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Article

Metadiscourse Features in Aeronautics and Aerospace Engineering: The Use of Interactive and Interactional Markers

Características Metadiscursivas na Engenharia Aeronáutica e Aeroespacial: O Uso de Marcadores Interativos e Interacionais

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ABSTRACT: Several studies on metadiscourse zero in on how genres show nuances of linguistic features that reside in various structures depending upon the linguistic exigencies of language for specific purposes. Inquisitive on how these nuances are demonstrated through a repertoire of metadiscoursal features in a highly contextualized discourse, this paper explores how metadiscourse resources are utilized in aeronautics and aerospace engineering and how these facilitate the development of a well-composed text in the field of aviation. Using Hyland and Tse's (2004) and Hyland's (2005, 2010) analytical frameworks for interactive and interactional resources, a corpus of thirty research articles comprising 125,298 words published in the Journal of Aeronautics and Aerospace Engineering was scrutinized. As revealed in the study, the investigated metadiscourse markers resembled Hyland and Tse's (2004) and Hyland's (2005, 2010) findings in terms of interactive and interactional markers, which contain similar features of academic writing such as formality and objectivity; however, in the use of interactional resources, it yielded a finding that supports informality through the use of self-mentions. The quantitative analysis yielded a higher frequency of interactive markers than interactional markers across the thirty articles. This argues that writers in aeronautics and aerospace engineering articles essentially employ more interactive resources than interactional resources, suggesting that these writers are primarily concerned with making their text more cohesive while being responsible for establishing an interpersonal stance toward both the propositional contents and the audience of the text. The findings of the present study provide pedagogical implications as to how writers in the field of aeronautics and aerospace engineering can effectively compose their articles through the strategic use of metadiscoursal markers.

KEYWORDS: metadiscourse; interactive markers; interactional markers; aeronautics; aerospace engineering.

RESUMO: Estudos sobre o metadiscurso concentram-se em como os gêneros delineiam nuances das características linguísticas que residem em várias estruturas, dependendo das exigências linguísticas da linguagem para fins específicos. Para entender como essas nuances se manifestam a partir de um repertório de características metadiscursivas em um discurso altamente contextualizado, este artigo explora como os recursos metadiscursivos são utilizados na engenharia aeronáutica e aeroespacial, e como estes facilitam a escrita de um texto na área da aviação. Por meio dos pressupostos analíticos de recursos interativos e interacionais de Hyland e Tse (2004) e Hyland (2005, 2010), este estudo examina um corpus com um

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total de 125.298 palavras, composto de trinta artigos de pesquisa publicados no Journal of Aeronautics and Aerospace Engineering. O estudo mostra que os marcadores metadiscursivos assemelham-se aos de Hyland e Tse (2004) e Hyland (2005, 2010) em relação aos marcadores interativos e interacionais, que contêm características semelhantes à escrita acadêmica, tais como formalidade e objetividade. Entretanto, no uso de recursos interacionais percebe-se informalidade por meio do uso de auto menções. A análise quantitativa ressalta uma frequência maior de marcadores interativos do que marcadores interacionais nos trinta artigos. Dessa forma, conclui-se que os autores de artigos de engenharia aeronáutica e aeroespacial empregam essencialmente mais recursos interativos do que recursos interacionais, o que pode sugerir que tenham uma preocupação em tornar o texto mais coeso, ao mesmo tempo em que se responsabilizam por estabelecer uma postura interpessoal em relação aos conteúdos proposicionais e ao público do texto. Os resultados deste estudo apresentam implicações pedagógicas sobre como escritores da área de engenharia aeronáutica e aeroespacial podem efetivamente escrever seus artigos por meio do uso estratégico de marcadores metadiscursivos.

PALAVRAS-CHAVE: metadiscurso; marcadores interativos; marcadores interacionais; aeronáutica; Engenharia aeroespacial.

1 Introduction

Studies on metadiscourse have focused on genre analysis as this facilitates the development of a well-structured proposition vis-a-vis the purpose of the whole text, the writer's stance, and the audience's engagement. Several studies on metadiscourse zero in on how a particular genre shows nuances of linguistic features that reside in various structures depending upon the linguistic exigencies of language for specific purposes (LSP). These nuances vary according to how language situates itself appropriately. This corroborates with several studies (Adel, 2006; Breivega; Dahl; Flottum, 2002; Dahl, 2004; Mauranen, 1993; McEnry; Kifle, 2002; ThueVold, 2006 *apud* Kuhi; Behnam, 2011) that have developed a variety of perspectives claiming that metadiscourse varies greatly depending on the way texts are written, used and responded by individuals (Swales, 1990) in a particular discourse community, as shown in the comparative genre analyses of research articles, textbooks, dissertations, and undergraduate studies (Hyland, 1994, 1996a, 1996b, 2002, 2007; Bunton, 1999; Myers, 2001 *apud* Kuhi; Behnam, 2011) that have led to exploring other genres. In fact, genre analysis on medical discourse (Mozayan; Allami; Fazilatfar, 2018), finance discourse (Alyousef, 2015), and sports discourse (McGannon, 2016) has revealed a mix of metadiscourse features as they are framed and used for specific purposes.

However, there is a lack of investigation on how metadiscourse features have been used for writing research articles in the field of aviation discourse, more specifically in published aeronautics and aerospace engineering research articles. This study employs Hyland and Tse's (2004) and Hyland's (2005, 2010) framework for analyzing textual and interpersonal metadiscourse features, which will provide the students, teachers, practitioners, and professional writers with discursive knowledge and discursive patterns on how research articles can be written in aviation contexts, more specifically in the field of aeronautical engineering. In the Philippines, aeronautical engineering is one of the few programs in aviation being offered by a few aeronautical engineering schools across the country. This program provides several academic writing subjects, including technical writing and research writing, to aeronautical engineering students whose professors require (more often by languages and linguistics professors) to produce research

papers in the field of aeronautical engineering. To my knowledge, there is a lack of investigation into how aeronautical engineering research can be written with the aid of discursive knowledge and discursive patterns necessary for creating a well-composed text. The aims of this study are to explore metadiscoursal features in aeronautics and aerospace engineering research articles (AAERAs) and how these metadiscourse resources can best facilitate the development of a well-constructed text. This linguistic investigation will inform students, teachers, practitioners, and professional writers in the Philippines about the pedagogy of research writing and production in the field of aeronautics and aerospace engineering.

Metadiscourse is commonly described as "self-reflective linguistic material referring to the evolving text and the writer and imagined reader of that text" (Hyland, 2012, p. 37). These linguistic expressions are realized through various metadiscourse markers that equip writers with discursive knowledge and discursive patterns in creating a well-developed text, carrying their social functions, which contributes to the practical knowledge dissemination in a discipline (Khedri; Heng; Ebrahimi, 2013). However, metadiscourse usage can be expectedly varied and distinct across disciplines (Hyland, 2005, p. 143) as this requires linguistic variation that successfully realizes its functions relative to the nature of such disciplines. Thus, it is appropriate to explore how metadiscourse variation is utilized across disciplines and how this can also augment the development of a text in various genres.

1.1 Literature Review

The study on metadiscourse analysis across disciplines has provided academic writers with a view that strategic manipulation of a variety of linguistic resources can augment the propositional contents of research articles which amalgamate the writers' stance, communicative purposes, and engagement of the audience in a text. As Hyland and Tse (2004, p. 161) argued, "all metadiscourse is interpersonal in that it takes account of the reader's knowledge, textual experiences, and processing needs". Hence, using interpersonal metadiscourse markers in academic texts influences the texts and helps writers establish an authorial presence. While it is undeniable that metadiscourse markers are used to show propositional meanings that affect the writer's stance, as revealed in various metadiscourse analyses across disciplines, these metadiscourse markers have to find their linguistic niche and realize their functions vis-a-vis the communicative purposes of both the writer and the text. Although these metadiscourse markers are heavily demonstrated in the form of interactive and interactional markers (Hyland, 2005), it is still imperative to revisit a variety of metadiscourse markers that can best underpin how these linguistic devices are realized in a particular niche or genre.

Using Hyland's (2005) interpersonal model of metadiscourse, Khedri, Heng and Ebrahimi (2013) analyzed interactive metadiscourse markers in 60 research article abstracts written in Applied Linguistics and Economics. The study revealed that applied linguists most commonly used interactive metadiscourse markers. However, a relatively higher frequency of each interactive category showed linguistic variation in the two disciplines. Featured as the leading category in both disciplines, *transition markers* (*e.g.*, *furthermore, however, therefore*) were used more often in Economics (23.05 per 1000 words) than in Applied Linguistics (17.49 per 1000 words). Secondarily, *code glosses* (*e.g., that is, for example*), however, revealed a higher frequency in Applied Linguistics (12.28 per 1000 words) than in Economics

(8.78 per 1000 words). The third top interactive category revealed that *endophoric markers* (*e.g.*, *in the discussion section of this paper*) were used 56 times (10.42 per 1000 words) by applied linguists and 21 times (5.76 per 1000 words) by economists. The fourth top interactive feature was *frame markers* (*e.g.*, *first, second*), which were used three times (9.30 per 1000 words) more in Applied Linguistics than they were used in Economics (3.29 per 1000 words). Among the interactive metadiscourse markers investigated, evidential markers appeared less in both disciplines. Still, they revealed differences as these were used twice more in Applied Linguistics (4.09 per 1000 words) than in Economics (2.47 per 1000 words). This study revealed a variation of interactive metadiscourse markers across the two selected disciplinary communities, which suggested that each disciplinary community within the broad domain of the soft sciences has social authorization and contextual restriction for metadiscoursal occurrence.

