

Advice for Preparing Contest Documents

Satellite Design Contest Review Committee

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This document contains advice related to the preparation of documents for the satellite design contest. This document does not provide guidance on satellite design techniques or ideas, but instead provides advice related to writing techniques. These basic techniques are applicable not only to documents for this contest, but also to other scientific or technical documents – these are best practices for scientific and technical writing.

This document should not be considered a comprehensive or exhaustive source on the subject at hand. While reviewing submissions, committee members have often expressed sentiments such as “this is difficult to understand”, or “this information would have been more valuable if it had been presented differently”. As a result, we have put together a collection of piecemeal yet impactful advice. Please peruse this information when preparing your contest documents. We hope that it will prove valuable.

1. Consideration of significant figures

Are you considering significant figures, and displaying values appropriately? For example, if you have values of $x = 9.2$ and $y = 3.8$ (both with error bounds of ± 0.1), would you write their quotient as $x / y = 2.4210526$? You may think that using a more precise number will give you a more accurate result. However, as x and y are only given in two significant figures (accurate to a few percent), the quotient also has the same level of precision, so the actual value of x / y could be anywhere from 2.37 to 2.43. So, in this case, the quotient should be expressed as 2.4.

2. Treatment of experimental results

In some instances, contestants try to draw general conclusions from experimental results. In such cases, please consider whether such general conclusions are valid.

For example, let's say you have proposed a mechanism to be used as a spacecraft component. You might fabricate a prototype, subject it to mechanical strength testing, and make a convincing argument that the mechanism is fit for practical use. In such a case, please consider how generalized the model shape, material, test conditions, etc. are. Drawing general conclusions based on specific examples is not considered to be convincing, so take care.

In the example above, ideally you would begin with a theoretical stress analysis, then use experiments and numerical simulations under constrained conditions to corroborate your analysis. Of course, this may not be possible with limited time and resources (budget, methods, materials, equipment, human resources, etc.) but you should at least consider the applicability limitations of your results.

To clarify further, here are some more specific examples:

- (A) When conducting operational testing for asteroid sample collection equipment, remember that the terrestrial gravitational acceleration is higher than the actual gravitational acceleration on the surface of an asteroid.
- (B) When using a vacuum chamber to simulate the space environment, remember that the actual space environment is also subject to large temperature fluctuations, and different levels of radiation.

3. Writing of formulas

When using equations, avoid showing numerical values in the first instance. Start with a general expression for the variable, and then follow up by assigning a specific numerical value. In the following example, (a) is incorrect, but (b) is correct.

- (a) The voltage across terminals A and B is $3 \times 5 = 15$ [Volt]
- (b) The voltage across terminals A and B can be determined based on Ohm's law, as shown in Equation (1).

$$E = I \cdot R \quad (1)$$

Where I represents the current (in Ampere) flowing between terminals A and B, and R represents the resistance between terminals A and B. By substituting in $I = 3$ [Ampere] and $R = 5$ [Ohm], we obtain the following result:

$$E = I \cdot R = 3 \times 5 = 15 \text{ [Volt]}$$

4. Citation of formulas

When using equation, assign a number to each equation, and cite the number in the relevant part of the text. In example (b) above, the number (1) is assigned to the equation, and it is cited as "Equation (1)" in the text.

5. Figures, Charts and Graphs

- (1) Wherever possible, describe each part of a figure in the figure itself, not just in the text.
- (2) For graphs, include at least labels for the horizontal and vertical axes, units and so on.
- (3) Arrange figures and tables in the order in which they are mentioned in the text. Try to keep figures as close as possible to relevant sections of text, to minimize the amount of page-turning required by the reader. There are exceptions, such as referring to a figure in a different section.
- (4) Ensure that you explain all figures, tables, and graphs in the text.
- (5) When using multiple similar graphs for the purpose of comparison, try to make the origin and axes the same. If this is not possible, take care to explain the differences in a way that is not misleading.

6. Coordinate systems

When using coordinate systems, do not forget to define them first. Ensure that the origin and axes in relevant figures match the description in the text. Also, use a consistent coordinate

system within an individual sentence. Avoid using x, y, z and X, Y, Z in the same figure and so on.

7. Layout

- (1) When dividing writing task amongst group members, avoid using inconsistent layouts and fonts between authors, and leaving blank spaces between sections.
- (2) Take care to avoid layout issues such as figures that are too small or that have abnormal margins, and excessively large blank spaces. Previous contest winners have used page margins of around 20mm.

