

29th Satellite Design Contest Application Guidebook

Satellite Design Contest Executive Committee

Organizer: The Japan Society of Mechanical Engineers (JSME), The Japan Society for Aeronautical and Space Sciences (JSASS), The Institute of Electronics, Information and Communication Engineers (IEICE), The Society of Geomagnetism and Earth, Planetary and Space Sciences (SGEPSS), The Astronomical Society of Japan (ASJ), The Japan Aerospace Exploration Agency (JAXA), The Society for Promotion of Space Science (SPSS), Japan Space Forum (JSF) ,Japanese Rocket Society

Co-sponsor: The Japan Society for Aeronautical and Space Sciences

Special Supporter: SHINKOSHUPPANSHA KEIRINKAN Co.,Ltd.

Sponsorship: National Space Policy Secretariat, Cabinet Office, The Ministry of Education, Culture, Sports, Science and Technology, The Ministry of Internal Affairs and Communications, Japan Ministry of Defense, Ministry of Economy, Trade and Industry

Planning & Operation: The Satellite Design Contest Executive Committee

1. Aims

This Contest provides an opportunity to activate basic and applied research related to the space science and technology and is intended for high school students, technical college students, and undergraduate/postgraduate students of universities/colleges. It also aims to contribute to the expansion of space development in Japan.

We call on students to submit their free-thinking creative works including small satellites, various space related missions, and design concepts. Awards will be given to those groups (or individuals) who have submitted excellent works.

This contest also offers an opportunity for education by experts in satellite developments. From this point of view, we will give appropriate guidance to promising applicants, and encourage them to submit revised works again even if unsuccessful in a single trial.

2. Category

The Contest consists of three categories; Design Category, Idea Category, and Junior Category.

The "Design Category" is for a detailed and complete design of satellite(s), including its onboard instruments, and the overall spacecraft system that is technically feasible and meets the design conditions.

The "Idea Category" is for a conceptual construction of a space mission. The works are evaluated for their originality and usefulness, rather than their design completeness

The "Junior Category" is for a proposal of space mission(s)/experiments with creative and useful ideas that could be utilized in the future. Detailed mission designs are not required.

3. Qualification

The "Design Category" and "Idea Category" are intended for high school students, technical college students, and university/college students (both undergraduates and postgraduates), while the "Junior Category" is intended for high school students. An application can be either from a group or an individual. The group may include their teacher as a member, and can consist of students from different schools. However, the number of group members should not exceed 10.

A proposal that was unsuccessful in a past Contest can be treated as a new application, as long as it has been improved significantly, taking into account subsequent studies and the advices by the Review Committee.

4. Application process

Applicants are first required to register, and once the registration is accepted, they may submit their works by the deadline.

(1) Registration procedure

Fill in the attached registration form and submit it to the secretariat by **5PM Monday 17 May, 2021 (JST)**.

The registration fee, per entry, is **3,000 Japanese Yen for the Design Category and the Idea Categories, whereas 1,000 Japanese Yen for the Junior Category.**

*Only the bank transfer is accepted

<Paying BANK>

BANK: SUMITOMO MITSUI BANKING Corporation (0009)

Swift code: SMBC JP JT

Branch Name (Branch code): TOKYOKOUMUBU (096)

Address: 1-6-12 Toranomom Minato-ku Tokyo JAPAN

Zip code: 105-0001

Bank Telephon: +81-03-3591-3201

Ordinary Account: 3014468

Beneficiary's Name: NIHON UCHU FORUM

Beneficiary's Address: Shin-Ochanomizu Urban Trinity Bldg.2F
3-2-1 Kandasurugadai, Chiyoda-ku, Tokyo JAPAN

Zip code: 101-0062

Beneficiary's Telephone: 03-6206-4900

***All bank transfer charges, which would occur at payer's bank and payee's bank, should be borne by the applicant.**

(2) Deadline for submission of the work

12PM Monday, July 5, 2021 (JST)

(3) Address for the registration form and submission of the works

The works (documents) can be submitted either via post or via e-mail.

Satellite Design Contest Secretariat

c/o Japan Space Forum

Shin-ochanomizu Urban Trinity Bldg. 2F, 3-2-1 Kanda surugadai,

Chiyoda-ku, Tokyo 101-0062 JAPAN

Tel: +81-3-6206-4902

E-mail: satconjimu@jsforum.or.jp

Satellite Design Contest Website: <http://www.satcon.jp/en/>

(4) The works (documents) can be submitted in either Word or PDF format.

