

IAC-23- B5.IP.2

Technology, Challenges, and Solutions for Space Travel Meals as Represented by "Yakitori", Grilled Chicken

Taiko Kawakami^{a,*}, Taichi Yamazaki^b

^a General Manager, ASTRAX, Inc., 1-1-4-301 Mukogaoka, Bunkyo, Tokyo, Japan 113-0023,
taiko.kawakami@astrax.space

^b CEO and commercial astronaut, International Space Services, Inc. and ASTRAX, Inc., 2-23-17 Komachi,
Kamakura, Kanagawa, Japan 248-0006, taichi.yamazaki@astrax.space

* Corresponding Author

Abstract

Have you ever heard of 'Yakitori'? It is a Japanese dish consisting of several bite-sized pieces of chicken skewered, tossed in sweet and spicy sauce or salt, and grilled. It is popular in Japanese izakaya (Japanese-style pubs) to eat yakitori while drinking beer. Yakitori is already one of the space foods eaten by Japanese astronauts on the International Space Station and elsewhere. However, its form is not a few bites of chicken on a skewer, but rather yakitori that has been removed from the skewer and placed in a can. The era of space travel will be in full swing in the future, and many people will travel to space. It is easy to predict that the need will gradually increase not only to go to space but also to eat and drink their favorite food in space. They will also be more particular about the shape of their grilled chicken and the preference of it to be skewered. In this paper, we will take eating skewered yakitori in space as an example, and discuss the necessary technology, problems, and solutions for a rich meal in space.

Keywords: Space Travel, Yakitori, meal, Space Food, ASTRAX,

1. Introduction

You can serve what you want to eat in a tasty and visually pleasing way, and enjoy it around the table with your family and friends. It is difficult to realize in space what we take for granted on Earth. However, at ASTRAX, we do not assume that it is impossible, but rather believe that by bringing it as close as possible to realization, we will be able to improve the service of commercial space travel. And we believe that is what is needed. In this paper, we will refer to making yakitori, which has already been certified as space food, even more satisfying, and discuss the necessary technologies, challenges, and solutions for what ASTRAX considers to be a rich meal in space.

2. Introduction of yakitori

Yakitori is a traditional Japanese dish. It is often eaten at izakaya (Japanese style pubs) with alcohol, especially beer. It is made by skewering various parts of chicken (thigh, liver, heart, etc.) cut into bite-sized pieces on bamboo skewers approximately 20 cm long and roasting them directly over a fire until the ingredients are cooked through. The skewers are then seasoned with salt or sweet and spicy sauce during the

roasting process. Yakitori, called negima, is made by alternately piercing bite-sized pieces of chicken thigh and green onion so that there are a total of five or six pieces of each. The combination of the chicken and the green onions is exquisite, making it a very popular menu item.



Fig.1 Yakitori being roasted over a fire

Fig.2 Example of Yakitori



Fig.3.Negima[92]

3. The current status of space food

In the past, many of them were on a liquid diet, sucking on a baggie of food or eating bite-sized solids. This was disapproved of as being like baby food, but it has gradually improved, and now cutlery such as spoons and forks are used even on board spacecraft.

There are hundreds of varieties of space food, not only Western but also Japanese. However, those that are cooked, or cooked with hot water, are scraped out of a pouch (pouch) each time they are eaten, which is a far cry from the elegant meals of staples, soups, and desserts that are beautifully presented on large plates on Earth.

Although the primary purpose of a meal is to obtain necessary nutrients, it is now recognized that there are other meanings to a meal that are different from mere nourishment, such as satisfying the desire of appetite and enriching the mind through eating. As a result, the environment in which meals are consumed on board spacecraft is gradually improving.

4. Current status of yakitori as space food

As of 2023, yakitori is among the space foods approved by Japan's Japan Aerospace Exploration Agency (JAXA). It is a bite-sized piece of chicken that is grilled, seasoned, and packed in a can.



