navigation systems and **Eniram's** own sensors. The types of data include the GPS coordinates, speed, power and attitude of a vessel. The on-board system provides real time information to aid the crew's decision making. In addition, the data is transferred to a data center on shore for further analysis and fleet-wide performance review.

Juuso Mäyränen, "Compression of Marine Vessel Telemetry," M.S. thesis, School of Science, Aalto Univ., Espoo, Finland, 2011.

In this second example, the project was highlighted in a separate section of its own.

1.2 The NewTREND Project

This thesis forms part of the European Union's NewTREND Project, which aims to develop a new software-based methodology to make retrofitting of buildings more efficient and easy. In the long run, the aim of the NewTREND project is to improve the energy efficiency of the existing European building stock and renovation rate. **To achieve this goal,** an integrated design methodology for building energy retrofit will be developed that addresses all phases of the retrofitting process. The project also aims to encourage collaboration among all stakeholders, involve building inhabitants and establish energy performance as a key component of retrofitting.

Tatu Jämsén, "New energy analysis process for the design of building retrofits," M.S. thesis, School of Engineering, Aalto Univ., Espoo, Finland, 2016.

7. Author's Contribution

Finnish government statutes regarding the awarding of master's theses clearly state that the thesis must not only be written by the student, but must also represent an *independent contribution*. This can cause problems when your thesis forms part of a larger project involving many master's theses. In such cases, your supervisor may require that include a section in your introduction chapter that defines what **you** personally did in the project.

1.3 Author's contribution

In this section, we list the author's contributions to this work. In performing the experiments with the SHAREMIND framework, **the author was responsible for** setting up the nodes in the cluster environment. **The author did the** scripting work related to gathering and aggregating the results. Some of the existing data gathering tools in SHAREMIND were extended **by the author** to allow for more precise statistics about the network.

In the model analysis, **the author performed various tasks such as** fitting the model to the gathered data and calculating the communication coefficients depending on the assumed network connection. Estimating the accuracy of the fit and the significance of the model coefficients **was also carried out by the author** in the model validation process.

As with the cluster machines, **the author was responsible for** setting up the SHAREMIND configuration in the cloud environment. This required some research on the existing cloud service providers and their pricing models, available server configurations, data center locations and other aspects affecting the choice of the provider. **The author also managed the experiments in** the cloud **and executed** the validation of our model on the data gathered in these experiments.

Finally, in the feasibility analysis, **the author estimated** the cost of performing certain operations in the cloud environment. An evaluation of the feasibility of SHAREMIND deployments in the cloud **was made** based on the estimates.

Reimo Rebane, "A Feasibility Analysis of Secure Multiparty Computation Deployments," M.S. thesis, School of Science, Aalto Univ., Espoo, Finland, 2012.

8. Contribution of the thesis

Some departments may require that you include this section, in which you clearly list what you have created or developed as a result of your work. However, as we have already seen, this not a problem if you have clearly stated your "contribution", as a *method*, *algorithm*, *model* or *design*, in the **research aims** of your thesis.

1.3 Contribution of the Thesis

This thesis proposes a novel approach to control congestion in CCNs by early detection of congested links based on computed probability of data packet drops for next time instances. A Neural Network technique **is used to realize this goal of** avoiding deterioration of network throughput. In various network scenarios, **we demonstrate the advantage of** early detection of congested links **and provide a performance analysis using** ndnSIM simulation environment. **Our simulation results show that** the proposed method is efficient and effective in early congestion detection in terms of applied performance metrics. **The technique also provides** multiple options for CCN-routers to decide in response to impending congestion in advance. **Moreover, the proposed technique can be considered** to be a general solution for congestion problem of ICNs in a more broad sense.

Mohammad Hovaidi Ardestani, "Congestion Control in Information Centric Networking using Neural Networks," M.S. thesis, Dept. Elect. Eng., Aalto Univ., Espoo, Finland, 2014.

9. Thesis Structure

In those theses that do not follow the traditional *Introduction-Methods-Results-Discussion* (IMRD) structure to organize the thesis, it is essential that you map out the structure of your thesis. Note the use of a **topic sentence** *"The rest of this thesis is organized as follows"* to introduce a description of each chapter.

1.4 Structure

The rest of this thesis is organized as follows. **Chapter 2 reviews** the literature covering the methods used in the process. **Chapter 3 describes** the development of the process. **Chapter 4 presents** the piloting of the new process**. Chapter 5 discusses** the different elements and aspects included in this process, as well as provides further development needs. Finally, **Chapter 6** summarizes the work and presents the most important conclusions drawn from the piloting of the process.

Tatu Jämsén, "New energy analysis process for the design of building retrofits," M.S. thesis, School of Engineering, Aalto Univ., Espoo, Finland, 2016.