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**REPORT ON POST-EDITING OF ABSTRACT OF AEROSPACE  
ARTICLES UNDER THE GUIDANCE OF FUNCTIONAL EQUIVALENCE  
THEORY**

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**ABSTRACT**

**Background:** According to the Language Service Development in China: 2020, Machine Translation(MT) is increasingly used in the language services industry. To analyze the problems of MT and find solutions, the author post-edited ten abstracts of aerospace papers from CNKI core journals by Google translate.

**Principal Findings:** The fact is that MT is restricted to the original text features and confined to formal correspondence, failing to recognize the differences between English and Chinese, resulting in errors at all levels: lexical, syntactic, and contextual, which greatly affects the textual quality. Therefore, it is quite necessary to conduct post-editing to correct the mistakes. In order to make the MT version accurate and readable, the author conducts the post-editing under the guidance of Functional Equivalence Theory and summarizes PE techniques. For lexical errors, especially for terminology errors, the author must figure out word meanings by checking the authoritative references. At the sentence level, the author needs to change the word order according to the meaning so as to achieve semantic equivalence. At the discourse level, the author must pay attention to the coherence and make the logical relationship clear to reproduce the contextual meaning of the original texts.

**Conclusions:** The results of the paper show that post-editing under the guidance of the Functional Equivalence Theory can correct MT errors, increase translation accuracy, and provide references for post-editing of MT.

**KEYWORDS:** Machine Translation; Post-Editing; Aerospace Text Abstract; Functional Equivalence Theory

## **1. INTRODUCTION**

This chapter consists of two parts. The author first introduced the research background, then gave the statement of research purpose and significance.

### **1.1 Research Background**

The rapid development of the internet witnessed the deepening exchanges among countries following the expanding language services market. At the same time, language service projects are characterized by multiple languages, different text formats and requirement types, a large number of tasks, and short lead times. Under this background, the traditional model of human translation can no longer meet the market demand. More and more translators are throwing the vision to machine translation(MT). According to the “2020 Language Services Industry Development Report” released by the China Translation Association: MT has been increasingly used, and its high efficiency has generally been recognized by the market. While it is becoming the new trend, MT presents problems like poor quality and low accuracy. The current MT quality still cannot be compared with professional human translation so far(Wang Huashu&Chen Nie’ao, 2021). To better improve work efficiency and achieve the translation purpose, post-editing(PE) emerges as the times require. Post-editing is performed on MT output for the purpose of checking its accuracy and comprehensibility, improving the text, making the text more readable, and correcting errors(ISO 18587: 2017b).

Accompanied by the widespread application of PE, related research fields have been expanded. Some scholars focused on developing and researching PE technology, and some paid attention to the PE quality assessment or the post-editor training. However, the major neural machine translation systems are mainly applied in general text translation. Translation quality in specialized texts is usually not as good as in general text translation(Guo Wanghao& Hu Fumao, 2021). There are few research about abstract of aerospace articles post-editing. Therefore, the author chooses the abstract of aerospace articles to analyze MT errors and summarizes PE strategies to provide references for future studies.

### **1.2 Research Purpose and Significance**

First of all, most researchers have focused on the technical English study and the translation principles or characteristics, with little research on abstract of aerospace articles and post-editing techniques. The studies on post-editing of aerospace texts’ abstracts still have much space for further study.

Secondly, the application of neural machine translation technology has significantly improved in machine translation quality. Although the quality of online machine translation systems “has

reached the level of basically achieving the communicative purpose in both English-Chinese translation and Chinese-English translation, neither of them can realize the level of good quality”(Li Fengxi, 2021), which makes post-editing necessary(Yang Wendi&Fan Zirui, 2021). As a result, it is indispensable to make the machine translation and post-editing work at full capacity by applying and summarizing PE strategies.

Ultimately, the author sums up the problems of MTPE and the strategies under the guidance of Functional Equivalence Theory. Through the study and analysis, the author hopes to increase MTPE quality and make suggestions on the MT engine and provide references for MT developers to improve accuracy.

## **2. LITERATURE REVIEW**

This chapter introduces the literature review of post-editing. Post-editing is conducted on MT output for the purpose of correcting errors, improving translation accuracy and comprehensibility, and making the text more readable (ISO 18587: 2017E).