Fig.4. Space Yakitori Can

This almost identical product is also available in Japan.



Fig.5, Canned yakitori that is also certified as space yakitori.

5. Current challenges and improvements

In Japan, yakitori is usually a bite-sized piece of chicken on a skewer, grilled over charcoal, seasoned with sauce or salt, and eaten.

As for the taste of space yakitori described in section 4, it is seasoned as yakitori on Earth and packed in cans, so it provides a fixed taste. However, "grilling" a bite-sized piece of chicken on a skewer, as is done on Earth, is not done in space. This is because there is no tool yet to grill something shaped like a grilled chicken in space.

5.1. Developed coil-type yakitori grill.

Therefore, ASTRAX is considering developing a tool that can grill yakitori in space. An electric heating wire is coiled in the image of a coil winding to create a cavity approximately 5 cm in diameter and 30 cm in length, and a skewer with meat inserted inside, it is heated and grilled. In the coiling process, heat is applied to the entire surface of the grilled chicken from the outside, so that the chicken is evenly heated. Once grilled, the yakitori can be removed from the coil and eaten as is.



Fig.6. Tool image

When yakitori is grilled on Earth, oil falls from the meat and smoke is emitted. Although it is necessary to conduct experiments using a zero gravity airplane to see how the yakitori will behave in a zero gravity environment, once this tool is completed, we will be able to develop technology to grill yakitori on a skewer in space and enjoy its delicious taste.

With this tool, it will be possible to grill not only yakitori but also other foods on skewers in zero gravity. It may also become possible to make cheese fondue, for example.

Incidentally, a special oven for grilling flat meat such as steak has already been installed on the International Space Station, and pre-cooked food as a retort is heated and eaten. By applying the tools for making grilled chicken this time, we think it would be possible not only to heat up steaks but also to enrich the appearance of the dining table by browning them.

5.2. Use a commercial yakitori grill

The opposite concept from Section 5.1 could be used to heat the yakitori skewers by rotating them around a bar-shaped heater.

ASTRAX is focusing on the yakitori grill available on the market in Japan. In a glass-fronted case, three yakitori skewers automatically rotate around a bar-shaped heater to slowly cook the yakitori. Smoke and oil are emitted when yakitori is grilled, but the smoke does not leak outside, and the oil does not contaminate the table because of the oil catch pan. And because of its compact shape, it can be used on a tabletop.



Fig.7. Examples of commercial yakitori grill in spacecraft simulators

We experimented with this yakitori grill using a spacecraft educational training simulator. No oil was emitted, but excess oil fell to the bottom, resulting in delicious yakitori. However, due to gravity, the smoke and oil went upward and the oil fell downward. Since smoke and oil do not go upward and downward, respectively, in a zero-gravity environment, some countermeasure, such as adding a vacuum cleaner-like function to suck up the smoke and oil, is necessary, but we will continue to experiment and verify this issue in the future.

6. Consideration (how to bring abundant food in space)

It may not be necessary to eat all food in the same way as on Earth in order to bring a rich diet in space. However, we can't assume that options are limited because we are in space, for example if we use the example of yakitori, we can season grilled chicken, pack it in a can, and take it to space to eat. We don't want to limit ourselves and say that we cannot grill chicken on a skewer in space and eat it. We will take this as a challenge in creating services that will enrich our lives as human life expands further into space. We believe that by thoroughly pursuing ways of eating, we can move from eating retort-packed food out of bags or cans in space to achieving a richer diet.

