Appendix 6: Getting the Tense Right

The **introduction** and **literature review** chapters in master's theses can choose from **three tenses** when reviewing the research area: the ***present perfect***, ***past*** and ***present*** tenses. These three tenses enable writers in engineering and science to clearly indicate a shift in perspective as they move from **(1)** introducing a new topic *(pres. perf.)* to **(2)** describing the work of previous studies *(past)* and then **(3)** providing the writer's own comments *(present)* on these studies. Let's now examine how these three tenses are typically used in introductions.

Please note that the rules listed here cover the ***simple tense form*** of these tenses (e.g., *'presents'*). Avoid using the continuous *(-ing)* forms of these tenses: *'**is** present**ing**', '**was** present**ing**', or '**has been** present**ing**'*.

6.1 PRESENT TENSE

The present tense can be used for a variety of purposes in engineering *Introduction*, *theory* and *literature review* chapters:

A. Use the present tense in ***definitions***, ***descriptions***, statements of ***general, accepted knowledge***, or for making ***generalizations*** or ***claims***.

> Lignins **are** aromatic polymers synthesized mainly from three phenolic monomers, called monolignols, at proportions varying between plant species.
>
> Common symptoms of severe distortion **include** nuisance tripping of industrial processes and medical equipment, excessive heating in transformers, and equipment failure.

B. In some fields of engineering, most notably *electrical engineering*, the present tense is used to report the ***work of a single study***. For reporting the work of *multiple* authors, use the present perfect tense.

> **In [14], the authors** **report** the sliding-mode control of a linearized plant models and numerical simulations.
>
> **In [1],** a directed diffusion approach **is proposed** for forwarding data in sensor networks.

C. Describe ***mathematical proofs*** and ***chemical formulas*** using the present tense, since going through the proof occurs at the time of reading.

> From Equation 1, we **derive** the following system of inequalities.

D. Use the present tense as a ***'timeless' tense*** to describe information in your own work that does not change over time, such as the ***aim/purpose*** of your study, references to ***tables and figures***, and descriptions of ***chapters and sections***.

> **The aim of this study is to** evaluate the relative energy savings of various control strategies.
>
> **Figure 1 shows** the structure of the SPE device.
>
> **Section 2 presents** an overview of the K-means algorithm.

E. Use the simple present tense to ***evaluate*** and ***comment*** on the work of previous studies.

> **However**, these technologies **suffer** from limited accuracy or a lack of infrastructure.
>
> **Unfortunately,** RFID **requires** a large number of infrastructures to accurately determine the location.

6.2 PRESENT PERFECT TENSE

Use the present perfect to introduce ***research activities*** *or* ***processes*** as a new topic that will be continued in the following sentences. Sentences using the present perfect typically announce either a ***line of research*** *or* ***results*** from ***multiple studies***.

> **Various methods have been used to** construct models for resistive antennas.
>
> **Several approaches have been proposed for** overcom**ing** these problems **[5],[6],[8].**
>
> **Numerous algorithms have been developed for the** detec**tion of** ECG beats **[4]-[8].**
>
> **Many studies have focused on** analyzing customer's mobile device usage **[10]-[15]**.
>
> **Much research has been directed towards** feature recognition in human faces **(See [7] for a review)**.

Table 3 shows the **research activities** most commonly used in engineering as the subject with a verb in the present perfect. These sentences function as topic sentences and use sentence **Strategies 5-7** listed in Appendix 5.

Table 3 Superordinate terms commonly introduced as **research activities** using the ***present perfect***.

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

6.3 PAST TENSE

In most fields of science, the past tense is the only tense that can be used for describing **methods**, **results** and the **past research of individual studies**. However, some fields of engineering (e.g., electrical engineering) may also use the *present tense* (See 6.1B above) for these three purposes.

A. In many fields of engineering, the *past tense* is used exclusively to report the ***methods, procedures*** used to validate or verify results, as well as the ***steps*** carried out to develop the thesis outcome/contribution.

