

Material Process in Mechanical Engineering Texts: Systemic Functional Linguistics Perspectives

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ABSTRACT

A creative clause is a type of clause operating either on the material process of doing or material process of happening. Since both material process types may occur in creative clauses, this study aims to investigate what verbs realize each of material process in creative clauses occurring in Mechanical Engineering texts and what verbs may realize both of the material process types in Mechanical Engineering texts. Therefore, this study employed the Systemic Functional Linguistic (SFL) framework to analyze the qualitative data obtained from an introductory textbook of Mechanical Engineering. The results showed that verbs *create*, *form*, *make*, *produce*, and *develop* realize the material process of doing while verbs *appear*, *grow*, *occur*, and *develop* realize the material process of happening. It implies that only one verb may realize both material process types.

I. Introduction

Mechanical Engineering (ME) texts belong to disciplinary text due to the content of the texts. The content or the field will be represented grammatically through Transitivity system, which encompasses six types of processes [1]. One of the process types called material process comprises two subtypes known as the material process of doing and material process of happening. Both processes may occur in two types of material clauses: creative and transformative clauses. Seeing that both types of the material process may appear in any kind of material clauses, this paper is raising an issue of what verbs can realize both material process and what verbs cannot.

Process types have been explored by several papers, such as the verbal process in academic writing [2], circumstantial relational process clauses in scientific texts [3] possessive relational process clauses in scientific texts [4] process verbs in EFL graduates' citations [5] a contrastive study of relational attributive process in English and Persian [6] relational process in accounting texts [7] and process in Bahasa Indonesia [8]. However, an investigation focusing on the material process, especially in Mechanical Engineering text is hard to find. Hence, it is essential to conduct a study of the material process in Mechanical Engineering texts since the results will affect various aspects.

Understanding the grammar of Mechanical Engineering texts will help English for Specific Purposes (ESP) practitioners who teach English for Mechanical Engineering students and the students. Although ESP practitioners possess adequate grammatical knowledge since their education background is Linguistics or Applied Linguistics, they have content knowledge weaknesses which will affect motivation and developing teaching materials. Meanwhile, the ESP program is commonly designed for the students with an intermediate level of English [9], but most students in Politeknik Negeri Bandung tend to possess a lower level of English. Although the students are familiar with the content, lack of grammatical knowledge will create a problem in understanding the texts [10]. To fulfil the gap, exploring the texts the students' study will help ESP practitioners and the students as well [11] since ESP which refers to the teaching and learning of English as a second or foreign language where the goal of learners is to use English in a particular domain [12] is centred on the language such as grammar, lexis, register, skills, discourse, and genres appropriate to these activities

[9]. Hence, in this case, analyzing the material process in Mechanical Engineering texts as a part of grammar will be essential for both parties.

The material process is a significant process realized by either transitive or intransitive verbs. Both verb kinds subdivide the material process into two types: the material process of doing and material process of happening, as mentioned above. Both types can occur in creative clauses which is a type of material clauses. Two instances below show them. Thus, this study addresses two questions.

1. What verbs do realize material process in creative clauses in Mechanical Engineering texts?
2. What verbs can realize both material process types in creative clauses in Mechanical Engineering texts?

II. Method

This study employed a qualitative method with descriptive analysis. The data in the form of the corpus were taken from an introductory textbook of Mechanical Engineering [13] since the introductory textbook helps undergraduate students to engage with their new field [14].

In analyzing the data using SFL, first, all clauses containing material process were collected. The clauses were selected based on creative clauses. The creative clauses were classified according to the material process of doing and the material process of happening. Then, each classification was analyzed. Finally, the conclusion was driven, referring to research questions previously designed. The steps taken in this process are illustrated in Figure 1.