In recent years, PE research has shown a trend of gradual increase. Research topics have become more and more diversified, deepened, and detailed.

Zhong Wenming and Shu Chao (2020) made suggestions on post-editing course design in China from the aspects of teaching objects, modules, and models, providing new perspectives for the course design. Zhu Huifen, Zhao Jinwen, and Zhu Yifei (2020) combined Newmark’s translation theory with practice to explore the PE principles at the textual, referential, cohesive, and natural levels based on the types of mistranslation in MT. Their study inspired later researchers to explore the possibilities of PE under the guidance of different translation theories. Yang Wendi and Fan Zirui (2021) compared machine and human translations of scientific texts in terms of semantics, pragmatics, and syntax, pointing out the importance of PE to improve MT quality. Their study further promoted the PE research of scientific text.

Overseas post-editing research started in the mid-1980s, and topics primarily focus on post-editing overview, evaluation, MT error identification, post-editing tool development, post-editor training, etc. Ana G. Arenas (2008) affirmed the value of post-editing by empirically finding that translators have higher quality and efficiency when using machine translation for post-editing than when dealing with the fuzzy matching of translation memories. In 2014, Sharon O’Brien and five others edited a collection of papers: *Post-Editing of Machine Translation: Processes and Applications*, which was a landmark research result in post-editing. The collection focused on the macro-translation process at the industry level, the micro-translation process at the individual level, and the principles and evaluation of post-editing, making vital contributions to PE research and development. Nico Herbig et al. (2019) developed a model to predict the translator’s

perceived cognitive load during MTPE by a sensor to quantify the physiological changes, thus concluding influencing factors of PE quality. Dimitar Shterionov et al. (2020) constructed a neural automatic post-editing (NPE) “map” to further improve post-editing efficiency by tracking different decision points of testers while translating and then used the map to train the selection system to reduce translator workload. It demonstrated that NPE using phrase-based statistical machine translation could improve efficiency in commercial translation workflow

### **3. METHODOLOGY**

Functional equivalence refers to dynamic relations rather than static relations in translation and the equivalence of communicative efficacy rather than literal meaning and form(Nida,1969). In Nida’s opinion, “Translating consists in reproducing in the receptor language the closest natural equivalent of the source-language message, first in terms of meaning and secondly in terms of style(Nida & Taber, 1969).”

Nida listed several translation skills: (1)permits adjustment of the form of the message to the requirements of the structure of the receptor language; (2)produces semantically equivalent structures; (3)provides equivalent stylistic appropriateness; and (4)carries an equivalent communication load(Nida &Taber 1964). The basic requirements of translation consist of (1)making sense, (2)conveying the spirit and manner of the original, (3)having a natural and easy form of expression, and (4)producing a similar response (Nida &Taber, 1964).

The receptor’s response is another important concept of Functional Equivalence. The dynamic equivalence is defined with “receptor’s response” as its nature(Ma Huijuan, 2009). Nida considers the relationship between receptor and language should be substantially the same as that which existed between the original receptors and the message(Nida, 1964). The target readers’ response must be compared with the way in which the original receptors presumably reacted to the message when it was given in its original setting(Nida, 1969).

### **4. CASE STUDY**

In this chapter, the author analyzes MT problems and PE strategies under the guidance of the Functional Equivalence theory.

#### **4.1 Lexical Equivalence**

Aerospace texts contain many terms and fixed collocations, making it more difficult for machine translation to achieve equivalence at the lexical level. Translating terms and fixed collocations is one of the critical research points. The functional equivalence at the lexical level is the most basic equivalence, which directly influences translation quality. In Google translate, the author

summarized three main error types at this level: mistranslation, omission, and over-translation. During post-editing, the author adopted different strategies to solve MT problems and complete the conversion of two languages with “the closest natural” expression.

#### Example 1

ST: 天生粒子群混合算法

MT: a hybrid algorithm of particle swarm optimization

PE: a hybrid Longicorn particle swarm optimization algorithm

In this example, the underlined word was an omitted term in the machine translation. So the translator needs to add the translation after looking up formal expression. The post-edited version is supposed to be “a hybrid Longicorn particle swarm optimization algorithm”.