> A vibrating motor **was used to** control the movement of the locomotion mechanism.
>
> The movement of the locomotion mechanism **was controlled using** a vibrating motor.

B. For most fields of engineering, use the *past tense* to describe ***results*** from your own thesis.

> As shown in Figure 12, MR2 **showed** an overshoot of 6.5% at 80 seconds.

C. In many fields of engineering other than electrical engineering, the *past tense* is exclusively used to report the ***work of a single study***. (For reporting the work of *multiple* authors, use the *present perfect tense*.)

> **In [19], a method was proposed** to achieve perfect secrecy by randomizing transmission coefficients.
>
> **Young et al. (2005) applied** a high-performance internal computer and flat panel display technology to the vehicle meter system to increase the vehicle's computing capacity

D. Use the *past tense* for **reviewing** or **summarizing** the contents of a chapter or section in your thesis (See **Appendix 1: Chapter-section previews**).

> The previous chapter **introduced** and **compared** two different virtualization methods. In this chapter, container orchestration is explained and several popular container orchestrators are presented for optimizing computing resource usage.

Tense Shift

Figures 1-3 present examples that use a **tense shift** (i.e., changes in tense) to distinguish between three types of information:

a. the topic sentence introducing the work of *multiple research groups*,
b. the work of a *single research group*, and
c. the voice of *you*—the thesis writer.

(1) Present perfect – Past – Present

As shown in Figure 1, the ***present perfect*** is used to introduce a "line" of research methods as a new topic. In Figure 1, **sentence 1** acts as an overall **topic sentence** to introduce a new focus on "methods" as the topic that will be discussed as **given information** in the following sentences, while **sentences 4 and 5** introduce a number of other methods. Note that the **subjects** of all three sentences refer to **research activities**.

[1]**Several other methods have** also **been** applied to merged measurement tracking. [2]**An approach** based on Multiple Hypothesis Tracking (MHT) **was** proposed **in [5],** which used a two-target resolution model to maintain tracks in the presence of merged measurements. [3]**A similar resolution model was** applied to Multiple Model JPDA **in [6], [7],** which **is again** limited to a maximum of two merged targets. [4]**Various numerical data association techniques have been** developed for merged measurements **in [8], [9]** (Probabilistic Data Association), and **[10]** (Markov Chain Monte Carlo). [5]In addition, Probabilistic MHT (PMHT) **[11],** and existence-based methods, such as Linear Multi-target Integrated PDA (LM-IPDA) **[12],** and Integrated Track Splitting (ITS) **[13] have** also **been** applied to this problem. [6]**These** are all useful techniques; **however,** with the exception of LM-IPDA (which trades off performance for reduced complexity), they only handle a small number of targets.

Figure 1. Tense shift of *Present perfect-Past-Present* using **information-prominent** reporting style (Elec. eng.)

Since the sentences following the topic sentence (i.e., **sentences 2-3**) typically describe what individual authors/research teams **"did"**, it is not surprising that they use the ***past tense***. Finally, in **sentences 3 and 6**, the writer evaluates and comments on the work of these individual authors using the ***present*** tense to clearly indicate that these are writer's ideas, and not those of the cited researchers.

[1]Market-based **mechanisms** for sensor management **have** start**ed** **to gain attention** only recently **[22]–[24].** [2]**In [22], the authors** explor**ed** the possibility of using economic concepts for sensor management without explicitly formulating a specific problem. [3]**The authors in [23]** us**ed** the concept of Walrasian equilibrium **[25]** to model market-based sensor management. [4]**In [24], the authors** also propos**ed** a Walrasian equilibrium-based dynamic bit allocation scheme for target tracking in energy- constrained wireless sensor networks (WSNs) using quantized data. [5]**However, as shown in [26],** Walrasian markets can be unstable and can fail to converge to the equilibrium. [6]**Moreover,** computing the equilibrium prices and allocations can be computationally prohibitive. [7]**Accordingly, the authors ([23] and references therein)** propos**ed** algorithms to compute an approximate equilibrium. [8]**However,** the **mechanisms** proposed **in [23], [24]** are not truthful and are, therefore, prone to market manipulations.