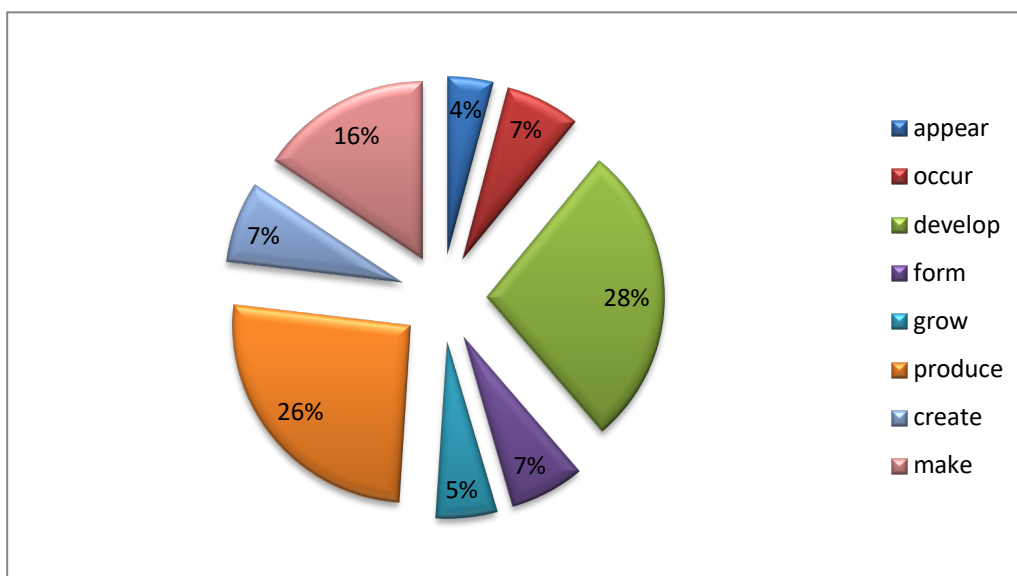
Fig. 1. The stages of data analysis



III. Results and Discussion

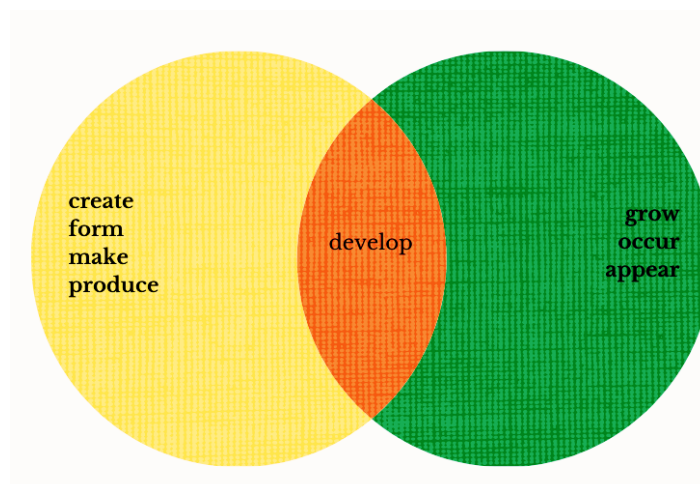
The results demonstrate two things. First, there are eight main verbs which realize material process in creative clauses in Mechanical Engineering texts, as shown in Figure 2. The verbs are *appear*, *create*, *occur*, *develop*, *form*, *grow*, *make*, and *produce*. However, the most frequent verbs which tend to frequently realize material process in this type of texts are *develop* (28%), *produce* (26%) and *make* (15%).

Fig. 2. Distribution of verbs realizing MP in creative clauses



Second, Figure 3. shows that more verbs tend to realize the material process of doing (*develop, form, grow, produce, create, and make*) than the ones which realize the material process of happening (*appear, occur, develop, and grow*). Interestingly, there is a single verb (*develop*) that can realize either the material process of doing or material process of happening.

Fig. 3. The verbs realizing Material Process types in Creative Clauses



IV. Discussion

The discussion of the results will be divided based on the types of material process. First, creative clauses working on the material process of doing will be presented. Then, creative clauses having the material process of happening will be analyzed.

A. Creative clause: the material process of doing

Five verbs realize the material process of doing occurring in creative clauses in Mechanical Engineering texts: verbs *create, develop, form, make, and produce*. Several clauses taken as the samples are discussed below.