In Japan, yakitori and beer are so much a part of the izakaya (Japanese style pub) menu that yakitori is often associated with beer, and beer with yakitori. ASTRAX is also developing a space beer that can be consumed in space. For more information on the development of space beer, please refer to another paper. [74,81]

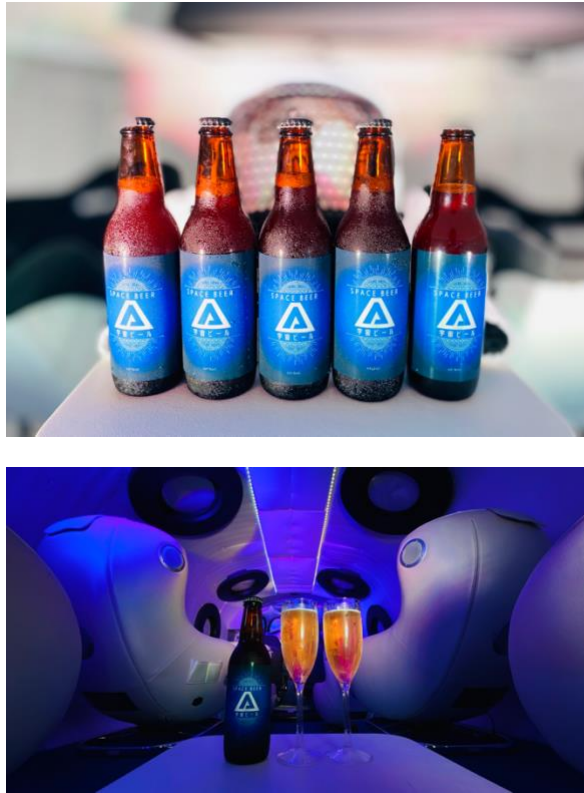


Fig.8. ASTRAX Space Beer

7. Conclusion

In this paper, we have discussed abundant meals in space using yakitori as an example. ASTRAX will continue to develop services to provide rich meals in space.

References

List of references

Reference to a conference/congress paper:

- [1] T. Yamazaki, 民間商業宇宙飛行士と新規宇宙ビジネスの展開について, 3D18, 50th Space Science and Technology Conference, Kita Kyushu, Japan, 2006, 8- 10 November.
- [2] T. Yamazaki, OVERVIEW OF ASTRAX SPACE SERVICES INCLUDING OVER 50 SPACE BUSINESSES, ISDC-2018-Many Roads to Space, International Space Development Conference 2018, Los Angeles, USA, 2018, 24-27 May.
- [3] T. Yamazaki, ASTRAX ZERO GRAVITY FLIGHT SERVICES IN JAPAN, ISDC-2018-Many Roads to Space, International Space Development Conference 2018, Los Angeles, USA, 2018, 24-27 May.
- [4] T. Yamazaki, ASTRAX LUNAR CITY DEVELOPMENT PROJECT, ISDC-2019-Many Roads to Space, International Space Development Conference 2019, Washington D.C., USA, 2019, 5-9 June.
- [5] T. Yamazaki, ASTRAX SPACE SERVICES PLATFORM BY USING BLOCKCHAIN TECHNOLOGY, ISDC-2019-Many Roads to Space, International Space Development Conference 2019, Washington D.C., USA, 2019, 5-9 June.
- [6] Taichi Yamazaki, Buhe Heshige, Yoshihide Nagase, ASTRAX UNIVERSAL SERVICE PLATFORM BY USING BLOCKCHAIN TECHNOLOGY, IAC-19- E6.5-GST.1.6, 70th International Astronautical Congress (IAC), Washington D.C., United States, 2019, 21-25 October.
- [7] Taichi Yamazaki, MISSION CONTROL CENTER TO SUPPORT COMMERCIAL SPACE MISSIONS AND PASSENGER'S ACTIVITIES INSIDE OF THE CABIN, IAC-19-B3.2.3, 70th International Astronautical Congress (IAC), Washington D.C., United States, 2019, 21-25 October.
- [8] Taichi Yamazaki, ASTRAX ACADEMY AND SPACE BUSINESS AND SPACE FLIGHT SUPPORT EDUCATIONAL SYSTEM, Next-Generation Suborbital Researchers Conference (NSRC), Broomfield, CO, United States, 2020, 2-4 March.
- [9] Taichi Yamazaki, MISSION SUPPORT CONTROL CENTER AND SUBORBITAL SPACECRAFT SIMULATOR TO SUPPORT COMMERCIAL SPACE MISSIONS AND CUSTOMER ACTIVITIES, Next-Generation Suborbital Researchers Conference (NSRC), Broomfield, CO, United States, 2020, 2-4 March.
- [10] Taichi Yamazaki, ZEROG-NAUT AND MISSION COMMANDER TO SUPPORT COMMERCIAL SPACE MISSIONS AND CUSTOMER ACTIVITIES INSIDE CABIN, Next-Generation Suborbital Researchers Conference (NSRC), Broomfield, CO, United States, 2020, 2-4 March.
- [11] Taichi Yamazaki, "SPACE SCOOTER": SPACE MOBILITY SYSTEM USED IN SPACE HOTELS AND SPACE STATIONS, IAC-20-B3.7.17, 71st International Astronautical Congress (IAC), The CyberSpace Edition, 2020, 12-14 October.
- [12] Taichi Yamazaki, ASTRAX LUNAR CITY DEVELOPMENT PROJECT 2020, IAC-20-D4.2.11, 71st International Astronautical Congress (IAC), The CyberSpace Edition, 2020, 12-14 October.