Figure 2. Tense shift of *Present perfect-Past-Present* using **author-prominent** reporting style (Elec. eng.)

In Figure 2, note that after the topic sentence, each the following sentences (Sentences 2-4 & 7) use the **past tense** and **"**the authors**"** as the **subject** to introduce the contributions of individual studies, and the **present tense** to critically evaluate these studies.

[10]Sludge characteristics **are** important when operating reactors to achieve a certain capacity. [11]Generally, granules with inferior settling ability are easier to be washed out. [12]Therefore, the floatation of anammox granules **has been** investigat**ed** **(Chen et al., 2010; Dapena-Mora et al., 2004; Trigo et al., 2006)** because floatation leads to granule washout and eventually deteriorates the capacity of the reactor. [13]**Chen et al. (2010) found that** floatation **could** cause instability and collapse of the anammox reactor. [14]Moreover, gas pockets **were found** inside the floating granules (FG). [15]These floating granules **were** wash**ed** out when the hollows **became** filled with gas bubbles. [16]The hollows inside the granules result**ed** from cellular lysis and the gaps form**ed** during the aggregation of small granules. [17]**Trigo et al. (2006)** claim**ed** **that** the addition of Ca^{2+} in the influent **could** improve the granule density but would reduce the ratio of volatile suspended solid (VSS) to suspended solid (SS) and the NRR. [18]However, the key factors that **cause** floatation in high-rate anammox systems **remain** unclear.

Figure 3 Tense shift of *Present perfect-Past-Present* using **author-prominent** reporting style (Elec. eng.)

Similar to the text in Figure 2, texts in chemical engineering (Fig. 3) tend to use an **author-prominent** reporting strategy, as well as the ***present perfect*** (**Sentence 12**) to introduce a new research activity, and the ***past tense*** (**Sentences 13-17**) to report the results of individual studies. The ***present tense*** is used in **Sentence 10** to signal the writer's comment about the importance of the topic, **Sentence 11** to make a generalization, and **Sentence 17** to evaluate (criticize) the claim made in the study described in the previous sentence.

(2) Present perfect – Present - Present

As we have already seen, although the *past tense* can be used in engineering fields, the ***present tense*** is more typically used to report single, individual studies. In Figure 4, the research activity **algorithms** is first introduced as a topic sentence (**Sentence 16**) in the ***present perfect***. Thereafter, all references to earlier studies (**Sentences 20, 22-23**) as well as comments on these studies (**Sentences 17-19, 21-22, 24**) are reported using the ***present tense***.

[16]**Many clustering algorithms** in various contexts **have been** proposed **[2]–[3], [5]-[7], [23]–[28]**. [17]**These algorithms are** mostly heuristic in nature and aim at generating the minimum number of clusters such that any node in any cluster **is** at most *d* hops away from the clusterhead. [18]**Most of these algorithms have** a time complexity of O(*n*) where *n* **is** the total number of nodes. [19]**Many of them** also **demand** time synchronization among the nodes, which **makes** them suitable only for networks with a small number of sensors. [20]**The Max-Min d-Cluster Algorithm [5] generates** d-hop clusters with a run-time of O(*d*) rounds. [21]However, **this algorithm does** not **ensure that** the energy used in communicating information to the information center **is minimized**. [22]**The clustering algorithm** proposed **in [7] aims** at maximizing the network lifetime, but **it assumes that** each node is aware of the whole network topology, which **is** usually impossible for wireless sensor networks which **have** a large number of nodes. [23]**Many of these clustering algorithms [23], [26]-[28] are** specifically **designed** with the objective of generating stable clusters in environments with mobile nodes. [24]However, in a typical wireless sensor network, the sensors' locations **are fixed** and the instability of clusters due to mobility of sensors **is** not an issue.