#### Example 2

ST: 精确制导技术

MT: precision guidance technology

PE: precise guidance technology

The machine translation in this example presented a word-to-word version, achieving the formal equivalence. During post-editing, the translator converted the noun to an adjective according to the principle of “meaning first”, making the translation more consistent with the source texts.

#### Example 3

ST: 机场群航班

MT: airport groups

PE: multi-airport system

The source text consists of two vocabularies: “机场群” and “航班”. The machine translation only presented the literal meaning of “机场群”. To realize functional equivalence, the translator corrected MT so as to provide target readers with the same information as the source language readers.

#### Example 4

ST: 机场航班时刻优化

MT: Airport flight slot optimization

PE: Optimal airport slot allocation

Affected by the text form of the source language, the machine translation intimated the Chinese structure in every word, making it impossible to realize lexical equivalence. Therefore, the translator readjusted sentence structure to make the translation unified, readable, and natural.

At the lexical level, the author summarized three main error types at this level: mistranslation, omission and, over-translation. Through the analysis of different error types, the author mainly applied post-editing strategies of addition, class shifts, and deletion to improve machine translation quality.

#### **4.2 Syntactic Equivalence**

There are many syntactic differences between Chinese and English, which bring difficult in language shift for machine translation. The coherence is achieved by meaning or the logical relation among words or sentences in Chinese sentences, which is called parataxis; while the English sentences emphasize structural completeness, words and sentences are connected by means of linguistic forms, which is called cohesion. (Ma Xuguang, 2010) Characters mentioned above make it difficult to realize functional equivalence in machine translation. In the view of Functional Equivalence theory, translation seeks for the same function between two languages rather than the rigid correspondents of form. Machine errors mainly include structural misuse and repetition, which are listed as follows:

Example 5

ST:

在基于天牛须搜索的粒子群算法 (BSO) 的基础上设计了一种天牛粒子群混合算法。(BSO-BAS)

MT: a hybrid algorithm of particle swarm optimization (BSO-BAS) was designed on the basis of particle swarm algorithm (BSO) based on beetle search

PE: a hybrid Longicorn particle swarm optimization algorithm (BSO-BAS) was designed based on the longicorn particle swarm optimization algorithm (BSO)

Chinese repetition is a common linguistic phenomenon. In contrast, English uses fewer same expressions in one sentence. In this example, the repeated part “基于” and “基础上” was

translated twice in the machine translation, confusing target readers. Therefore, the translator adjusted the sentence structure to make the translation unified and readable.

#### Example 6

ST:

传统低发射率涂层材料通常在整个红外波段具有低发射率特性，不具备光谱选择性，其辐射散热效果较差，不利于目标整体红外信号的降低。

MT: Traditional low-emissivity coating materials usually have low emissivity in the entire infrared band, do not have spectral selectivity, and have poor radiation and heat dissipation effects, which are not conducive to the reduction of the overall infrared signal of the target.

PE: Traditional low-emissivity coating materials usually have low emissivity characteristics in the entire infrared band and do not have spectral selectivity. This causes a poor effect on radiative cooling, which is not conducive to the reduction of the overall infrared signal of the target.

The source text includes four short sentences with a loose structure. In the C-E translation, Google translate arranged short sentences without logical relationships. To realize functional equivalence, the post-editor reconstructed the machine translation according to the target readers' expression. Therefore, the translator gathered parts into a whole to present the levels of the source text.

#### Example 7

ST:

光谱选择性辐射红外隐身材料可以在降低大气窗口波段（3~5 $\mu\text{m}$ 和8~14 $\mu\text{m}$ ）发射率的同时，利用非窗口波段（5~8 $\mu\text{m}$ ）进行辐射散热，具备更高效的红外隐身性能，是目前研究关注的热点。

MT: Spectrally selective radiation infrared stealth materials can reduce the emissivity of the atmospheric window band (3-5 and 8-14  $\mu\text{m}$ ) and use the non-window band (5-8  $\mu\text{m}$ ) for radiation heat dissipation, and have more efficient infrared stealth performance is the focus of current research.