- [13] Taichi Yamazaki, ASTRAX LUNAR CITY ECONOMIC SYSTEM BY USING BLOCKCHAIN TECHNOLOGY, IAC-20-E6.2.9, 71st International Astronautical Congress (IAC), The CyberSpace Edition, 2020, 12-14 October.
- [14] Taichi Yamazaki, ASTRAX SPACE SERVICE CATALOG SYSTEM FOR SPACE TOURISM, IAC- 20-B3.2.12, 71st International Astronautical Congress (IAC), The CyberSpace Edition, 2020, 12-14 October.
- [15] Taichi Yamazaki, ASTRAX UNIVERSAL SERVICE PLATFORM BY USING BLOCKCHAIN TECHNOLOGY, IAC-20-D4.1.20, 71st International Astronautical Congress (IAC), The CyberSpace Edition, 2020, 12-14 October.
- [16] Taichi Yamazaki, EXPERIENCE AND LESSONS LEARNED FROM THE COVID-19 PROBLEM IN JAPAN AND APPLICATION TO SPACE TRAVEL, IAC-20-A1.3.15, 71st International Astronautical Congress (IAC), The CyberSpace Edition, 2020, 12-14 October.
- [17] Taichi Yamazaki, ZERO-G-NAUT AND MISSION COMMANDER TO SUPPORT COMMERCIAL SPACE MISSION AND CUSTOMER ACTIVITIES INSIDE CABIN, IAC-20-B3.2.13, 71st International Astronautical Congress (IAC), The CyberSpace Edition, 2020, 12-14 October.
- [18] Chieko Takahashi, Yuko Kirihara, Creating a new business of Space Flight Attendant service & SFA Academy, IAC-20-B3.2.10, 71st International Astronautical Congress (IAC), The CyberSpace Edition, 2020, 12-14 October.
- [19] Taiko Kawakami, Taichi Yamazaki, THE IMPORTANCE OF KIMONO IN SPACE, IAC-20- E1.9.2, 71st International Astronautical Congress (IAC), The CyberSpace Edition, 2020, 12-14 October.
- [20] Taiko Kawakami, Taichi Yamazaki, WHAT WOMEN NEED FOR SPACE TRAVEL, IAC-20- E3.2.9, 71st International Astronautical Congress (IAC), The CyberSpace Edition, 2020, 12-14 October.
- [21] Taichi Yamazaki, Taiko Kawakami, ASTRAX LUNAR CITY DEVELOPMENT PROJECT 2021, IAC-21-D3.1.6, 72nd International Astronautical Congress (IAC), Dubai, United Arab Emirates, 2021, 25-29 October.
- [22] Taichi Yamazaki, COMMERCIAL SPACE MISSION SUPPORT CONTROL CENTER AND SUBORBITAL SPACECRAFT SIMULATOR TO SUPPORT COMMERCIAL SPACE MISSIONS AND PASSENGERS ACTIVITIES IN SPACE, IAC-21-B6.2.12, 72nd International Astronautical Congress (IAC), Dubai, United Arab Emirates, 2021, 25-29 October.