5. Screening Process

5.1 Initial Screening (Paper examination)

- (1) 10 to 15 works are selected in total through documentary examination.
- (2) The selection results are notified to the representatives, together with advices, questions, and comments from the Review Committee.
- (3) The result notification period is from late August to early September.

5.2 Final review (Presentation)

***Online presentation**

(1) Date: Saturday, November 13, 2021

(2) Conferencing method: Oral on-line presentation (Zoom)

(3) Presentation time (per entry):

Design Category: 30-40 min (including Q&A)

Idea Category: 20-30 min (including Q&A)

Junior Category: 5 min, followed by Q&A for 10 min

** The presentation times may change depending on the result of Initial Screening.

(4) Presenter: Up to 3 people

(5) Language: Japanese or English

(6) Method: Oral on-line presentation (either live, or using a pre-recorded video movie), incorporating PowerPoint slides, a mockup model (see below), and apparatus used for experiments (if any). In addition, several supplementary materials, as described in 9, must be submitted in advance, for preliminary inspection by the Review Committee. These cannot be modified after submission.

5.3 Evaluation criteria

5.3.1 The Design Category

The evaluation is made on the basis of knowledge and application skills of the satellite design technique, the depth of consideration, and accuracy/reliability of the design/calculatooon. Specific evaluation points are as follows. The items (5) and (6) apply to the Final Review only.

- (1) Completeness of the design as a satellite system.
- (2) Clarity of the technical basis and feasibility of the design.
- (3) Originality and ingenuity of the design.
- (4) Significance and sales points of the proposed satellite mission.
- (5) Improvements considering the advices, questions, and comments from the Initial Screening.
- (6) Presentation abilities and attractiveness.

5.3.2 The Idea Category

Proposals are evaluated in view of technical feasibility in the first place, and also novelty and usefulness

of the proposed mission concept. Specific evaluation points are as follows, where the items (4) and (5) apply to the Final Review only.

- (1) Originality of the mission.
- (2) Significance and usefulness of the mission.
- (3) Clarity and accuracy of the technical basis towards the realization of the proposed concept.
- (4) Improvements considering the advices, questions, and comments from the initial screening.
- (5) Presentation abilities and attractiveness.

5.3.3 The Junior Category

The submitted works are evaluated from a point of view whether it is clearly innovative, and meaningful as a space mission or space utilization. Specific evaluation points are as follows, where items (3) and (4) apply to the Final Review only.

- (1) Significance, originality, and uniqueness of the proposed mission.
- (2) Accurate and clear explanations towards the realization of the ideas.
- (3) Improvements considering the advices, questions, and comments from the Initial Screening.
- (4) Presentation abilities and attractiveness.

6. Awarding

Based on the Initial Screening and the Final Review, the following awards are granted to those proposals that proceeded to the Final Review. The Grand awards will be given to the best work (usually one) of each Category, and the other awards will be given to works that are suitable for the activity of the respective award presenters. In addition, the Best Model Award is decided by votes by members of Committees. Each award winner, except those of (5), will also be given a trophy as an auxiliary prize.

- (1) Design Grand Award (The best work in the Design Category)
- (2) Idea Grand Award (The best work in the Idea Category)
- (3) Junior Grand Award (The best work in the Junior Category)
- (4) The Japan Society of Mechanical Engineers Award, The Japan Society for Aeronautical and Space Sciences Award, The Institute of Electronics, Information and Communication Engineers Award, The Society of Geomagnetism and Earth, Planetary and Space Sciences Award, The Astronomical Society of Japan Award, The Society for Promotion of Space Science Award, and The Japan Space Forum Award.
- (5) The Special Award from the Review Committee Chair, The Encouragement Awards (The Design and Idea Categories), The Junior Experiment Award (the Junior Category), The Junior Encouragement Awards (the Junior Category), and The Best Model Award (the Design and Idea Categories).

7. Design Conditions

The proposals for each Category must meet the following design conditions.