8. Writing Style

[Note: this section focuses on Japanese writing style. Some structure and grammar points are not relevant in English]

- (1) Your sentences can be written in polite form (です/ます) or plain form (である), but please ensure that they are consistent throughout the paper.
- (2) Ensure that the subject and predicate of the sentences correctly correspond to each other. For example, “This satellite’s power subsystem composes a battery, a DC-DC converter, a Charge/Discharge system controller and selector switches for alternating between these components” is an awkward sentence to read. Writing it as “This satellite’s power subsystem includes...” or “This satellite’s power subsystem is composed of...” gives a better impression.
- (3) Check that you use a consistent tense throughout your document. For example, if you express the result of Experiment 1 as “The voltage reached 20.3V”, then write the result of experiment 2 as “the power is 0.56W”, it creates a sense of inconsistency. Either past tense or present tense is acceptable, but please use it consistently.
- (4) Please take care to avoid errors when inputting Kanji. For instance, writing 大い (“ooi”/large) instead of 多い (“ooi”/many), or writing 硬化 (“kouka”/hardening) instead of 効果 (“kouka”/effect). The presence of many such input mistakes will create a poor impression for the reader. As authors may not notice errors in their own writing, even after multiple reviews, it is prudent to have an independent 3rd party read your work. Also, regarding the use of kana suffixes (“okurigana”) for space terminology such as ロケットの“打上げ” (rocket “launch”), the suffix is omitted when using the word as a noun (打上げ), and included when using it as a verb (打ち上げ). i.e., “本日ロケットを打ち上げました” (the rocket was launched today) vs. “本日ロケットの打上げが行われました” (the rocket launch was carried out today). 打上 can be used for proper nouns.
- (5) Be consistent with vocabulary. For example, it might not be incorrect to use “automatic control” in one section and “autonomous control” in another, but it creates additional burden for the reader.
- (6) Avoid using the same word too often in a single sentence. Refer to the following sentence:

“In many cases, the attitude of satellites used in Earth observation needs to be controlled at a predetermined attitude, and we need to install attitude sensors which are needed for attitude determination, and attitude actuators which are needed for attitude control.”

This is an extreme example, but the word “attitude” is repeated 6 times, and the word “need(s)”/“needed” is repeated 4 times, making the sentence somewhat annoying to read. The following example shows an improved version: “To achieve their mission objectives, Earth observation satellites need to control their attitude in a predetermined direction, and are therefore fitted with attitude sensors and control actuators.”

- (7) Try to make it clear which words align with each other in your sentences. For example, isn't it difficult to derive the meaning of the following sentence just by perusing it?

“Regarding the temperature difference between A and B, if the voltage between P and Q is increased rapidly, the temperature difference between R and S is held constant, and the current between X and Y is minimized, it can be increased.”

This sentence is difficult to understand because the subject (“the temperature difference between A and B”) is at the beginning of the sentence, but the verb (“increased”) is at the end. If you read the sentence from start to finish, you might wonder “well, what was the subject?”, and you would be forced to read it again.

Suggestion 1: bringing the subject and verb closer together will make the sentence easier to read.

“The temperature difference between A and B can be increased by rapidly increasing the voltage between P and Q, holding the temperature difference between R and S constant, and minimizing the current between X and Y.”

Suggestion 2: itemizing the conditions can make the sentence easier to understand.

“If the following conditions are met, the temperature difference between A and B can be increased:

- [1] Rapidly increase the voltage between P and Q,
- [2] Hold the temperature difference between R and S constant,
- [3] Minimize the current between X and Y.”

9. Citation of Other Documents

- (1) If an idea, design or analysis method, formula, experimental procedure, etc. appear to be novel, but were not originated by you, include a reference to the original document.
- (2) When you cite other documents, specify the source in a format that makes it easy for the reader to find.
- (3) Copying text, diagrams, photographs, graphs, and tables from other documents and using them as they are is undesirable. This can raise suspicions about the originality of your work, so avoid it unless necessary.

10. Submission of Similar Work

Please avoid submission of entries with similar content (or duplication of key content) to different sections of the satellite design contest.

11. Page Limits

Please observe page limit rules for your entry documents. As a rule, entries which exceed the page limits will be disqualified, regardless of content. Also, these limits should be adhered to even if figures or text are added to address feedback from initial screening.

12. Detailed “Satellite Design Analysis” vs. Brief “Satellite Overview”

- (1) The “overview” is not simply the main part of the “analysis”, but also a short summary of your work. Even if the content is the same, please provide details in the analysis document, and a condensed summary in the overview document.
- (2) On the other hand, all content included in the overview document must be described in detail in the analysis document. Just because content has been included in the overview document, that does not mean that it can be omitted from the analysis document.

Based on the above points, as a general rule do not copy + paste sentences or paragraphs between the overview document and analysis document without editing.

[Translated by Dr. Matt Richardson, University of Tokyo]