- [23] Taichi Yamazaki, INITIATIVE OF DEVELOPMENT OF THE SOLAR SYSTEM ECONOMIC BLOC BY USING BLOCKCHAIN TECHNOLOGY, IAC-21-D4.1.11, 72nd International Astronautical Congress (IAC), Dubai, United Arab Emirates, 2021, 25-29 October.
- [24] Taichi Yamazaki, Mika Islam, SPACE FASHION AND SPACE CULTURE IN THE AGE OF SPACE TRAVEL AND THE POSSIBILITIES OF "SPACE HAGOROMO", IAC-21-E5.3.6, 72nd International Astronautical Congress (IAC), Dubai, United Arab Emirates, 2021, 25-29 October.
- [25] Taichi Yamazaki, Taiko Kawakami, Keiichi Iwasaki, Akifumi Mimura, MAKING ASTRAX ACADEMY ONLINE AND MULTILINGUAL, IAC-21-E1.7.10, 72nd International Astronautical Congress (IAC), Dubai, United Arab Emirates, 2021, 25-29 October.
- [26] Taichi Yamazaki, POTENTIAL FUTURE PLAN OF SPACE IZAKAYA AS A PLACE TO CREATE NEW PRIVATE SPACE BUSINESS, IAC-21-E1.9.10, 72nd International Astronautical Congress (IAC), Dubai, United Arab Emirates, 2021, 25-29 October.
- [27] Taichi Yamazaki, FOSTERING UNIVERSAL HUMAN RESOURCES AND SUPER NEWTYPES FOR THE SPACE AGE, IAC-21-E1.9.8, 72nd International Astronautical Congress (IAC), Dubai, United Arab Emirates, 2021, 25-29 October.
- [28] Taichi Yamazaki, Shunsuke Chiba, DEMAND AND SUPPLY MATCHING BY THE ASTRAX LUNAR CITY BUSINESS COMMUNITY AND RESIDENCE CLUB, IAC-21-D3.3.3, 72nd International Astronautical Congress (IAC), Dubai, United Arab Emirates, 2021, 25-29 October.
- [29] Taichi Yamazaki, OUTLINE OF ASTRAX PRIVATE SPACE BUSINESS CREATION EDUCATION AND TRAINING CENTER, IAC-21-B3.2.5, 72nd International Astronautical Congress (IAC), Dubai, United Arab Emirates, 2021, 25-29 October.
- [30] Taichi Yamazaki, PROTOTYPE PLANS FOR VARIOUS COMMERCIAL SPACECRAFT TRAINING SIMULATORS, IAC-21-B3.2.2, 72nd International Astronautical Congress (IAC), Dubai, United Arab Emirates, 2021, 25-29 October.
- [31] Taichi Yamazaki, Yuki Yamazaki, EXPERIMENTS ON COLORING SOAP