7.1 The Design Category

(1) Constraints :

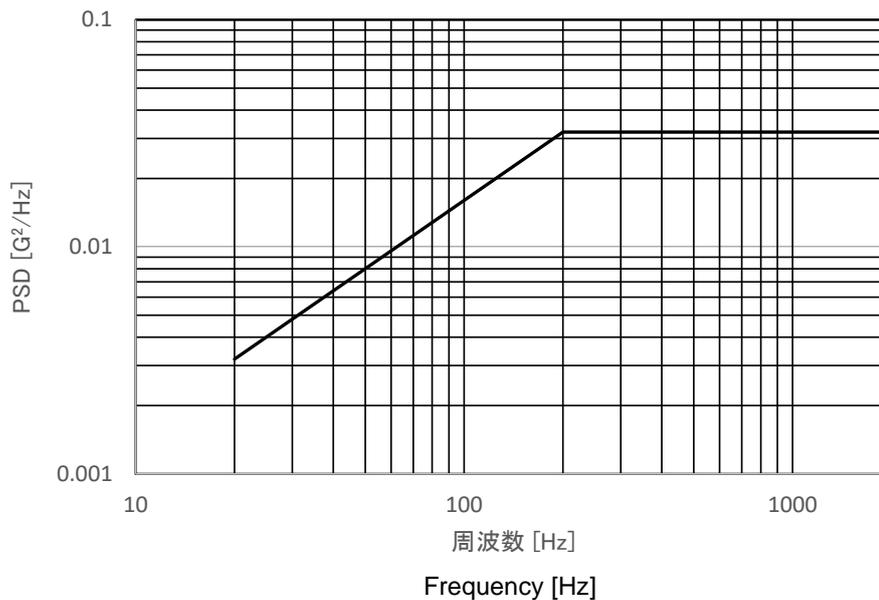
[Mass] Up to 50kg

[Configuration] Fit in 50cm×50cm×50cm space when launched.

[Launch environment] The mechanic design must be made to withstand the following conditions.

- Random vibration (3-axis common)

20~200Hz	+3db/oct	Effective value 7.8Grms
200~2000Hz	0.032G ² /Hz	



- Sine wave vibration level

Axis direction 2.5 Go-p (5~100Hz)

Axis orthogonal direction 2.0 Go-p (5~100Hz)

- Quasi-static acceleration

Axis direction +5.0/-6.0G

Axis orthogonal direction ±5.0G

- Rigidity requirements (the first-order natural frequency of the satellite when its separation plane is rigidly fixed)

Thrust direction higher than 120Hz

Lateral direction higher than 60Hz

*The design must incorporate an appropriate safety factor.

*The same environment conditions apply to both the 50 kg class and the CubeSat class.

* Even if the proposal employs multiple satellites, their summed mass and the total dimension must meet the same requirements as above.

(2) Mission objectives:

The mission objectives are unspecified, and can be various, including technology demonstrations, scientific observations, space explorations, civil and business applications, and entertainments. To

achieve the mission objective(s), the applicants may freely choose the most appropriate orbit configurations, such as near-Earth orbits, Lagrangean points, transfer and Lunar orbits, and deep-space trajectories. If the constraints of (1) are considered inappropriate or inapplicable to the selected orbit condition, these may be modified, on the condition that a suitable alternative launching vehicle is specified, and the associated launch/operation environments are elucidated.

(3) Based on the constraints as stated above, the applicants must concretely design the overall satellite system, including the mechanical and thermal structures, electrical power budgets, feasibilities for the telecommunication and data transfer, and the onboard instrument(s) needed to carry out the mission. If the mission requires particular orbit and attitude constraints, the orbit- and attitude- control subsystems must be designed likewise. In short, the applicants must convince that the design they have made will lead to a successful achievement of the proposed mission objective(s).

7.2 The Idea Category

(1) Constraints:

The configuration and mass are limited to either a small rocket, an Epsilon Launch Vehicle, an H-IIA Launch Vehicle, or International Space Station.

(2) Objective: The same as 7.1 (2). In addition, mission concepts that cannot be substituted for by non-space means are encouraged.

(3) Unlike the Design Category, detailed designs are not required, but the technical basis for the realization of the proposed ideas must be clarified.

7.3 The Junior Category

(1) Constraints:

The configuration and mass are limited to a small rocket, H-IIA Launch Vehicle, Epsilon Launch Vehicle and/or International Space Station.

(2) Objective: Any mission can be proposed, as long as it is a space utilization attempt which involves satellites, satellite instruments, lunar and planetary explorations, and the ISS utilization.

8. Documents to be Submitted (for the Initial Screening)

Documents should all be publishable, except the personal information. The Overview, which is to be printed and handed out to the Review Panel, must be produced using the specified style/format. The Analysis part (the Design Category only) is a very important document which is to be used for the evaluation. Be sure to make the documents easy to understand. If the work contains techniques that can be patented, the applicants are advised to apply for the patents and acquire them in advance.

More specifically, follow the guidelines for the document preparation (see the attached “Document Preparation Guidelines).