However, Fu (2012) explored the interactional metadiscourse markers in analyzing 220 job postings (77,100 words), together with 30 informants' feedback on the attitude toward its use. Proposing taxonomy of interactional metadiscourse based on Hyland's (2005) model, this investigation of two broad categories of interactional metadiscourse remarkably revealed a similar frequency of stance markers (234 per 10,000 words; *e.g.*, hedges, boosters, attitude markers, self-mentions) and engagement markers (228 per 10,000 words; *e.g.*, reader-inclusive pronouns, questions, and directives) which indicates writer's consciousness of equal use of such interactional resources in conveying stance and bringing in the readers in job postings. Notable stance features in job postings were self-mentions (149 per 10,000 words; *e.g.*, *I*, *We*), attitude markers (51 per 10,000 words; *e.g.*, *interesting*, *important*), hedges (26 per 10,000 words; *may*, *approximately*), and boosters (8 per 10,000 words; *always*, *certainly*) while engagement features were reader-inclusive pronouns (194 per 10,000 words; *e.g.*, *we*, *you*), directives (19 per 10,000 words; *e.g.*, *see* website), and questions (15 per 10,000 words). Generally, this investigation on macro-interactional metadiscourse resources in job postings revealed that the abundance in the use of stance markers and engagement markers is equally distributed in this genre, offering valuable insights into how interactional metadiscourse in job postings may enable teachers and students to examine the text from an interpersonal metadiscourse perspective.

Using Hyland's (2004) model of metadiscourse as an analytical framework for their study, Kim and Lim (2013) investigated the similarities and differences in the use of metadiscourse (*i.e.*, interactive and interactional resources) in 20 Chinese and 20 English research articles in the field of educational psychology. Accordingly, the most frequent subcategory of metadiscourse yielded in the corpus is evidential, which forms at least 50% of all interactive uses in both datasets. Furthermore, Kim and Lim (2013) concluded that evidential markers were used as references (citation in most cases) to other sources to strengthen their claims and arguments. Further, this suggests that the use of citation through evidential markers implicitly creates an impression on the reader's part that the writer is well-informed about the literature context related to the study.

Metadiscourse features are characterized by the way they are used in different discourse niches. However, studies show that these features in the lingua-cultural context in which texts are composed can change the use of metadiscourse markers even within the same genre (*e.g.*, Lafuente-Millán, 2014; Lee; Casal, 2014 *apud* Bal-Gezegin, 2016). Comparing genre-based studies on metadiscourse markers can explain an overt contrast between such propositions. For instance, an investigation by Kawase (2015) on how research writers construct metadiscourse in the introductions of Ph.D. theses and research articles revealed that six out of eight writers make greater use of metadiscourse in their research articles introductions than in their thesis introductions. Accordingly, these metadiscourse resources in research articles introductions

are heavily employed through interactive markers such as *endophoric markers*, *evidentials*, *code glosses*, and *transition markers.* About four out of eight writers use more interactional markers in research article introductions, such as *attitude markers, self-mentions*, and *hedges*. This investigation points to a conclusion that although there were changes in the use of interactive and interactional items due to similar reasons (*e.g.*, related to how research writers construct their authorial presence in their theses or RAs), the increased use of an interactive item may be an underlying factor of greater use of a relevant interactional item. These suggest that both metadiscourse markers can be closely related.

Kuhi and Mousavie (2015) conducted a diachronic study of interpersonality in research articles' discussion sections in the field of linguistics to find out changes over time in terms of three prominent interactional markers: hedges, boosters, and attitude markers. Hyland and Tse's (2004) model on metadiscourse was used as the analytical framework in scrutinizing a corpus of 50 research articles in Applied Linguistics. This diachronic investigation revealed that changes were revolutionary over time, owing to the extensive use of hedges in most discussion sections. These changes could be attributed to (1) an increase in the average length of research article discussions over time; (2) being a separate subgenus in research articles over time; and (3) their subjective nature in soft disciplines, which demand far more use of interactional devices (*e.g.*, hedges) over time, which further explained that more extended research articles discussions manifest a higher frequency of interactional metadiscourse. In addition, it was found that interactional metadiscourse resources were more frequent in recent years (the 2000s) in ESP-published journal articles than in articles from the 1980s. However, an empirical study on metadiscourse elements, as shown in accounting research articles published in the Journal of Accounting and Management Information Systems over the period 2006-2014, revealed that there is a correlation between publication's maturity and the number of interactional instances and that the number of such metadiscourse elements has increased over time. In addition, Mocanu (2015) found a significant pattern of hedges (9,903 per 10,000 words), boosters (19,373), and attitude markers (27,323) as the most frequent elements of interactional metadiscourse.

Mansouri, Najafabadi and Boroujeni (2016) conducted a cross-lingual and disciplinary investigation on metadiscourse used in 20 abstracts of Persian and English research articles in two disciplines, Applied Linguistics, and computer engineering, based on Hyland's (2005) taxonomy. The interlingual analysis revealed that languages used interactive resources more than interactional resources, revealing their significance in making the text coherent and convincing the audience through engagement. However, Applied Linguistics showed more metadiscourse resources over computer engineering and used interactive markers more than interactional ones.

In a spectrum of academic texts investigated, Kuhi and Behnam (2011) found that the sharpest variation of metadiscourse markers may depend on how applied linguists prioritize them. Focusing on research articles alone, the study yielded a relatively higher frequency of interactive metadiscourse markers such as *evidentials* (9.7 per 1000 words), *transitions* (9.3 per 1000 words), and *code glosses* (8.2 per 1000 words) than of interactional markers like *hedges* (11.4 per 1000 words), *boosters* and *self-mentions* (both 3.2 per 1000 words) and *attitude markers* (2.8 per 1000 words). Although a significant linguistic pattern from previous research would reveal a higher frequency of interactive and interactional markers in a spectrum of academic texts, it remains a question whether this resembles research articles across various discourse communities such as academic discourse and business discourse, including the field of aeronautics and aerospace engineering.

Using Hyland and Tse's model and Hyland's model for the multimodal analysis of metadiscourse markers in finance texts, Alyousef (2015) explored the use of metadiscourse markers in three multimodal management reports written by ten international Master's of Accounting students and revealed a higher frequency of interactional markers (4.21 markers per 100 words) than interactional markers (3.42 markers per 100 words) across the three reports. The metadiscourse analysis of the interactive markers revealed that *transitions* (or logical connectives: *e.g.*, *in addition, however, thus,* etc.) ranked the highest across the three orthographic texts, followed by *code glosses* (*e.g.*, *i.e.,*) and *frame markers*, "*first, second, third, fourth,* and *finally*" while *evidentials* and *endophytic* rarely occurred in the three texts. On the other hand, the metadiscourse analysis of interactional markers in the texts revealed that *hedges* (*e.g.*, *would, might, perhaps*) occurred most often, followed by *engagement markers* (*e.g.*, *suggest, recommend*). *Attitude markers, self-mentions,* and *boosters* rarely occurred in the orthographic texts. Alyousef's (2015) study corroborated Hyland's (1999) study of marketing textbooks, suggesting that students have been enculturated into the business discourse of their community of practice.

Using Hyland's theory and classification of metadiscourse, Lichen and Yi (2016) examined two small abstracts corpora which included 30 mathematical and 30 linguistic abstracts of academic papers from Social Science Citation Index (SSCI) and Science Citation Index (SCI) journals. Lichen and Yi (2016) found that more metadiscourse occurred in the abstracts of linguistic academic papers than in mathematical academic papers, both disciplines utilizing more interactive resources than interactional resources in abstracts, while demonstrating the same frequencies of the five sub-categories. Accordingly, hedges were the most frequently used metadiscourse markers in linguistic academic papers, while self-mentions were more commonly used in mathematics. Furthermore, it was suggested that more interactive metadiscourse should be used in abstracts of both arts and science academic papers.

Mina and Biria (2017) explored interactive and interactional metadiscourse in discussion sections of social science and medical science research articles. Composed of 70,000 running words published between 2010 and 2016, the corpus of 100 English research articles written by Iranian writers was analyzed using Hyland's taxonomy. The results revealed that while interactive metadiscourse resources (transitions, 73.4 %; frame markers, 7.4 %; and evidentials, 11.1%) in social science articles were more frequent than in medical science texts, interactional metadiscourse resources (hedges, 42.7 %; boosters, 20.4 %; and self-mentions, 17.3 %) were more frequent in medical science articles than in social science articles. Notably, authors in social science preferred to use interactive metadiscourse, while the medical science authors utilized interactional metadiscourse markers more frequently.

In medical discourse, Mozayan, Allami and Fazilatfar (2018) compared metadiscourse markers found in 160 research articles in terms of type and frequencies based on Hyland's (2005) taxonomy. It was found that boosters (378.78 per 10,000 words) dominated the list, followed by transition markers (182.95 per 10,000 words) and hedges (141.58 per 10,000 words). The higher frequency of boosters in medical research articles can be attributed to the nature of the experimental research since authors have to be decisive on the blatant outcomes of experiments. In marine discourse, however, Marcellino (2014) used sample lexical items for marine talk as a basis for discourse analysis. Some features, such as *clearly* and *certainly*, classified as self-mention and booster respectively, were elicited in the analysis. A few metadiscourse markers were investigated due to the nature of marine talk, as it highly uses a standard English stipulated in the manuals of the International Civil Aviation Organization (ICAO).