- BUBBLES UNDER MICROGRAVITY, IAC-21-A2.6.5, 72nd International Astronautical Congress (IAC), Dubai, United Arab Emirates, 2021, 25-29 October.
- [32] Taichi Yamazaki, STUDY OF THE SELECTION OF LOCATION FOR COMMERCIAL SPACEPORTS IN JAPAN, IAC-21-D6.3.8, 72nd International Astronautical Congress (IAC), Dubai, United Arab Emirates, 2021, 25-29 October.
- [33] Taichi Yamazaki, SPACE RADIATION SHIELDING BY WATER DOME IN ASTRAX LUNAR CITY ON THE MOON, IAC-21-A1.5.10, 72nd International Astronautical Congress (IAC), Dubai, United Arab Emirates, 2021, 25-29 October.
- [34] Taichi Yamazaki, Hiroki Nakaegawa, INTRODUCTION OF A PRACTICAL EXAMPLE OF ASTRAX LUNAR CITY MAPPING WITH MINECRAFT AND ITS LINKAGE TO ECONOMIC ACTIVITIES ON EARTH, IAC-21-D4.2.6, 72nd International Astronautical Congress (IAC), Dubai, United Arab Emirates, 2021, 25-29 October.
- [35] Taichi Yamazaki, Hiroki Nakaegawa, DEVELOPMENT OF A CIVILIAN SPACECRAFT INTERIOR SIMULATOR USING MINECRAFT, IAC-21-B6.3.11, 72nd International Astronautical Congress (IAC), Dubai, United Arab Emirates, 2021, 25-29 October.
- [36] Taichi Yamazaki, PROPOSAL TO ADD A SPACE ECONOMICS SUBCOMMITTEE TO THE UN OFFICE FOR OUTER SPACE AFFAIRS' COMMITTEE ON THE PEACEFUL USES OF OUTER SPACE (COPUOS IN UNOOSA), IAC-21-E3.4.7, 72nd International Astronautical Congress (IAC), Dubai, United Arab Emirates, 2021, 25-29 October.
- [37] Ayako Kurono, Haruto Kurono, Taichi Yamazaki, THE GENDER GAP AND ITS IMPACT IN MANGA, ANIME AND OTHER SPACE CREATIONS, IAC-21-E5.3.10, 72nd International Astronautical Congress (IAC), Dubai, United Arab Emirates, 2021, 25-29 October.
- [38] Ayako Kurono, Haruto Kurono, Taichi Yamazaki, CAREER DESIGN IN SPACE - FROM CHALLENGED TO CHALLENGING, IAC-21-B3.9-GTS.2.1, 72nd International Astronautical Congress (IAC), Dubai, United Arab Emirates, 2021, 25-29 October.
- [39] Haruto Kurono, Ayako Kurono, Taichi Yamazaki, THE EFFECTS OF USING MINECRAFT TO TEACH CHILDREN ABOUT SPACE, IAC-21-E1.8.2, 72nd International Astronautical Congress (IAC), Dubai, United Arab Emirates, 2021, 25-29 October.
- [40] Tomoko Imaizumi, Taichi Yamazaki, MAINTAINING THE HEALTH OF PILOTS AND CREW, IAC-21-D6.3.4, 72nd International Astronautical Congress (IAC), Dubai, United Arab Emirates, 2021, 25-29 October.
- [41] Taichi Yamazaki, Mami Oka, CONSIDERATION ON THE CREATION OF A CHICKEN EGG MARKET AT THE MOON VILLAGE, IAC-21-D4.2.10, 72nd International Astronautical Congress (IAC), Dubai, United Arab Emirates, 2021, 25-29 October.
- [42] Chieko Takahashi, Yuko Kiriha, Taichi Yamazaki, CONSIDERATION OF THE FUTURE PROSPECTS OF THE SPACE FLIGHT ATTENDANT(SFA) PROFESSION WITH THE EXPANSION OF SPACE TRAVEL MARKETING, IAC-21-B3.9-GTS.2.10, 72nd International Astronautical Congress (IAC), Dubai, United Arab Emirates, 2021, 25-29 October.
- [43] Taiko Kawakami, Taichi Yamazaki, PROBLEMS AND SOLUTIONS THAT ARE PREVENTING MORE WOMEN FROM BECOMING SPACE TOURISTS, IAC-21-B3.2.3, 72nd International Astronautical Congress (IAC), Dubai, United Arab Emirates, 2021, 25-29 October.
- [44] Hayaki Tsuji, Taichi Yamazaki, Satoshi Takamura, Yoichi Sugiura, PEACE THOUGHT AND SOCIO-ECONOMY FOR THE SPACE AGE USING SATELLITES, IAC-20-E5.5.5, 71st International Astronautical Congress (IAC) – The CyberSpace Edition, 2020, 12-14 October.
- [45] Taichi Yamazaki, ADVANCED SPACE SERVICE ACCESS APPLICATION TOOL: ASTRAX UNIVERSAL USER INTERFACE (U2U), IAC-20-B3.1.11, 71st International Astronautical Congress (IAC) – The CyberSpace Edition, 2020, 12-14 October.
- [46] Taichi Yamazaki, Taiko Kawakami, DEVELOPMENT OF A TERIPPER FOR INTRA-SPACECRAFT TRANSPORTATION, IAC-22-A1.3.17, 73rd International Astronautical Congress (IAC), Paris, France, 2022, 18-22 September.
- [47] Taichi Yamazaki, Taiko Kawakami, POSSIBILITY OF ZERO-GRAVITY FLIGHT SERVICE BY MRJ (MITSUBISHI REGIONAL JET), IAC-22-A2.IPB.1, 73rd International Astronautical Congress (IAC), Paris, France, 2022, 18-22 September.