PE: Spectrally selective radiation infrared stealth materials can reduce the emissivity of atmospheric windows (3-5 and 8-14  $\mu\text{m}$ ), while using non-atmospheric window (5-8  $\mu\text{m}$ ) for radiative cooling. They have more efficient infrared stealth performance, thus attracting a lot of attention currently.

The problem of MT occurs in sentence segmentation as the underlined part showed. Similar errors happened because it is difficult for machine translation to identify sentence components according to meaning. In the premise of conveying information, the translator should flexibly adjust the sentence structure to align with the English expression habits.

During the post-editing process, translators should utilize different strategies based on linguistic features to correct errors at the syntactic level. In the view of Functional Equivalence theory, translation seeks the same function between two languages rather than the rigid correspondents of superficial form. Therefore, the author summarized the following post-editing strategies: segmentation and integration, rewriting, and adjusting order.

### **4.3 Contextual Equivalence**

“A discourse refers to any natural language that is not entirely bound by the syntax and represents complete meaning in a certain context.” (Hu Zhuanglin, 1994) To achieve equivalence at the discourse level, translators need to convey meaning from the textual level rather than be restrained at the lexical and syntactic level and reproduce the effect and function so that the translation and the original text can reach a high level of equivalence. The main problems of textual equivalence in machine translation are cohesive and coherent confusion.

#### **Example 8**

ST: 本文根据前期工作, 结合局部喘振扰动是轴对称的, 并且频率由系统的 Helmholtz 频率决定这一发现, 提出系统响应在局部喘振型失速先兆的形成中起到了关键作用这一猜想, 并针对此猜想, 采取实验的手段, 通过在压气机和容腔内壁面上新增实验测点, 来监测压气机的失速演化过程与系统的响应变化, 从而深入揭示局部喘振的失稳机制。

MT: Based on previous work, combined with the finding that the local surge disturbance is axisymmetric and the frequency is determined by the Helmholtz frequency of the system, this paper proposes that the system response plays a key role in the formation of the local surge-type stall precursor. For this conjecture, by means of experiments, by adding experimental measurement points on the compressor and the inner wall of the cavity, the stall evolution process of the compressor and the response changes of the system are monitored, so as to deeply reveal the instability mechanism of local surge.

PE: In this paper, the effect of the system response on the partial surge-type inception is investigated experimentally in a transonic compressor. A new test point is set on the wall of the plenum to detect the system response during the stall evolution. To further explore the significance of the system response, a screen is installed at the interface between the compressor outlet and the plenum to prevent feedback from the plenum.

In this example, it is obvious that the logical relationship of the source text is vague and lacks cohesive and coherent components. Hence, the machine translation is rigid and needs to be corrected in post-editing. According to Nida, “the effective translator is quite prepared to make any formal changes necessary to reproduce the message in the distinctive structural forms of the receptor language.”(Nida&Taber, 1969) Therefore, the post-editor adopted a substitution strategy to solve problems of logical relation confusion. That is, accurately identifying the logical relationship of the original text and then choosing the most equivalent expression to represent the contextual relationship, adapting to receptors’ language habits.

## **5. CONCLUSION**

Firstly, the author found that machine translation has effectively reduced the time taken to translate and improved translation efficiency. However, there is still much room for accuracy improvement in machine translation. The high-frequency errors of machine translation include mistranslation, omission, and over-translation. The author found that machine translation is difficult to select the accurate translation from its system, which takes the post-editor extra time in proofreading. In the abstract translation of machine translation, efficiency will be further increased by improving authority at the lexical level, and by adjusting structure at the syntactic level.

Secondly, the author proposed post-editing strategies guided by the Functional Equivalence theory. At the level of lexical equivalence, the author attempted to understand the source text accurately and choose the most natural and appropriate expressions in the target language during post-editing. At the syntactic level, different strategies have been summarized to solve the problem of rigid correspondence in machine translation, by doing so the post-editing not only reproduces the semantic meaning of the original as accurately as possible but also is easily accepted by the target readers. At the textual level, the author can supplement the articulation means, reveal the hidden logical relations, and enrich the expressions of the translation to reflect the coherence of the discourse, achieving a high-level discourse equivalence between the translation and the original text.

Finally, for MT software developers, more attention should be paid to text processing in the accuracy of words and terms to make machine translation a more intelligent device, thus better assisting translators and contributing to translation practice.

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