A recent study by Seoane and Hundt (2018), which has focused on differences regarding degrees of author involvement in relation to the functions of active and passive voice across disciplinary areas, revealed that texts in both hard sciences (natural sciences and technology) and soft sciences (humanities and social sciences) remain equally impersonal. It is worth emphasizing that the referents in most of the patterns investigated in hard sciences were predominantly the author(s) of the text (more than 50%). In contrast, the author(s) referred to soft sciences only, amounting to 13.3%. Despite the higher authorial presence in hard sciences as elicited in the study, a detailed qualitative analysis construed that scientific texts still preferred impersonal expressions irrespective of voices. On the other hand, Hyland and Jiang's (2016) study focused on the use of stance noun and its grammatical feature of discourse in a corpus of 160 research articles across eight disciplines, totaling 1.7 million words. The study revealed that writers in soft sciences (22.3 per 100 discourse and cognition stance nouns) were far more likely to use integral citation forms than science writers (5.4 per 100 discourse and cognition stance nouns). This means that writers of the text tend to use cited authors in the body of the sentence rather than in parenthesis or a footnote. This pattern helps construct a discursive and contextual framework for arguments. Another study was conducted by Mur-Dueñas and Jolanta Šinkūnienė (2016), who reviewed previous research on self-reference in research articles from an intercultural perspective. Focusing on stance features (*e.g.*, self-mentions) in 13 lingua-cultural contexts (Bulgarian, Chinese, Danish, Dutch, English, French, German, Italian, Lithuanian, Norwegian, Persian, Russian, Spanish) as demonstrated in 22 studies in the field of English for Academic Purposes and English for Specific Purposes published from 1998 to 2012. The study revealed that while the author's projection in research articles through the use of self-mentions (*e.g.*, personal subject pronouns) does not seem to be the norm in the lingua-cultural local contexts and self-reference is avoided to a certain extent, the use of self-reference appears to be manifested to a much larger extent in English research articles published internationally, suggesting a higher authorial presence of English writers. However, it is worth distinguishing that, in a large number of languages and local contexts of publication, the authors tend to use the plural pronoun instead of *I* to exclude their personal reference in research articles – a textual practice that could also be extended to other cultural contexts.

An investigation on metadiscourse in written and spoken registers across the press, general prose, academic prose, and fiction was conducted by Zhang (2016) to extract and interpret through multidimensional analysis how writers show authorial presence, engage the readers, and present the texts in the Freiburg update of the Lancaster-Oslo/ Bergen Corpus of British English (500 texts, 1,000,000 words). Zhang (2016) found that metadiscourse markers extensively occurred in more informational and abstract registers (academic, general prose, editorial), especially for the function of text presentations. In contrast, metadiscourse markers rarely occurred in narrative and concrete registers (fiction, press, reportage) and were used purposefully to guide the readers. The multidimensional analysis revealed that text-oriented metadiscourse markers were used in introducing what the text was like; writer-oriented metadiscourse markers were used in presenting the writer's contributions to the text, and reader and participant-oriented metadiscourse markers were used in guiding the reading process of the text.

With reference to the abovementioned studies on the use of metadiscourse markers across discourse communities in the fields of business, medicine, marine, Applied Linguistics, and other cross-cultural, interdisciplinary studies, all of which observe relatively academic features in writing, I believe that

to my knowledge, similar studies in the field of aeronautics and aerospace engineering have not yet been explored, which is what the present study would like to address.

1.2 Scope and Limitation of the Study

This study analyzed metadiscoursal resources used in aeronautics and aerospace research articles. Specifically, it investigated the interactive and interactional metadiscoursal markers utilized in thirty aeronautics and aerospace engineering research articles, consisting of 125,298 words, all published in the Journal of Aeronautics and Aerospace Engineering. This Journal is an open access journal with an impact factor of 1.62. It has been indexed in the following: Index Copernicus, Google Scholar, Sherpa Romeo, Open J Gate, Genamics JournalSeek, Academic Keys, JournalTOCs, RefSeek, Hamdard University, EBSCO A-Z, OCLC- WorldCat, and Publons. In addition, all published articles in this Journal are permanently archived and available on the OMICS International website in HTML and PDF formats.

The investigated research articles were published between 2016 and 2018. Therefore, this study also considered the year of publication of these articles to explore how research articles are written and conveyed by aeronautics and aerospace engineers at present times, as there might be changes regarding the use of metadiscoursal markers in hard sciences research articles written in the past.

Although this Journal focuses on a broad range of aeronautics and aerospace engineering topics, this study is delimited to two sub-disciplinary areas: aeronautics and aerodynamics. This means that the articles obtained from this Journal mainly focus on the practical aspect of aeronautics, design, development, production, and operation of manned aircraft and unmanned aerial vehicles (UAVs), as well as the study of the properties of moving air, especially of the interaction between the air and any manned aircraft and UAVs moving through it.

As this paper views that metadiscourse features are shown across disciplines, this study utilized Hyland and Tse's (2004) and Hyland's (2005, 2010) models to analyze how metadiscoursal resources are distributed in AAERAs and how these metadiscoursal markers are used in making AAERAs more cohesive and in conveying interpersonal stance both toward the propositional contents and the audience of the text.

1.3 Theoretical and Analytical Framework

This study employed Hyland and Tse's (2004) and Hyland's (2005, 2010) framework for analyzing interactive and interactional markers, as this model fits an exploratory study on metadiscourse yet provides a clear-cut distinction between these two major metadiscourse divisions.

Table 1 – Hyland and Tse's (2004) and Hyland's (2005, 2010) Models of Metadiscourse

Metadiscourse	Examples	
Interactive Markers	Help guide the reader through the text	Resources
Transitions	Express semantic relations between main clauses	In addition/furthermore/thus/hence
Evidentials	Refer to sources of information from other texts	According to X/(Y, 1990)/Z states
Code glosses	Signal the restatement of ideational information	Namely/for instance/*e.g.*,/such as/in other words/ that is/*i.e.*
Frame markers	Refers to discourse acts, sequences, or text stages	Nevertheless/therefore/moreover/ however/ still/alternatively/consequently/on the other hand/in contrast
Endophoric markers	Refer to information in other parts of the text	Noted above/below/see figure/in section/table/ in figure/ in section
Interactional markers	Involve the reader in the argument	Resources
Engagement markers	Explicitly build a relationship with the reader	Consider/suggest recommend/assumed/ require/ expected/regarded/ should be/must
Self-mentions	Explicitly refer to the text's author(s)	I/me/mine/we/our/ours
Hedges	Withhold commitment to present	Might/perhaps/possible/about/may/ would/could/it appears that/seem/I think
Attitude markers	Express a writer's stance toward proposition(s) and the audience of the text	Importantly/fortunately/hopefully/I agree/surprisingly/ significantly
Boosters	Emphasize a writer's certainty in proposition	In fact/indeed/definitely/indefinitely/ highly/clearly

Source: Elaborated by the author based on Hyland and Tse's (2004) and Hyland's (2005, 2010).

Table 1 shows Hyland and Tse's (2004) and Hyland's (2005, 2010) models for analyzing metadiscourse features in AAERAs. These models distinguish between two primary metadiscourse resources categorized into interactive and interactional markers. Hyland and Tse (2004, p. 168) stated that the interactive category refers to "the writer's management of information flow" to help guide the reader through the text, while the interactional type refers to the writer's "explicit interventions to comment on and evaluate material" (Hyland; Tse, 2004, p. 168). These interactive markers are subcategorized into transitions, evidentials, code glosses, frame markers, and endophoric markers. Transitions (or logical connectives; *e.g.*, in addition, however, furthermore) show semantic relations between clauses through conjunctions and adverbial and prepositional phrases. Frame markers (*e.g.*, first, second, finally) refer to discourse acts, sequences, or text stages. Evidential (*e.g.*, according to) refers to information from other texts, while endophoric markers refer to information in other parts of the text.

On the other hand, interactional markers are categorized into hedges, boosters, self-mentions, attitude markers, and engagement markers. According to Hyland (1998, p. 8), hedges and boosters

"indicate the degree of commitment, certainty and collegial defence a writer wishes to convey". However, these hedging devices (*e.g.*, would, could) have two overlapping categories: low-value subjective moralization and low-value modulated operators that express possibility and quality. Self-mentions are used to suggest authorial presence through the use of first-person pronouns (*e.g.*, *I, we*). Attitude markers indicate the writer's emotions that affect their propositional contents and the text's audience. In contrast, engagement markers are used to "explicitly address readers, either by selectively focusing their attention or by including them as participants in the text through second person pronouns, imperatives, question forms and asides" (Hyland, 2010, p. 129).

All these metadiscourses framed in Hyland and Tse's (2004) and Hyland's (2005, 2010) models would be used in exploring and analyzing interactive (transition markers, endophoric markers, code glosses, frame markers, and evidentials) and interactional resources (hedging devices, boosting devices, engagement markers, self-mentions, and attitude markers) as would be revealed in the thirty research articles published in the Journal of Aeronautics and Aerospace Engineering.

1.4 Research Questions:

To provide a substantial account for this exploration, the present study sought to answer the following questions:

1. How are metadiscoursal resources used in aeronautics and aerospace engineering research articles in terms of interactive markers?
2. How are metadiscoursal resources used in aeronautics and aerospace engineering research articles in terms of interactional markers?
3. How are these metadiscoursal markers used in making aeronautics and aerospace research articles more cohesive and in conveying interpersonal stance compared to other interdisciplinary genres?

2 Methodology

This study takes a corpus-based approach in describing and interpreting the metadiscourse features shown in thirty AAERAs published in the Journal of Aeronautics and Aerospace Engineering. It seeks to recognize how linguistic repertoire, discursive knowledge, and discursive patterns are used as interpretive and social resources for establishing the communicative purpose of the text, the writer's stance, and the audience's engagement.