(1) All documents must use A4 format, with the top, bottom, left and right margins more than 20 mm.

- (2) Font size: 10.5 pt or larger, except mathematical formulae and figure captions. For clarity, use large or bold letters for titles and points to be emphasized.
- (3) Each document must strictly keep the page limit as specified below. A cover page should be omitted to make an effective use of pages. Unlike the *Satellite Overview* part, The *Satellite Analysis* document does not require any frames. Each page may be divided into two columns.

*** In order not to violate the copyright credits, explicitly state the source(s) when the works by others (including ideas, papers, calculations, images, music, and any other forms) are quoted, and when applicable, go through the necessary procedures such as asking for a license.**

8.1 The Design Category

- (1) The *Satellite Overview* document, prepared in the specified style (a template shall be provided). It should describe the purpose, the orbit, operational methods, the ways to obtain the aimed results (including the mission instruments), the ground station(s), the satellite body, and the entire system of the satellite. Applicants are encouraged to use appropriate figures. The total length should be 3 pages at most.
- (2) The *Satellite Design Analysis* document, which complements (1) by providing the basis for the employed techniques, detailed calculations (say, of the power budget and of the needed telemetry rate), and preliminary experiments if any. It should be prepared conforming to the attached “*Satellite Analysis Preparation Guidelines*”, keeping the total length of maximum 37 pages.

8.2 The Idea Category

- (1) The *Mission Overview* document. See 8.1 (1).
- (2) The *Mission Overview* document, prepared following the attached “*Mission Analysis Preparation Guidelines*”. It complements (1), and explains from various aspects that the proposed mission concept is feasible. The total number of pages is limited up to 7. If this page limit appears too tight, you may consider applying to the Design Category instead.

8.3 The Junior Category

- (1) The *Junior Mission Overview* document, prepared in the specified style (a template should be provided) as described in the attached “*Junior Overview Preparation Guidelines*”. The total number of pages must be 3 pages at most. It should explain the aim and methods of the proposal, its novelty and uniqueness, and results from preliminary experiments if any.
- (2) If necessary, you may submit *Supplementary Material* for further explanation. The total length must be up to 3 pages.

9. Instructions to the finalists

The finalists, namely, those applicants who have successfully passed the Initial Screening, are required to carry out further tasks as specified below, prior to the Final Review.

9.1 The Design Category / Idea Category

- (A) Resubmit the *Overview/Analysis* documents, which have been revised taking into account the advices, questions, and comments from the Review Committee, as well as subsequent progress in the studies.
- (B) Prepare for the on-line presentation (either live or pre-recorded; see Schedule for the Final Review).
- (C) Summarize the PowerPoint (or any other equivalent software) slides used in (B), into an electronic file, and submit it in advance. This is for the purpose of preliminary inspection by the Review Committee.
- (D1) Fabricate a mockup model of the satellite/instrument. The model should preferably be full-size, but if it is too big, a scale model is acceptable (consult the secretariat in advance). Any materials are accepted including aluminum, plywood, corrugated papers, and plastics. If the work is a proposal for new software or communication method, and it is not suitable for a hardware mockup, a CG movie or something similar would be acceptable (consult with the Secretariat).
- (D2) Produce and submit a 2-minutes video, in which they explain the model in (D1). This is also meant for preliminary inspection by the Review Committee, and is different from (B).

9.2 The Junior Category

- (A) Resubmit The *Junior Mission Overview* document, which has been revised taking into account the advices, questions, and comments from the Review Committee, as well as subsequent progress in the relevant studies.
- (B) Prepare for the on-line presentation (either live or pre-recorded; Schedule for the Final Review). It may incorporate either the poster C below, or an appropriate number of slides (e.g., with PowerPoint).
- (C) Create a poster in A1 format summarizing the work, and submit it in a PDF file prior to the Final Review. This is for preliminary inspection by the Review Committee.
- (D) (Optional) Like in the *Design/Idea* categories, the applicants may fabricate a mockup model of their spacecraft/instrument, take a 2-minutes video using the model, and submit the video in advance.