B. Material process of doing: verb create

The results show that the verb *create* only realize the material process of doing in creative clauses 1) – 3). As a transitive verb, this verb requires the presence of an object when it appears in a

clause. Further investigation shows that Actor or subject in the clause may be realized either by animate *They, An engineer* or inanimate *Commercial passenger aviation, Both Fx and Fy, Gravity, The aircraft's wings*. Moreover, Goal is realized by nominal groups which possess either modifier or qualifier or both.

Table 1. Material process: verb create

Actor	Process	Goal
Nominal group	Verbal group	Nominal group
They	also create	a large number of other products
The	also create	a large number of other products
An engineer	creates	a machine or product to help someone solve a technical problem.
Commercial passenger aviation	has created	travel opportunities for business and recreational purposes.
Both Fx and Fy	create	an additional force
Gravity	would create	an additional force
The aircraft's wings	create	an upward lift force

C. Material process of doing: verb develop

Material process operating on creative clauses which occur in Mechanical Engineering texts is dominantly realized by verb *develop* as seen in Figure 2. This verb does realize not only the material process of doing but also the material process of happening (Figure 3.). Furthermore, material process realized by this verb may also possess Agent realized by animate. They are realized by nominal groups *A design engineer, The design team, Engineers* all of which refer to a human. Whereas, Actor, which is realized by inanimate, uses nominal group *Innovation, Control automotive brakes, The fluid*. Furthermore, Goal which the participant required by the material process of doing is realized by nominal groups *a comprehensive set of system requirements, the design details, reputation for paying attention to details, a wide range of technologies, their large forces by transmitting pressure from the liquid hydraulic fluid to pistons and other actuators, viscous shear stress* as illustrated in Table 2.

Table 2. Material process realized by verb develop

Actor	Process	Goal
Nominal group	Verbal group	Nominal group
A design engineer	develops	a comprehensive set of system requirements
The design team	develops	the design details
Engineers	have developed	reputation for paying attention to details
Innovation	can develop	a wide range of technologies
Control automotive brakes	develop	their large forces by transmitting pressure from the liquid hydraulic fluid to pistons and other actuators
The fluid	develops	viscous shear stress

D. Material process of doing: verb form

The results also show that verb *form* may realize the material process of doing in creative clauses appearing in Mechanical Engineering texts. The inanimate Actor is realized by nominal groups *Base units, The two given forces, together with the resultant, The forces in the vector polygon*. At the same time, Goal is also realized by nominal groups *The core building blocks of any unit system, A triangle, An isosceles triangle*, as shown in Table 3.

Table 3. Material process realized by the verb form

Actor	Process	Goal
Nominal group	Verbal group	Nominal group
Base units	Form	The core building blocks of any unit system
The two given forces, together with the resultant,	Will form	A triangle
The forces in the vector polygon	Form	An isosceles triangle

E. *Material process of doing: verb make*

Material process of doing in creative clauses may also be realized by verb *make*. Like the material process in Table 1., the material process realized by this verb may have Actor represented by either animate or inanimate. Actor represented by animate is realized by nominal groups *They (engineers)* and *Mechanical engineers* while Actor represented by inanimate is realized by nominal groups *The turbine* and *The hub* as shown in Table 4.

Table 4. Material process realized by the verb make

Actor	Process	Goal
Nominal group	Verbal group	Nominal group
They (engineers)	make	important contributions to our society
Mechanical engineers	make	hardware
The turbine	makes	contact with the tubes
The hub	makes	three revolutions

F. *Material process of doing: verb produce*

Material process of doing may be realized dominantly by verb *produce*. However, Actor is realized by the inanimate subject of nominal groups *A gasoline- power engine*, *An assembly plant*, *A coal-fired power plant*, *A natural-gas-fired electrical power* as seen in Table 5. Moreover, Goal is also realized by nominal groups *a peak output of 10 hp*, *400 vehicles per day*, *a net electricity output of 1GW*, *an output of 750 MW*.