- [48] Taichi Yamazaki, Taiko Kawakami, DEVELOPMENT OF ASTRAX COMMERCIAL SPACECRAFT EDUCATION AND TRAINING SIMULATOR, IAC-22-B3.IPB.4, 73rd International Astronautical Congress (IAC), Paris, France, 2022, 18-22 September.
- [49] Taichi Yamazaki, Taiko Kawakami, DEVELOPMENT OF SPACE SHOWER, IAC-22-B3.3.5, 73rd International Astronautical Congress (IAC), Paris, France, 2022, 18-22 September.
- [50] Taichi Yamazaki, Taiko Kawakami, PRODUCTION OF SPACE SUITS AND REPLICAS FOR SPACE TRAVEL, IAC-22-B3.9-GTS.2.1, 73rd International Astronautical Congress (IAC), Paris, France, 2022, 18-22 September.
- [51] Taichi Yamazaki, Taiko Kawakami, ADVANCED SPACE SERVICE ACCESS APPLICATION TOOL “ASTRAX UNIVERSAL USER INTERFACE (ASTRAX U2U)”, IAC-22-B5.IPB.7, 73rd International Astronautical Congress (IAC), Paris, France, 2022, 18-22 September.
- [52] Taichi Yamazaki, Taiko Kawakami, ASTRAX SOLAR SYSTEM ECONOMIC BLOC CONCEPT USING NFT AND METAVERSE TECHNOLOGIES, IAC-22-D4.1.10, 73rd International Astronautical Congress (IAC), Paris, France, 2022, 18-22 September.
- [53] Taichi Yamazaki, Taiko Kawakami, DEVELOPMENT OF A REAL-LIFE (ANALOG) ASTRAX LUNAR CITY CONSTRUCTION PROJECT IN JAPAN, IAC-22-D4.2.6, 73rd International Astronautical Congress (IAC), Paris, France, 2022, 18-22 September.
- [54] Taichi Yamazaki, Taiko Kawakami, MULTILINGUALIZATION OF ASTRAX ACADEMY, IAC-22-E1.7.10, 73rd International Astronautical Congress (IAC), Paris, France, 2022, 18-22 September.
- [55] Taichi Yamazaki, Taiko Kawakami, POSSIBILITY OF ZERO-GRAVITY FLIGHT AND SPACE FLIGHT BY PEOPLE WITH DISABILITIES, IAC-22-E1.9.18, 73rd International Astronautical Congress (IAC), Paris, France, 2022, 18-22 September.
- [56] Taichi Yamazaki, Kentaro Chimura, Taiko Kawakami, DEVELOPMENT OF SPACE TOILET "SPACE BENKING" IN JAPAN, IAC-22-E5.IPB.10, 73rd International Astronautical Congress (IAC), Paris, France, 2022, 18-22 September.
- [57] Taichi Yamazaki, Taiko Kawakami, DISASTER PREVENTION AND EVACUATION TECHNOLOGIES ON EARTH AND THEIR APPLICATION TO SPACE TRAVEL, IAC-22-E5.4.9, 73rd International Astronautical Congress (IAC), Paris, France, 2022, 18-22 September.
- [58] Mika Islam, Taichi Yamazaki, CLEANING METHODS FOR REUSING CLOTHES IN SPACE, IAC-22-B3.7.7, 73rd International Astronautical Congress (IAC), Paris, France, 2022, 18-22 September.