10. Miscellaneous

- (1). If you have any question as to the application procedure, or the selection results (after the Initial Screening), do not hesitate to contact the Satellite Design Contest Secretariat
- (2) Any submitted documents will not be returned to the applicants.
- (3) The applicants keep the copyright of the materials which they submitted to the Contest.
- (4) Photos and part of the submitted documents are to be posted on the website of the Contest. In addition, the *Overview* will be published as "Presentation Abstracts" and be given out to the audience at the final review. The *Analysis* documents are to be posted on the website of the Contest in principle after the final review. (If the applicants do not want to some of their materials to be made public, they should contact the secretariat in advance.)
- (5) The submitted documents will not be used, in principle, for any purpose other than the Satellite Contest related matters. However, as the documents are to be published as "Presentation

Abstracts”, and the “Analysis Document” is posted on the website, they may be provided to the some of the Contest organizers or press, to advertise the Contest, or for space-related educational events which are arranged by the Contest organizers. If some organizations or institutions wish to use some of the documents submitted to the Contest, a consultation should be made to the secretariat. Such attempts need to be certified, in principle, by the document authors or the teacher.

- (6) Applicants are responsible for all the Contest-related expenses, including traveling and communication costs, those needed to fabricate the models, and others.

< Schedule for the Final Review >

Item	Instructions
<p>(A) Documentary materials for all Categories</p>	<p>Deadline: Monday, November 8, 5:00PM (JST), NO EXCEPTIONS</p> <p>Resubmit the document(s), revised according to the advices, questions, and comments from the Initial Screening, and subsequent work progress. The pages should not exceed the specified limit.</p> <p>※ Any document cannot be modified after the submission</p>
<p>(B) Presentations on the Final Review (live or pre-recorded), all categories</p>	<ol style="list-style-type: none"> 1. The program for the Final Review will be noticed later to the finalists. 2. You may choose either live on-line presentation, or advanced submission of a pre-recorded presentation video. 3. In either case, the presenters should appear on the screen, but the number must be at most 3 people (including those for Q&A) from the team members. 4. The presentation time is 30-40 min (including Q&A) for the Design Category, and 20-30 min (including Q&A) for the Idea Category, depending on the results of the Initial Screening. For the Junior Category, the presentation is 5 min, followed by Q&A for 10 min. <p>When choosing the Live presentation option:</p> <ul style="list-style-type: none"> - Be sure to participate in the test connection specified by the secretariat, and connect to Zoom a few minutes before your allocated time. <p>When submitting a pre-recorded video file:</p> <ul style="list-style-type: none"> - Create the video file in either MPEG, mp4, MOV, or WMV format, and submit it by the deadline of Wednesday, November 10 12:00PM (JST), NO EXCEPTIONS. - For technical reasons, leave about 10 seconds of blank (no narration) intervals both at the beginning and the end of your video. - You may upload the video online (e.g., YouTube), or an online storage. In either case, select the "private" setting so that it does not become public. Then, create a text file where the URL is written, and send it to the secretariat via e-mail as an attachment. - Alternatively, you may send the pre-recorded presentation video in DVD to the secretariat by regular mail. - Once submitted, these videos cannot be replaced or modified. - Even in this option, Q&A will take place as a live online Zoom session, after your pre-recorded video has been replayed. So, connect to Zoom a few minutes before your video replay starts. - If you have difficulty in complying with any of the above instructions, give the live presentation on the day.

(C) Supplementary materials for the presentation, to be inspected by the Reviewers prior to the Final Review	Deadline: Monday, November 8, 5:00PM (JST); NO EXCEPTIONS	
	The Design and Idea Categories	The Junior Category
	A PDF file summarizing the slides, which are created with PowerPoint etc. and used in the presentation. ※If you make a live presentation online in the Final Review, you may correct the content by that time. However, the PDF file distributed to the Reviewers cannot be changed.	A poster in PDF format, with a size equivalent to A1. ※Cannot be modified or replaced after it was submitted. ※No need to submit presentation slide data in advance.
(D) Mockup models and their movies	The Design and Idea Categories	The Junior Category
	Deadline: Thursday November 11, 12:00PM (JST); NO EXCEPTIONS	Optional
	- Fabricate a mockup model of the satellite equipment, as specified in 9.2. - Take a 2-minutes video of the model including commentary (in narration or text). This cannot be modified after submission. - Refer to the pre-recording option in (B) above for details of the video and how to send it to the Secretariat.	You may fabricate a model of your spacecraft or experimental device, and show it on the Final Review, but no need to submit the video in advance (except when choosing the pre-recording option).

* The presentations will be uploaded on YouTube in real time. If your presentation is not allowed to publish on the website, contact the secretariat in advance.

The Design Category: *Satellite Analysis* Preparation

Guidelines

<Items to be included in the *Satellite Analysis* document>

The satellite should be those which can actually be launched, instead of being imaginary or fictional. Describe the details of the proposed satellite, including the following items approximately in this order.