Table 5. Material process realized by the verb produce

Actor	Process	Goal
Nominal group	Verbal group	Nominal group
A gasoline- power engine	produces	a peak output of 10 hp
An assembly plant	produces	400 vehicles per day
A coal-fired power plant	produces	a net electricity output of 1GW
A natural-gas-fired electrical power	produces	an output of 750 MW

G. *Creative clause: material process of happening*

The results show that there are four verbs which realize the material process of happening in creative clauses occurring in Mechanical Engineering texts. The verbs are *appear*, *occur*, *develop* and *grow*. Although this type of material clause does not have an object, the meaning conveyed is a new entity caused by the process. Several clauses taken as the samples are discussed.

H. *Material process of happening: Verb appear*

Figure 3 denotes that the verb that may realize the material process of happening in creative clauses is *appear*. The creative clauses possess Agent which are realized by nominal groups *The base unit kg*, *Everything within the dotted line*, *Diagram*, *Flowing fluids*. These nominal groups are inanimate. Unlike the material process of doing which requires Goal, the material process of happening is characterized by the absence of Goal, however, the clauses possess Circumstance as Attribute realized by prepositional phrases expressing Circumstance as in Table 6. Although Attribute is a participant role commonly found in circumstantial relational process clauses as identified by [3], however, they are different. In circumstantial relational process clauses, Circumstance as Attribute is obligatory since two participant's roles should be present to make meaning ultimately. Conversely, in the material process of happening in the creative clause, the meaning is complete in the Actor and the process.

Table 6. Material process realized by the verb appear

Actor	Process	Attribute/Circumstance
Nominal group	Verbal group	Prepositional phrase
The base unit kg	can appear	in a dimension's denominator

Everything within the dotted line	should appear	on the diagram
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I. Material process of happening: Verb occur

The verb *occur* also realizes the material process of happening in creative clauses. The creative clauses working on this kind of process contain only Actor and process, as seen in Table 7. Nominal groups realize the inanimate Actor as the only participant in the clauses.

Table 7. Material process realized by the verb occur

Actor	Process
Nominal group	Verbal group
Plastic deformation	<i>occurs</i>
Yielding	<i>occurs</i>
Shockwaves	<i>occur</i>
<i>Some amount of slippage</i>	<i>invariably occurs</i>

J. Material process of happening: Verb develop

As Figure 3. shows, the material process of happening may also be realized by verb *develop*. Like in other creative clauses, the nominal group realizes Actor. Operating on the material process of happening, these creative clauses do not require Goal. However, they might have Circumstance as Attribute, which is realized by prepositional phrase as shown in Table 8.

Table 8. Material process realized by the verb develop

Actor	Process	Circumstance/Attribute
Nominal group	Verbal group	Prepositional phrase
The high temperatures	developed	in jet engines.
Small eddies and whirlpools	develop	behind the sphere.
Buoyancy forces	develop	even in stationary fluids.
Thermals	develop	near mountain ridges.

K. Material process of happening: Verb grow

The last verb identified, which realizes the material process of happening in creative clauses occurring in Mechanical Engineering texts, is *grow*. As a characteristic of the material process of happening, the clauses do not have Goal as seen in Figure nominal groups which are inanimate realize Actor. There is no Goal present; however, the clauses possess circumstance realized by prepositional

Table 9. Material process of happening realized by the verb grow

Actor	Process
Nominal group	Verbal group
The Reynolds number	Grows
The rotation angle	Grows
Urban centres	Grow

V. Conclusion

Investigating the verbs realizing each material process type in creative clauses appearing in Mechanical Engineering texts allows making conclusions. The verbs *create*, *form*, *make*, *produce*, and *develop* tend to realize the material process of doing. The Goals are realized by nominal groups. Whereas, the verbs *appear*, *grow*, *occur*, and *develop* tend to realize the material process of happening. Although there is no Goal presence in the clauses, Circumstance serving as Attribute might occur. Besides, only one verb, that is, the verb *develop* which might realize both material process types. ESP practitioners may use the findings to improve their students' grammatical weaknesses, especially Mechanical Engineering students.

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