2.1 Corpus of the Study

The corpus was a collection of thirty AAERAs published in the last three years in the Journal of Aeronautics and Aerospace Engineering. This corpus was composed of 125,298 words which, I believe, contained metadiscoursal features that would be the basis for establishing metadiscourse analysis. Obtained from the three latest volumes (v. 5, 6, and 7) archived on the website of the Journal of Aeronautics and Aerospace Engineering, these research articles were extracted based on the primary criteria, following the work of Grabe (1987) and Paltridge (1996): genre, English for Specific Purposes (ESP), and text type. First, research articles qualify as a genre on their own. Second, research articles published in the Journal of Aeronautics and Aerospace Engineering are ESP in character. Third, research articles contain text types such as abstract, introduction, methodology, results and discussion, and conclusion and recommendation. However, the corpus was taken as a collection of all research articles and did not account for the analysis of each text type. Another criterion that this corpus considered was that all research articles extracted were published in the last three years (2016, 2017, 2018), exploring discursive changes in the frequency and usage of metadiscourse. Finally, this corpus focused on specific aspects of aeronautics and aerodynamics, revealing how aeronautics and aerospace engineers write research articles relative to these two subdisciplinary areas in aviation. These research articles extracted from the Journal of Aeronautics and Aerospace Engineering are presented in Annex A.

2.2 Data Analysis

This study's two phases of analysis were: (1) quantitative analysis and (2) qualitative analysis. The quantitative analysis of the metadiscoursal features was conducted through Antconc, a program created by Laurence Anthony (Waseda University) and used for analyzing electronic texts (that is, corpus linguistics) to find and reveal metadiscoursal patterns in aeronautics and aerospace engineering research articles. The quantitative analysis revealed occurrences of the metadiscoursal resources in the research articles. First, the frequencies of interactive metadiscourse and interactional markers were elicited through several hits; each metadiscourse marker appeared in the Antconc. However, these frequencies were reduced when a manual analysis of each metadiscourse was done since not all markers showed their linguistic meaning inherent to their discourse function. Then, a percentage was calculated for each subcategory of the interactive and interactional metadiscoursal marker by dividing the frequency of each subcategory by the total number of frequencies of the overall category and then multiplying this by 100.

The quantitative analysis used corresponding interpretations such as "higher" and "most" to make it more precise. The results yielded the frequency of occurrences of all metadiscourse markers. Then, a comparison between the instances of interactive and interactional metadiscourse markers per 100 words was elicited by dividing the total number of occurrences of each category by the total number of words in the corpus and multiplying this by 100. Finally, using Hyland and Tse's (2004) and Hyland's (2005, 2010) framework, the qualitative analysis was achieved by scrutinizing the interactive and interactional resources used in the aeronautics and aerospace engineering research articles. The qualitative analysis included

weeding out some metadiscourse markers and reassigning them to other subcategories of metadiscourse resources. For instance, interactional markers *we* can be subcategorized as engagement markers but can also be grouped in the subcategory of self-mentions.

The use of Hyland and Tse's (2004) and Hyland's (2005, 2010) models for investigating the distribution and nature of metadiscourse markers seemed to be suitable for this study since it sought to examine how interactive markers were used in making aeronautics and aerospace engineering research articles more cohesive, as well as to analyze how interactional markers were used in conveying interpersonal stance toward both the propositional content and the audience of the text. The interactive and interactional metadiscoursal markers to be analyzed based on Hyland and Tse's (2004) and Hyland's (2005, 2010) framework were transitions, endophoric markers, evidential markers, code glosses, hedges, boosters, self-mentions, engagement markers, and attitude markers, all of which were discussed previously.

For interactive resources: First, the transition markers would be investigated to determine whether these functions show the relationship between statements expressed in the research articles. These would take into account the use of transition markers, such as *addition, however, furthermore*, as logical connectives rather than frame markers (such as those that function to guide or facilitate propositions). Second, frame markers (*e.g.*, first, second, finally) would be used to determine whether the identified markers realized the linguistic expression inherent to their functions. The basis for analyzing frame markers is whether these are believed to refer to discourse acts, sequences, or text stages. Third, the evidential marker (*e.g.*, according to) would be identified according to its inherent linguistic expression, *i.e.*, if it's used to refer to information from other texts. Fourth, code glosses would be determined through their innate linguistic expression, as shown in Hyland's and Tse's (2004) framework to construe whether these code glosses functions signal restatement or reformulation of ideas. Last, endophoric markers would be identified as whether these markers were selectively used to refer to any information in other text parts.

For interactional resources: First, the hedging devices (*e.g.*, *would, could, might*) would be construed based on whether these interactional resources indicate a strong commitment or rather a detachment to their propositions. Second, self-mentions would be used to determine whether the same interactional markers (*e.g.*, *I, we)* suggest authorial presence through personal pronouns, either singular or plural. Third, the attitude markers indicate the writer's emotions that affect their propositional contents and the text's audience. In contrast, engagement markers would determine whether the writers explicitly engage the audience in the text.

3 Results

This section presents the analysis of metadiscourse features investigated in aeronautics and aerospace engineering research articles. This includes both the quantitative and qualitative analysis of discursive patterns that reveal how writers arrive at writing a well-constructed article.

Table 2 – Metadiscoursal Resources in Aeronautics and Aerospace Engineering

Categories	Metadiscourse tokens	
Interactive Markers	Subtotal	%
Transitions	1629	54.05
Evidentials	67	2.22
Code glosses	485	16.10
Frame markers	119	3.95
Endophoric markers	714	23.68
Total	**3014**	**100**
Per 100 words	**2.41**	**100**
Interactional markers	Subtotal	%
Engagement markers	93	5.86
Self-mentions	294	18.53
Hedges	726	45.75
Attitude markers	53	3.33
Boosters	421	26.53
Total	**1587**	**100**
Per 100 words	**1.27**	**100**

Source: Elaborated by the author based on Hyland and Tse's (2004) and Hyland's (2005, 2010).

The frequency of metadiscourse markers in the investigated articles revealed their importance in writing aeronautics and aerospace engineering research articles. As seen above, the metadiscourse analysis showed a higher frequency of interactive markers (2.41 markers per 100 words) than interactional markers (1.27 per 100 words) across the thirty articles.

The metadiscourse analysis of the interactive markers revealed that transitions (or logical connectives; 54.05%) ranked the highest across the thirty published research articles, followed by endophoric markers (23.68%) and code glosses (16.10%). However, frame markers (3.95%) and evidential markers (2.22%) rarely occurred.

> **Therefore**, [Interactive: Transition] a new design of vortex generators is considered in the current investigation to control the secondary flow losses and consequently enhance the compressor\x92s performance (Diaa; El-Dosoky; Ahmed, 2016).

All authors of the published articles in aeronautics and engineering extensively used transitions because these show the relationship of each procedure in the design and production of mechanisms or devices that considerably influence the aerodynamic performances of any aircraft or unmanned aerial vehicle in general. Likewise, they heavily employed endophoric markers and code glosses because much of the exemplification and reformulation of such procedures was demonstrated through these visual markers, as shown below:

> **In Figure 9**, [Interactive: Endophoric marker] **we** [Interactional: Self-mention] **could** [Interactional: Hedge] find the strong bow shock was aroused near the nose part of the blunt body, and flow speed would tremendously decrease when hypersonic flow passes through the bow shock, thus the highest pressure occurs at the stagnation point due to the speed of the flow at this point is equal to zero, and all kinetic energy would be changed into the internal energy of gas that is demonstrated **by Figure 10** [Interactive: Endophoric marker] (Wan; Liu, 2017).

> In the MDDES, the aim is to combine the most favourable aspects of the two techniques, **i.e.**, [Interactive: Code Gloss] the application of the RANS models for predicting the attached boundary layers and LES for the resolution of time-dependent three-dimensional large eddies within the non-zonal definition (Schneider, 2017).

Evidential markers rarely occurred in the investigated AAERAs. Surprisingly, frame markers rarely occurred as well in the research articles.

> **According to** [Interactive: Evidential marker] Balabel [22] it found that the numerical predictions using the SST\x96k\x96? turbulence model show close agreement with the experimental measurements (El-Zahaby *et al*., 2017).

> **First**, [Interactive: Frame marker] the volume of air that a wing directly flies through and catches or directly displaces each meter flown, is estimated (Landell-Mills, 2017).

The analysis of interactional metadiscourse markers in the thirty AAERAs revealed that hedges (45.75%) dominantly occurred, followed by boosters (26.53%) and self-mentions (18.53%).

> **First**, [Interactive: Frame marker] the aerospikes **would** [Interactional: Hedge] vary with different length-domain-body-diameter ratios ***i.e.***, L1/D=1.5\x964.0 [Interactive: Code gloss]. **Second**, [Interactive: Frame marker] several gapsize-to-disk-length ratios (S1/L2) for the gaps amongst the aerodisks **would** [Interactional: Hedge] range from 0 up to 0.6 (Wan; Liu, 2017).

> Since the estimated value gained by Kriging method is much closer to simulated one, thereby Kriging method is, **indeed**, [Interactional: Booster] reliable and practical optimization approach (Wan; Liu, 2017).

> Hence, while choosing the configuration **we** [Interactional: Self-mention] **must** [Interactional: Booster] take into account the following subjects [...] (Khuntia; Ahuja, 2018).

Relatively, the thirty AAERAs rarely used engagement markers (5.86%) and attitude markers (3.33%).

> It is also **suggested** [Interactional: Engagement marker] that three-dimensional turbulence effects, such as turbulent eddy topologies in the form of hairpins, strips, or

streaks, are described and calculated with at least a quasi\x96three-dimensional simulation model (Schneider, 2017).