1. Mission requirements (aims of the satellite) and its significance

Clearly describe the mission requirements (the aims of the satellite), as well as its importance and significance in technology, science, civil life, education, art, and other aspects.

2. Anticipated results

State the expected results once the satellite is put into orbit, with emphasis on their social, technological, scientific, and other impacts. In addition, explain the means to achieve these results, including, for example, the selection of the orbit, the ways of satellite operation and data acquisition, the onboard mission instruments to be used, the mission life needed, and possible relations to other space activities (e.g., the ISS, other satellites, and ground facilities) if applicable.

3. Originality

Identify the originality/uniqueness of the proposed satellite and the particular design employed, in such sales points as the mission objectives, the way of its operation and data acquisition/utilization, the technologies utilized, the instruments to be onboard, and others. If some of them are inherited from previous missions or R&D attempts (by anybody), these should be credited.

4. Detailed design results

State how the mission objectives translate into the requirements for the satellite and its subsystems, and describe how the satellite system and its subsystems have been designed to fulfill the requirements. In particular, the following points must be covered.

- 4.1. The mass, shape, and the overall satellite system design, as well as the orbital constraints.
- 4.2. Details of the design of the individual subsystems such as; the mechanical structure and assembly, the thermal control subsystem, the power generation/supply subsystem, the communication subsystem, the data processing/storage subsystem, the mission instrument(s), and the attitude/orbit control subsystem (if applicable). Demonstrate the validity of the design by quantitative (numerical in particular) analyses.
- 4.3. The relations to ground facilities, required for the command up-links and data down-links.
- 4.4. The actual operational procedures of the satellite, and the data acquisition methods.

5. Concrete achievement methods, prospects and budget for manufacturing

Keeping in mind the stages from the launch to the operation of the designed satellite, explain such aspects as the concrete achievement methods to realize the proposed satellite, to what extent the satellite shall be manufactured, and which components should be purchased. The budget must be estimated as well. In addition, describe the state-of-the-art basis, availability/feasibility, and near-future prospects of the key technologies/components employed in the proposed satellite. Identify potential difficulties/risks in these items, and consider conceivable means to get around them.

6. Development, manufacture and launch schedule

Explain the assumed schedule from the development to launch. A use of figures/tables is encouraged.

7. Conclusion, references, and others

State the conclusion, and give reference to all the literature (books, papers, articles, essays, figures, photos, illustrations, calculations, and others) used/quoted in the proposal. A failure in this point would lead to a potential violation of the copyright credits.

In addition, refer to **8. Documents to be Submitted (for the Initial Screening)** on the "Application Guidebook".

The Idea Category: *Mission Analysis* Preparation Guidelines

<Items to be included in the *Mission Idea Analysis* document>

1. Aims and purposes of the mission

The proposed concept should be on Earth-orbiting satellites, planetary/interplanetary missions, their onboard instruments, experiments on the International Space Station, or other similar space activities. State the aims of the proposal, together with its significance in social, technological, scientific, and other aspects. Also, clarify the reason why the objectives cannot be achieved by space-unrelated means.

2. Concrete design and necessary future tasks

Using figures/tables/photos if necessary, describe the overall configuration, the mass and shape, and the orbit of the proposed mission concept. Explain how the mission works, in relation to the mission instruments, and the methods of operation and data acquisition (including the assumed ground station configuration). In addition, identify remaining tasks, additional studies, and future technological developments that are needed toward the realization of the proposed mission.

3. Originality and impacts of the expected results

State the originality of the proposed mission, and describe the expected results. Also, identify the anticipated social, technological, and scientific impacts, including in particular those on future space exploration/utilization, and who will mainly benefit from the mission.

In addition, refer to **8. Documents to be Submitted (for the Initial Screening)** on the "Application Guidebook".

The Junior Category: *Junior Overview* Preparation Guidelines

Although detailed design of the proposed satellite/instrument/experiment is not needed in this Category, the document should clearly describe the following points, using figures, tables, and illustrations if necessary.

1. The overall configuration of the satellite/instrument/experiment, an approximate mass and size, the mission instruments to be onboard, the orbit to be employed, the way of operation and data acquisition, and the necessary ground facilities (for sending commands and receiving the data).
2. The advantages of using space, and reasons why the objectives cannot be achieved by space-unrelated means.
3. The originality, uniqueness, and novelty of the proposal, and the expected benefits in civil life, technology (including future space exploration in particular), science, education, business application, entertainments, and other aspects.

In addition, refer to **8. Documents to be Submitted (for the Initial Screening)** on the "Application Guidebook".