Figure 4 Tense shift of *Present perfect-Present-Present* using **information-prominent** reporting style (Elec. eng.)

Note how important it is that all the sentences are linked through a single topic **algorithms**. This is important, since the text lacks the typical *past-present* tense shift. As already mentioned earlier, the ***present tense*** is used to express **established facts**. Does this then mean that engineers view earlier studies as being facts, not to be challenged or questioned?

Figure 5 presents an extract from an engineering article introduction that uses an **author-prominent** strategy to report and link the ideas of other researchers. Once again the first sentence (**12**) appears to be a topic sentence, since it uses the present perfect. However, it is not effective as a topic sentence, since it only makes a claim about the amount of effort, not about the content of the following sentences. Would **sentence 13** make a better topic sentence? Is a "metric" the same thing as a "technique" (**14**) or a comparison (**15**)?

[12]**There has been** considerable **work** reported on detecting scene changes based on entire images. [13]Difference metrics **are used to** evaluate the changes between successive frames, and global thresholds **are used to** determine whether changes have taken place. [14]**Nagasaka and Tanaka [3] experiment** with various comparison techniques, including difference of gray-level sums, sum of gray-level differences, difference of gray-level histograms, colored template matching, difference of color histograms and x2 comparison of color histograms. [15]Such comparisons **are** only **applied to** a portion of each image. [16]**They conclude that** the most robust methods is the xz comparison of color histograms. [17]To guard against momentary noises like camera flashes, **they** further **divide** each frame into 4x 4 rectangular regions of equal size and **compare** every pair of regions. [18]The largest differences **are discarded**, and the detection **is done** on the remaining ones. [19]**Their** method **is** robust against zooming and panning, but **may fail** to detect special effects such as fading. [20]**Otsuji et al. [4] use** brightness data to compute both the frame-based histogram and pixel-base inter-frame difference. [21]A cut break **is defined** as a seamed point between different moving pictures. [22]Continuous transitions **are** not **considered**. [23]**In a later paper, Otsuji and Tonomura [5] propose** a projection detection filter for more reliable video cut detection.

Figure 5 Tense shift of *Present perfect-Present-Present* using author-prominent reporting style (Elec. eng.)

Sources:

Figure 1 Koch, Wolfgang & Van Keuk, G. (1997). Multiple hypothesis track maintenance with possibly unresolved measurements. Aerospace and Electronic Systems, IEEE Transactions on. 33. 883 - 892. 10.1109/7.599263.

Figure 2 N. Cao, S. Brahma and P. K. Varshney, "An incentive-based mechanism for location estimation in wireless sensor networks," *2013 IEEE Global Conference on Signal and Information Processing*, Austin, TX, 2013, pp. 157-160. doi: 10.1109/GlobalSIP.2013.6736839

Figure 3 Hui Chen, Chun Ma, Guang-Feng Yang, Hui-Zhong Wang, Zhi-Ming Yu, Ren-Cun Jin, Floatation of flocculent and granular sludge in a high-loaded anammox reactor, Bioresource Technology, Volume 169, 2014, Pages 409-415.

Figure 4 Seema Bandyopadhyay and E. J. Coyle, "An energy efficient hierarchical clustering algorithm for wireless sensor networks," *IEEE INFOCOM 2003. Twenty-second Annual Joint Conference of the IEEE Computer and Communications Societies (IEEE Cat. No.03CH37428)*, San Francisco, CA, 2003, pp. 1713-1723 vol.3.

Figure 5 Boon-Lock Yeo and Bede Liu, "Rapid scene analysis on compressed video," in *IEEE Transactions on Circuits and Systems for Video Technology*, vol. 5, no. 6, pp. 533-544, Dec. 1995.