Most importantly, [Interactional: Attitude marker] both the compression wave (*Figure 14*) [Interactive: Endophoric marker] and the flow recirculation zones enlarge as the aerospike length increases (Wan; Liu, 2017).

4 Discussion

The results of the analysis showed that the research in the field of aeronautics and aerospace engineering used a combination of interactive markers (*e.g.*, transitions, endophoric markers, and code glosses; 2.41 per 100 words) and interaction markers (*e.g.*, hedges, boosters, and self-mentions; 1.27 per 100 words). Furthermore, the analysis of metadiscourse markers indicates that the research articles in aeronautics and aerospace engineering likewise contain discourse markers used in academic discourses. In other words, these articles use linguistic markers that resemble formality and objectivity in writing various procedural descriptions of the design and development of any aircraft or unmanned aerial vehicle. This suggests that writers who published articles in the field of aeronautics and aerospace engineering also use metadiscourse features in terms of interactive markers and interactional markers with an armory of rhetorical appeals to achieve (Hyland; Tse, 2004) the purpose of the texts.

Relying heavily on transitions (1.30 per 100 words), these metadiscourse markers are used to express semantic relations between clauses in articles that help the readers make meaning and bring the procedural descriptions of aircraft or unmanned aerial vehicles into reality. This is realized through the guiding and facilitating functions (Kuhn; Behnam, 2011) of these interactive resources as they are used to accommodate readers' knowledge of aircraft procedural descriptions and designs in several ways, such as signal addition, comparison, causative relations, and contrast. Several studies support this finding that transitional devices, among other metadiscourse markers, are used to carry out organizing functions of linguistic resources (Kuhi; Behnam, 2011) for a variety of purposes across genres such as those in economics (Khedri; Heng; Ebrahimi, 2013), in finance writing (Alyousef, 2015), and even in early and advanced academic writing (Aull; Lancaster, 2014). Thus, transitions appeared to be one of the important interactive metadiscoursal markers in aeronautics and aerospace engineering articles, which might also be extended to other cross-lingual and interdisciplinary contexts. This suggests that these metadiscoursal resources were more frequently used in hard sciences but were less commonly used in disciplines such as computer engineering (Mansouri; Najafabadi; Boroujeni, 2016) as compared to Applied Linguistics, where interactive resources were heavily used. Although this proposition seemed to contradict previous research as regards the extensive use of transitions in hard sciences, it cannot take away the fact that transitions function significantly in aeronautics and aerospace engineering research articles. Undoubtedly, writers in aeronautics and aerospace engineering research articles preponderantly utilized transitions to show the interrelations of various procedures in aircraft design and development.

Surprisingly, endophoric markers (0.57 per 100 words) are secondarily prioritized in aeronautics and aerospace engineering research articles as opposed to Alyousef's (2015) and Kuhi and Behnam's (2011) findings, as these markers rarely occurred in finance texts (0.29 per 100 words) and research articles written by Applied Linguistics (0.18 per 100 words). Nevertheless, using their function to refer to information in other parts of the text, endophoric markers (*e.g.*, in Figure X, Table X, etc.) play a significant role in writing aeronautic and aerospace engineering research articles. This functional role shows the author's responsibility to visually guide the readers in understanding complex computational data analysis regarding the aerodynamic performances of aircraft or any unmanned aerial vehicle. However, what seems to be novel in this finding is that there appears to be a shared responsibility of transitions and endophoric markers in guiding and facilitating readers' understanding and analyzing of the complexity of data used in aeronautics and aerospace engineering research articles. This suggests that metadiscoursal transitions and endophoric markers facilitate the development of a well-constructed text in which intertextuality and discursive patterns are revealed in these interactive resources.

Code glosses have also been significant resources of interactive metadiscourse in AAERAs as these appeared (0.39 per 100 words) relatively higher along with transitions and endophoric markers and more frequently than frame markers (0.09 per 100 words) and evidentials (0.05 per 100 words). Code glosses (*e.g.*, *i.e.*) in the research articles were frequently used by writers in stating a reformulation and exemplification. In other words, these interactive resources are utilized to illustrate further a procedure or design that requires other points in the text with examples. In addition, these were used to express the simplicity of meaning with more acceptable degrees of precision (Aull; Lancaster, 2014), since writers in aeronautics and aerospace engineering need to be accurate in elaborating the intricacies of data and configurations of aircraft design as well as its procedural descriptions and computational analysis of aerodynamic performance. As can be revealed in other metadiscourse analyses across disciplines such as in business texts, academic texts, or research articles written by applied linguists, this supports the claim of Vande Kopple (1985) that these linguistic resources help the readers to capture accurate meanings which could be gleaned from various elements in the texts.

In contrast, frame markers and evidentials were only slightly used interactive resources in AAERAs. These metadiscourse markers rarely signal sequences or text stages rather than logical connections of propositional contents. For example, in business texts, Alyousef (2015) claimed that frame markers frequently occurred in finance texts since these provide discourse acts. However, these frame markers (*e.g.*, *first, second, finally*) appeared to be subsidiary to transitional devices as the former project places less importance on procedures per se while the latter gives more emphasis on how specific procedures would tend to affect the whole process of designing an aircraft or unmanned aerial vehicle concerning aerodynamics. However, this points to a tentative conclusion that while frame markers function is relatively crucial to provide guidance and facilitation of ideas in social sciences, these markers also seemed to be relative in the aeronautics and aerospace engineering fields.

On the other hand, evidential resources (*e.g.*, *according to*) were utilized to a certain extent to establish a reference to other authorities in aeronautics and aerospace engineering articles. This occasion, however, appeared to be less observed in this study, which suggests that writers aim to help the readers distinguish who is more responsible for a position in the argument (Kuhi; Behnam, 2014) as presented in aeronautics and aerospace research engineering articles. This linguistic phenomenon in the field

of aeronautics and aerospace engineering is an overt contrast to how evidential markers were used and performed in educational psychology. Kim and Lim (2013) found that 50% of all interactive uses in Chinese and English educational psychology research articles were predominated by evidential markers, which further suggested that the use of citation through these interactive markers implicitly creates an impression on the part of the reader that the writer is well-informed about the literature context related to the study. It is worth noting, however, that writers in the field of aeronautics and aerospace engineering seemed to underuse evidential markers. Although evidential markers appeared to co-establish strong references to other cited authors in aeronautics and aerospace engineering articles to achieve credibility of the writer's and cited authors' claims, these interactive markers seemed to be marginally used. Thus, it can be argued that writers in aeronautics and aerospace engineering research articles vouch for a higher frequency status of interactive resources to make their text coherent and cohesive while marginally responsible for sending a certitude attitude of the writers towards the text. However, evidential markers seemed to portray an important role across lingua-cultural contexts (Mansouri; Najafabadi; Boroujeni, 2016).

The interactional resources in aeronautics and aerospace engineering research articles rely heavily on hedges (0.58 per 100 words) to withhold commitment to categorize propositional information (Hyland; Tse, 2014; Hyland, 2005, 2010). This corroborates with the corpora-based metadiscourse investigation by Kuhi and Behnam (2011), which shows the preponderance of hedges (*e.g.*, *might, would, could, perhaps*), suggesting the writers' top priority is interactional category ranking. Similarly, these hedging devices indicate the degree of commitment and certainty writers wish to convey (Hyland, 1999, p. 8) in aeronautics and aerospace engineering research articles. These hedging devices fall into two overlapping categories:

1. Low-value subjective modalization

   e.g. If the wing has a zero or negative angle of attack, this air flow through *might* not actually be displaced down (Landell-Mills, 2017).

2. Low-value modulated operators expressing
   a. Possibility

      e.g. Maximum reduction in drag of nearly 19% *could* be achieved with the injection (Rajesh; Ganesha, 2017).

   b. Quality

      e.g. It is very interesting to note that the longer spike length *could* lead to the flow separation point away from the main body surface and most importantly, both the compression wave (Figure 14) and the flow recirculation zones enlarge as the aerospike length increases... (Wan; Liu, 2017)

Precisely, writers in AAERAs make greater use of hedging devices as they express less commitment to their propositions. However, the excessive use of these interactional resources is mitigated through the use of boosting devices (0.34 per 100 words) frequently appearing in the research articles. While the top interactional resources of these writers seem to be hedges, boosting devices significantly function to signal the assertion of their propositions. This finding relates to Mojica's (2005) investigation on hedging devices

in research articles, which claimed that engineering research articles boost more while linguistics research articles hedge more. Concomitantly, Kuhi and Behnam (2011) argued that when writers use hedging devices to close down alternatives in the argument, it allows them to head off conflicting views and express their certainty in their propositions. While this is true in engineering and linguistics research articles, this contrasts with business discourse since writers infrequently express their certainty in finance texts (Alyousef, 2015). One possible explanation for this is that writers in AAERAs are more concerned with the exactness and accuracy of procedures in the design and development of aircraft or any unmanned aerial vehicle, as well as in their complex computational analysis of aerodynamic performances.

Another notable finding in this exploratory investigation on metadiscourse markers used in AAERAs is the relatively higher frequency of self-mentions (0.23 per 100 words) which express explicit reference to the author. This supports Hyland and Tse's (2004) claim that personal pronouns' use signals explicit authorial presence in the text. While self-mention is underused in business discourse and academic discourse, this present study on aeronautics and aerospace engineering discourse asserts that writers in this field establish a more robust image of writers, as explicitly revealed in the relatively higher status of self-mentions in the thirty AAERAs compared to business texts, Ph.D. thesis, and research articles in linguistics. This is evident in the heavy usage of self-mentions (*e.g.*, we, I), which suggests that AAERA writers tend to present a more visible stance. However, the increase of self-mentions is confined to plural forms, *we*, then the first person, which allows writers to create more distance between themselves and their research articles. Although it is common for writers in hard sciences to downplay their personal role (Hyland; Jiang, 2016) to highlight the development and designs of any heavier-than-air materials, these writers of the investigated AAERAs have shown dramatic changes in the use of self-mentions, with *we* replacing *I* as the preferred marker to express authorial presence in aeronautics and aerospace engineering. This contrasts with how applied linguists and socialists involve themselves in their discourse community since the use of *I* replacing *we* has dramatically changed their authorial presence. Thus, it can be argued that writers in hard sciences, such as aeronautics and aerospace engineering, are becoming more participative in the discourse community while being responsible for their propositional contents. However, while it can be construed that the referent *we* of any passive stance construction has taken the place of *I* in revealing authorial presence, its extensive use cannot generalize the plausibly growing personal disposition, but instead creates a pattern of participatory authorial stance since authors still preferred impersonal expression irrespective of voice constructions (Seoane; Hundt, 2018).

However, engagement markers (0.07 per 100 words) and attitude markers (0.04) rarely established their linguistic functions in aeronautics and aerospace engineering research articles, respectively. This suggests that while writers employ these interactional resources to attempt to build a relationship with their readers and express their stance about their propositions, these are overpowered by other interactional resources such as hedges, boosters, and self-mentions. That means establishing the audience's engagement vis-a-vis the writers' communicative purposes in the text can be augmented through a relatively higher presence of hedges, boosters, and self-mentions. This is in line with Hyland and Tse's (2004) claim that hedges and boosters can be closely related as they provide interactional resources to relate and account for the reader's knowledge, textual experiences, and processing needs. Hence, writers in AAERAs bank on the relatively higher presence of interactive resources to signal interpersonal stance toward both the propositional content and the text's audience. This means AAE writers opt to recognize the readers'

presence and overtly bring them into texts (Hyland, 2005). This is in contrast, however, to the findings of Alyousef (2015) and Fu (2012), claiming that writers in finance texts and job postings appeared to be more explicitly engaged with their audience. The subtle use of engagement markers and attitude markers are thus augmented through closely related interactive metadiscoursal features such as hedges, boosters, and self-mentions. While attitude markers marginally function in AAERAs to bring the audience to the text, these attitude markers also marginally function in a spectrum of academics works (Kuhi; Behnam, 2011) written by applied linguists. Thus, writers in AAERAs and Applied Linguistics research articles share common characteristics in engaging the audience of the text as opposed to writers in business and finance discourses who are inherently required to demonstrate strong engagement of the audience in the text, such as in job posting.

The use of metadiscourse resources in AAERAs displayed somewhat more controversial findings on interactional resources than interactive resources due to the following reasons: (1) there is a varying degree of expressing commitment and detachment towards writers' propositions as can be compared to previous studies; (2) the higher occurrence of hedges is mitigated by the relatively high frequency of boosters, causing the articles in AAE to observe a more balanced proposition; (3) the involvement of author can be explained through the surprisingly higher frequency of interactional item self-mentions.

Authors' involvement in AAERAs appeared to be more frequently observed, as revealed in the relatively higher frequencies of self-mentions, which in this study proved to be evident. This novel finding is in contrast with a recent study (Seoane; Hundt, 2018) on determining the authorial presence, which argued that while there is a higher authorial presence in hard sciences (natural sciences and technology), scientific texts still preferred impersonal impressions irrespective of linguistic structures (*e.g.*, passive, active voices). This is because writers in AAERAs adhere to the use of a more participative interactional item, self-mention in the form of the first person plural pronoun *we*, than the first person singular pronoun *I*. What can only be accounted for in this investigation is the higher frequency of self-mention, but the qualitative analysis of the self-mention *we* revealed a more dialogical space that allows the writer to be more participative and responsible for their claims, such as those in presenting a complex computational analysis of aerodynamic performances. Likewise, this points to a tentative conclusion that the use of first person plural *we* indicated a revolutionary change in demonstrating authorial presence in the text of hard sciences, particularly in AAERAs. These changes point to a certain extent that the use of self-mention *we* to signal participatory authorial presence can be attributed to the increase in the average length of research articles over time, which demands far more use of an interactional item that engages both the writer and audience in the text. Although this investigation did not account for a comparison of data in this regard, it could not ignore the incremental growth of the writer's participation towards the audience in the text.

5 Conclusion and Recommendation

This study explored the metadiscourse features shown in AAERAs. The analysis of interactive and interactional resources provides a substantial account for exploring what metadiscourse markers can be used to express how these interactive markers make the research articles more cohesive and how interactional

markers signal an interpersonal stance toward both the propositional content and the audience of the text. As revealed in the study, the investigated metadiscourse markers resembled Hyland and Tse's (2004) and Hyland's (2005, 2010) findings in terms of interactive and interactional markers, which contain similar features of academic writing such as formality and objectivity, yet yielded notable linguistic variation in the use of interactional resources, more specifically self-mentions. Furthermore, the quantitative analysis yielded a higher frequency of interactive markers (2.41 markers per 100 words) than interactional markers (1.27 per 100 words) across the thirty articles. This argues that writers in AAERAs essentially employ interactive resources rather than interactional resources, suggesting that these writers are primarily concerned with making their text more cohesive while remaining responsible for establishing an interpersonal stance toward both the propositional contents and the audience of the text.

However, a mix of interactive and interactional markers is generally distributed across the thirty AAERAs, with new findings contradicting the other previously conducted metadiscourse analyses across disciplines. In the interactive metadiscourse analysis, AAERAs rely heavily on transitions (1.30 per 100 words) which are thought to have to guide and facilitate functions (Kuhn; Behnam, 2011) across genres such as those in Applied Linguistics (Kuhi; Behnam, 2011), early and advanced academic writing (Aull; Lancaster, 2014), and in finance writing (Alyousef, 2015). What came as a surprise was the excessive use of endophoric markers (0.57 per 100 words), which writers secondarily employed in aeronautics and aerospace engineering research articles – as opposed to Alyousef's (2015) and Kuhi and Behnam's (2011) findings, as these markers rarely occurred in finance texts (0.29 per 100 words) and in research articles written by Applied Linguistics (0.18 per 100 words) –, which suggested that there seems to be a shared responsibility of transitions and endophoric markers in guiding and facilitating readers' understanding and analyzing the complexity of data used in AAERAs. Likewise, code glosses were significantly used in AAERAs as these appeared (0.39 per 100 words) relatively higher along with transitions and endophoric markers, as well as more frequently than frame markers (0.09 per 100 words) and evidentials (0.05 per 100 words), which were found to be infrequently used interactive resources in AAERAs, similarly to business discourse. In the interactional metadiscourse analysis, aeronautics and aerospace engineering research articles bank on hedges (0.58 per 100 words) to withhold commitment to present propositional information categorically (Hyland; Tse, 2014; Hyland, 2005, 2010), which corroborates with the findings in corpora-based metadiscourse investigations. However, the excessive use of these interactional resources is mitigated through the use of boosting devices (0.34 per 100 words) which frequently appeared in the research articles as well, suggesting that writers in aeronautics and aerospace engineering research articles are more concerned with the exactness and accuracy of procedures in the design and development of aircraft or any unmanned aerial vehicle, more so, in their complex computational analysis towards aerodynamic performances. Notably, self-mentions (0.23 per 100 words) appeared higher along with hedges and boosters and more often than engagement markers (0.07 per 100 words) and attitude markers (0.04) which rarely established their linguistic functions in aeronautics and aerospace engineering research articles respectively, suggesting that writers employ these interactional resources to attempt building a relationship with their readers and express their stance about their propositions.

It is worth mentioning that this metadiscourse analysis in the field of aeronautics and aerospace engineering shares significant patterns of the writer's discursive knowledge and intertextuality as they are framed in metadiscourse markers. As this study aims to explore the way writers in AAERAs construct

cohesive articles and establish interpersonal stance toward both the propositional contents and the audience of the texts, it is pertinent to provide pedagogical implications on how fellow writers in the field can augment their writing through the use of metadiscourse features shown in this exploratory investigation. This study has provided valuable information about effective writing in aeronautics and aerospace engineering and theoretical knowledge about the role of discursive patterns of language in technical analysis. This research likewise provides aeronautics and aerospace engineering students, teachers, practitioners, and professional writers with practical information on how a variety of metadiscoursal markers can be used in creating a research paper in which propositional contents on aeronautics and aerodynamics, writer's interpersonal stance toward these propositions, and engagement of the audience in a text are all intermingled.

Similarly, aeronautics and aerospace engineering teachers can include the investigated interactive and interactional resources in teaching academic or technical writing and how a mix of these metadiscourse markers can provide students with linguistic choices, which will help them in creating a well-constructed research article. There are three valuable insights lifted in this study. First, the interactive metadiscoursal features such as the typical linguistic behavior of transitions and the surprisingly strong presence of endophoric markers suggest that these two interactive markers shared responsibility in guiding and facilitating readers' understanding and analyzing the complexity of data used in aeronautics and aerospace engineering research articles. Thus, it is essential to note that teachers of aeronautics and aerospace engineering research writing must emphasize the seemingly significant linguistic function of transitions and endophoric markers as these will provide students with practical guidance in facilitating the development of a well-constructed aeronautics and aerospace engineering research paper. Second, the interactional metadiscoursal features such as the typical linguistic behavior of hedges and boosters and the relatively higher presence of authorial stance through self-mentions, considering the metadiscoursal shift in the use of plural forms over the first person suggest that writers create more distance between themselves and their research articles. Practically, this linguistic phenomenon can inform teachers in emphasizing the use of these interactional metadiscoursal features in teaching research writing. Finally, strategic manipulation of various metadiscourse resources can facilitate the development of effective AAERAs.

Although this study has explored the metadiscoursal functions of the interactive and interactional resources to this end, a similar analysis can be done using a larger sample of research articles that will provide comprehensive quantitative datasets to generalize metadiscoursal functions of such interactional and interactive resources across disciplines. Likewise, future metadiscourse studies on cross-cultural discourse communities vis-a-vis soft and hard sciences research articles can be explored using a multidimensional and multimodal analysis.

References

ADEL, A. *Metadiscourse in L1 and L2 English*. Philadelphia: John Benjamins, 2006.

ALYOUSEF, H. S. An Investigation of Metadiscourse Features in International Postgraduate Business Students' Texts: The Use of Interactive and Interactional Markers in Tertiary Multimodal Finance Texts. *SAGE Journals,* v. 5, n. 4, p. 1-10, 2015.

AULL, L. L.; LANCASTER, Z. Linguistic Markers of Stance in Early and Advanced Academic Writing: A Corpus-based Comparison. *Written Communication,* v. 31, n. 2, p. 151-183, 2014.

BAL-GEZEGIN, B. A Corpus-Based Investigation of Metadiscourse in Academic Book Reviews. *Procedia* – Social and Behavioural Sciences, v. 232, p. 713-718, 2016.

BREIVEGA, K. R.; DAHL, T.; FLOTTUM, K. Traces of Self and Others in Research Articles: A Comparative Study Pilot Study of English, French and Norwegian Research Articles in Medicine, Economics and Linguistics. *International Journal of Applied Linguistics*, v. 12, n. 2, p. 218-239, 2002.

BUNTON, D. The Use of Higher Level Metatext in PhD Theses. *English for Specific Purposes*, v. 18, p. 41-56, 1999.

DHAL, T. Textual Metadiscourse in Research Articles: A Marker of National Culture or of Academic Discipline? *Journal of Pragmatics*, v. 36, n. 10, p. 1807-1825, 2004.

DIAA, A. M.; EL-DOSOKY, M. F.; AHMED, M. A. Enhancing the Performance of an Axial Compressor Cascade Using Vortex Generators. *Journal of Aeronautics & Aerospace Engineering*, v. 5, n. 4, p. 1-9, 2016.

EL-ZAHABY, A. M.; HAMED, M. H.; OMARA, Z. M.; ELDESOUKEY, A. M. Study of the Configuration and Performance of Air-Air Ejectors Based on CFD Simulation. *Journal of Aeronautics & Aerospace Engineering*, v. 6, n. 4, p. 1-9, 2017.

FU, X. The Use of Interactional Metadiscourse in Job Postings. *Discourse Studies,* v. 14, n. 4, p. 399-417, 2012.

GRABE, W. Constrastive Rhetoric and Text Type Research. *In*: CONNOR, U.; KAPLAN, R. B. (ed.). *Writing Across Languages*: Analysis of L2 Text Reading. MA: Addison-Wesley, 1987. p. 115-138.

HYLAND, K. Applying a Gloss: Exemplifying and Reformulating in Academic Discourse. *Applied Linguistics*, v. 28, p. 266-285, 2007.

HYLAND, K. Boosting, Hedging and the Negotiation of Academic Knowledge. *Text*, v. 18, n. 3, p. 349-382, 1998.

HYLAND, K. *Disciplinary Identities*: Individuality and Community in Academic Discourse. Cambridge: Cambridge University Press, 2012.

HYLAND, K. Hedging in Academic Writing and EAP Textbooks. *English for Specific Purposes*, v. 13, p. 239-256, 1994.

HYLAND, K. *Metadiscourse*: Exploring Interaction in Writing. London: Continuum, 2005. 241p.

HYLAND, K. Metadiscourse: Mapping Interactions in Academic Writing. *Nordic Journal of English Studies,* v. 9, n. 2, p. 125-143, 2010.

HYLAND, K. Nurturing Hedges in the ESP Curriculum. *System*, v. 24, p. 477-490, 1996a.

HYLAND, K. What do They Mean? Questions in Academic Writing. *Text*, v. 22, p. 529-557, 2002.

HYLAND, K. Writing Without Conviction? Hedging in Science Research Articles. *Applied Linguistics*, v. 17, p. 433-454, 1996b.

HYLAND, K.; JIANG, F. Change of Attitude? A Diachronic Study of Stance. *Written Communication,* v. 33, n. 3, p. 251-274, 2016.

HYLAND, K.; TSE, P. Metadiscourse in Academic Writing: A Reappraisal. *Applied Linguistics,* v. 25, n. 2, p. 156-177, 2004.

KAWASE, T. Metadiscourse in the Introductions of PhD Theses and Research Articles. *Journal of English for Academic Purposes,* v. 20, p. 114-124, 2015.

KHEDRI, M.; HENG, C. S.; EBRAHIMI, S. F. An Exploration of Interactive Metadiscourse Markers in Academic Research Article Abstracts in Two Disciplines. *Discourse Studies*, v. 15, n. 3, p. 1-13, 2013.

KHUNTIA, S. K.; AHUJA, A. S. Optimal Design and CFD Analysis of Wing of a Small-Scale UAV to Obtain Maximum Efficiency. *Journal of Aeronautics & Aerospace Engineering*, v. 7, n. 1, p. 1-7, 2018.

KIM, L. C.; LIM, M. H. Metadiscourse in English and Chinese Research Article Introductions. *Discourse Studies*, v. 15, n. 2, p. 129-146, 2013.

KUHI, D.; BEHNAM, B. Generic Variations and Metadiscourse Use in the Writing of Applied Linguists: A Comparative Study and Preliminary Framework. *Written Communication*, v. 28, n. 1, p. 97-141, 2011.

KUHI, D.; BEHNAM, B. Metadiscourse in Newspaper Genre: A Cross-Linguistic Study of English and Persian Editorials. *Procedia* – Social and Behavioral Sciences, v. 19, p. 1046-1055, 2014.

KUHI, D.; MOUSAVI, Z. A Diachronic Study of Interpersonality in Research Articles' Discussion Section: The Field of Applied Linguistics. *International Journal of Research in Humanities and Social Studies*, v. 2, n. 4, p. 6-13, 2015.

LAFUENTE-MILLÁN, E. Reader Engagement Across Cultures, Languages and Contexts of Publication in Business Research Articles. *International Journal of Applied Linguistics*, v. 24, n. 2, p. 201-223, 2014.

LANDELL-MILLS, N. Calculation of the Air Displaced by a Wing. *Journal of Aeronautics & Aerospace Engineering*, v. 6, n. 4, p. 1-9, 2017.

LEE, J. J.; CASAL, J. E. Metadiscourse in Results and Discussion Chapters: A Cross-Linguistic Analysis of English and Spanish Thesis Writers in Engineering. *System*, v. 46, p. 39-54, 2014.

MANSOURI, S.; NAJAFABADI, M. M.; BOROUJENI, S. S. Metadiscourse in Research Article Abstracts: A Cross Lingual and Disciplinary Investigation. *Journal of Applied Linguistics and Language Research,* v. 3, n. 4, p. 296-307, 2016.

MARCELLINO, W. M. Talk Like a Marine: USMC Linguistic Acculturation and Civil-Military Argument. *Discourse Studies*, v. 16, n. 3, p. 1-21, 2014.

MAURANEN, A. Contrastive ESP Rhetoric: Metatext in Finnish-English Economic Texts. *English for Specific Purposes*, v. 12, p. 3-22, 1993.

MCENRY, T.; KIFLE, N. A. Epistemic Modality in Argumentative Essays of Second Language Writers. *In*: FLOWERDEW, J. (ed.). *Academic Discourse*. London: Longman, 2002. p. 182-195.

MCGANNON, K. Critical Discourse Analysis in Sport and Exercise: What, Why and How. *In*: SMITH, B.; SPARKES, A. E. (ed.). *Routledge International Handbook of Qualitative Research in Sport and Exercise*. London: Routledge, 2016. p. 230-242.

MINA, K. G.; BIRIA, R. Exploring Interactive and Interactional Metadiscourse Markers in Discussion Sections of Social and Medical Science Articles. *International Journal of Research in English Education,* v. 2, n. 4, p. 11-29, 2017.

MOCANU, M. An Empirical Analysis of Metadiscourse in the Abstracts of Romanian Accounting Research Articles. *Accounting and Management Information Systems*, v. 14, n. 2, p. 362-377, 2015.

MOJICA, L. Filipino Author's Ways of Showing Detachment/Commitment in Their English Academic Papers. *In*: DAYAG, D.; QUAKENBUSH, J. S. (ed.). *Linguistics and Language Education in the Philippines and Beyond*: A Festschrift in Honour of Ma. Lourdes S. Bautista. Manila: Linguistic Society of the Philippines, 2005. p. 511-525.

MOZAYAN, M. R.; ALLAMI, H.; FAZILATFAR, A. M. Metadiscourse Features in Medical Research Articles: Subdisciplinary and Paradigmatic Influences in English and Persian Practice. *Journal of Research in Applied Linguistics,* v. 9, n. 1, p. 83-104, 2018.

MUR-DUEÑAS, P.; ŠINKŪNIENĖ, J. Self-Reference in Research Articles Across Europe and Asia: A Review of Studies. *Brno Studies in English*, v. 4, n. 1, p. 71-92, 2016.

PALTRIDGE, B. Genre, Text Type, and the Language Learning Classroom. *ELT Journal*, v. 50, n. 3, p. 237-243, 1996.

SEOANE, E.; HUNDT, M. Voice Alternation and Authorial Presence: Variation Across Disciplinary Areas in Academic English. *Journal of English Linguistics*, v. 46, n. 1, p. 3-22, 2018.

SCHNEIDER, M. Failure Aeroacoustic's Investigation on High-Lift Device by Using a Modern Hybrid RANS/LES-Model. *Journal of Aeronautics & Aerospace Engineering*, v. 6, n. 3, p. 1-15, 2017.

SWALES, J. *Genre Analysis*: English in Academic and Research Setting. Cambridge: Cambridge University Press, 1990.

THUEVOLD, E. Epistemic Modality Markers in Research Articles: A Crosslinguistic and Cross-Disciplinary Study. *International Journal of Applied Linguistics*, v. 16, n. 1, p. 61-87, 2006.

WAN, T.; LIU, C. M. Drag Reduction Optimization for Hypersonic Blunt Body With Aerospikes. *Journal of Aeronautics & Aerospace Engineering*, v. 6, n. 4, p. 1-8, 2017.

ZHANG, M. A Multidimensional Analysis of Metadiscourse Markers Across Written Registers. *Discourse Studies*, v. 18, n. 2, p. 204-222, 2016.

Annex A – Aeronautics and Aerospace Engineering Research Articles (AAERAs)

ABDELGHANY, E. S.; ABDELLATIF, O. E.; ELHARIRY, G.; KHALIL, E. E. NACA653218 Airfoil Aerodynamic Properties. *Journal of Aeronautics & Aerospace Engineering*, v. 5, n. 2, p. 1-5, 2016.

AHMED, A. H.; GAMAL, B.; OUDA, A. N.; KAMEL, A. M.; EL-HALWAGY, Y. Z. Autopilot Design of Unmanned Aerial Vehicle. *Journal of Aeronautics & Aerospace Engineering*, v. 7, n. 2, p. 1-7, 2018.

ANAND, S. S.; MATHIYAZAGHAN, R. Design and Fabrication of Voice Controlled Unmanned Aerial Vehicle. *Journal of Aeronautics & Aerospace Engineering*, v. 5, n. 2, p. 1-5, 2016.

BAIG, A. Z.; CHEEMA, T. A.; ASLAM. Z.; KHAN, Y. M.; SAJID DAR, H.; KHALIQ, S. B. A New Methodology for Aerodynamic Design and Analysis of a Small Scale Blended Wing Body. *Journal of Aeronautics & Aerospace Engineering*, v. 7, n. 1, p. 1-6, 2018.

BOIKO, A. V.; USATY, A. P.; MAKSIUTA, D. I. Combined Method (1D + 3D) of the Axial Turbine's Stage Aerodynamic Optimization. *Journal of Aeronautics & Aerospace Engineering*, v. 6, n. 2, p. 1-5, 2017.

COOPER, M. A.; HEIDLAUF, P. T. Nonlinear Feed Forward Control of a Perturbed Satellite Using Extended Least Squares Adaptation and a Luenberger Observer. *Journal of Aeronautics & Aerospace Engineering*, v. 7, n. 1, p. 1-7, 2018.

DE FELICE, T. P.; DUNCAN, A. Developing the Framework for Integrating Autonomous Unmanned Aircraft Systems into Cloud Seeding Activities. *Journal of Aeronautics & Aerospace Engineering*, v. 5, n. 3, p. 1-6, 2016.

DIAA, A. M.; EL-DOSOKY, M. F.; AHMED, M. A. Enhancing the Performance of an Axial Compressor Cascade Using Vortex Generators. *Journal of Aeronautics & Aerospace Engineering*, v. 5, n. 4, p. 1-9, 2016.

DINESH KUMAR, B.; SHISHIRA NAYNA, B.; SHRAVYA SHREE, D. Design and Structural Analysis of Solid Rocket Motor Casing Hardware Used in Aerospace Applications. *Journal of Aeronautics & Aerospace Engineering*, v. 5, n. 2, p. 1-7, 2016.

EL-ZAHABY, A. M.; HAMED, M. H.; OMARA, Z. M.; ELDESOUKEY, A. M. Study of the Configuration and Performance of Air-Air Ejectors Based on CFD Simulation. *Journal of Aeronautics & Aerospace Engineering*, v. 6, n. 4, p. 1-9, 2017.

GANGADHARAN, S.; BALIGA, S. V.; SONAWANE, N. H.; SATHYANARAYAN, P.; KAMDAR, S. Impact Analysis of Composite Repair Patches of Different Shapes at Low Velocities for Aircraft Composite Structures. *Journal of Aeronautics & Aerospace Engineering*, v. 5, n. 4, p. 1-4, 2016.

HARASANI, W. Generating Cost Efficiency Charts: A Comparison Between B737, A319 and A321. *Journal of Aeronautics & Aerospace Engineering*, v. 5, n. 1, p. 1-4, 2016.

HONG, Z.; CAO, G.; CHEN, W. R. Green Engines: Possible Damages by Firing Alternative Fuels and Protection. *Journal of Aeronautics & Aerospace Engineering*, v. 5, n. 1, p. 1-4, 2016.

KHAN, M. A.; PADHY, C.; NANDISH, M.; RITA, K. Computational Analysis of Bio-Inspired Corrugated Airfoil With Varying Corrugation Angle. *Journal of Aeronautics & Aerospace Engineering*, v. 7, n. 1, p. 1-4, 2018.

KHUNTIA, S. K.; AHUJA, A. S. Optimal Design and CFD Analysis of Wing of a Small-Scale UAV to Obtain Maximum Efficiency. *Journal of Aeronautics & Aerospace Engineering*, v. 7, n. 1, p. 1-7, 2018.

KIS, K. I.; TAYLOR, P. T.; WITTMAN, G. Determination of the Earth's Magnetic Field Gradients From Satellites Measurements and Their Inversion Over the Kursk Magnetic Anomaly. *Journal of Aeronautics & Aerospace Engineering*, v. 5, n. 2, p. 1-7, 2016.

LANDELL-MILLS, N. Calculation of the Air Displaced by a Wing. *Journal of Aeronautics & Aerospace Engineering*, v. 6, n. 4, p. 1-9, 2017.

MITIKOV, Y. O.; IVANENKO, I. S.; PAUK, O. L. New Way of Eliminating the Temperature Stratification of Liquid Oxygen in the Tanks of Rocket Propulsion Units. *Journal of Aeronautics & Aerospace Engineering*, v. 6, n. 4, p. 1-3, 2017.

PRADHANI, N. L.; RAJESH, A.; GANESH PRASAD, M. S. CFD Analysis on Can-Type Combustor and Variation of Air Injection Angle Under Typical Engine Condition. *Journal of Aeronautics & Aerospace Engineering*, v. 5, n. 2, p. 1-5, 2016.

RAJESH, A.; BADRI, D. R.; PRASAD, M. S. G. Numerical Analysis on the Effect of Fluidic on Demand Winglet on the Aerodynamic Performance of the Wing. *Journal of Aeronautics & Aerospace Engineering*, v. 6, n. 3, p. 1-5, 2017.

RATHINA, K. V.; NANDA, M.; JAYANTHI, J. Analyze the Mode Transition Logic of Automatic Flight Control System Using Semi-Formal Approach. *Journal of Aeronautics & Aerospace Engineering*, v. 5, n. 2, p. 1-13, 2016.

RIBEIRO, C. G.; RAPTOPOULOS, L.; DUTRA, M. S. A Platform for Autonomous Path Control of Unmanned Airship. *Journal of Aeronautics & Aerospace Engineering*, v. 6, n. 2, p. 1-8, 2017.

ROSSETT, M. Kite Sky Anchor Analysis for Drone Launching System. *Journal of Aeronautics & Aerospace Engineering*, v. 5, n. 2, p. 1-4, 2016.

SCHNEIDER, M. Failure Aeroacoustic's Investigation on High-Lift Device by Using a Modern Hybrid RANS/LES-Model. *Journal of Aeronautics & Aerospace Engineering*, v. 6, n. 3, p. 1-15, 2017.

TORRES, M.; FRANCO-URQUIZA, E. A.; HERNANDEZ-MORENO, H.; GONZALES-VILLA, M. A. Mechanical Behavior of a Fuselage Stiffened Carbon-Epoxy Panel Under Debonding Load. *Journal of Aeronautics & Aerospace Engineering*, v. 7, n. 2, p. 1-5, 2018.

UDAYA KUMAR, D.; KANMAN, S.; VIMAL CHAND, D.; SRIRAM, R.; GANAPATHI, C. Aerodynamic Analysis of Multi Element Airfoil. *Journal of Aeronautics & Aerospace Engineering*, v. 5, n. 2, p. 1-4, 2016.

WAN, T.; LIU, C. M. Drag Reduction Optimization for Hypersonic Blunt Body With Aerospikes. *Journal of Aeronautics & Aerospace Engineering*, v. 6, n. 4, p. 1-8, 2017.

WANG, H.; GUO, L.; WU, P. Design and Realization of Payload Operation and Application System of Chinas Space Station. *Journal of Aeronautics & Aerospace Engineering*, v. 5, n. 2, p. 1-4, 2016.

XUAN, H.; CHENG, S.; FANG, L. The Research of Supersonic Aircraft Low Sonic Boom Configuration Design and Optimizations. *Journal of Aeronautics & Aerospace Engineering*, v. 5, n. 2, p. 1-7, 2016.

ZHENG, W.; WANG, L.; ZHOU, M. X. Analytical State Deviation Prediction Model for Improving the Guidance Precision of Missile. *Journal of Aeronautics & Aerospace Engineering*, v. 7, n. 2, p. 1-8, 2018.

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