- [59] Mika Islam, Taichi Yamazaki, HOW TO GO TO SPACE WITH DIFFERENT HAIRSTYLES, IAC-22-E1.9.7, 73rd International Astronautical Congress (IAC), Paris, France, 2022, 18-22 September.
- [60] Yuko Kiriara, Airi Negisawa, Chieko Takahashi, Taichi Yamazaki, Cocoro Tamura, RESEARCH ON PSYCHOLOGICAL CHANGES AND GROWTH OF CHILDREN THROUGH EDUCATION RELATED TO COMMERCIAL SPACE BUSINESS, IAC-22-E1.IPB.9, 73rd International Astronautical Congress (IAC), Paris, France, 2022, 18-22 September.
- [61] Ayako Kurono, Taichi Yamazaki, WHAT DO THEY NEED FOR A SPACE MUSEUM?, IAC-22-E5.5.8, 73rd International Astronautical Congress (IAC), Paris, France, 2022, 18-22 September.
- [62] Haruto Kurono, Taichi Yamazaki, ESTABLISHMENT AND DEVELOPMENT OF A LUNAR COMMUNITY AND ACTIVITY SPACE BY CHILDREN FOR CHILDREN, IAC-22-D4.2.10, 73rd International Astronautical Congress (IAC), Paris, France, 2022, 18-22 September.
- [63] Akifumi Mimura, Taichi Yamazaki, VIDEO EDITING SERVICES FOR SPACE TRAVELLERS, IAC-22-B3.2.6, 73rd International Astronautical Congress (IAC), Paris, France, 2022, 18-22 September.
- [64] Akifumi Mimura, Taichi Yamazaki, TECHNOLOGIES ON A TRANSPARENT RESTROOM COULD BE USED FOR LUNAR HABITATS, IAC-22-E5.1.8, 73rd International Astronautical Congress (IAC), Paris, France, 2022, 18-22 September.
- [65] Taiko Kawakami, Taichi Yamazaki, ASTRAX LUNAR CITY PROJECT 2022, IAC-22-D3.1.12, 73rd International Astronautical Congress (IAC), Paris, France, 2022, 18-22 September.

- [66] Chikako Murayama, Taichi Yamazaki, THE NEED FOR A SPACE VERSION OF HAND SIGNALS, A COMMUNICATION TOOL FOR SPACE TRAVELERS, IAC-22-B3.2.1, 73rd International Astronautical Congress (IAC), Paris, France, 2022, 18-22 September.
- [67] Chikako Murayama, Taichi Yamazaki, Taiko Kawakami, PHOTOGRAPHY SERVICES AND TECHNIQUES REQUIRED FOR SPACE TRAVEL, IAC-22-D6.1.8, 73rd International Astronautical Congress (IAC), Paris, France, 2022, 18-22 September.
- [68] Chikako Murayama, Taichi Yamazaki, ON IMAGES OF THE UNIVERSE INFLUENCED BY MANGA AND ANIME, IAC-22-E1.9.3, 73rd International Astronautical Congress (IAC), Paris, France, 2022, 18-22 September.
- [69] Hikaru Otsuka, Taichi Yamazaki, A SPACE EDUCATION PROGRAM TO SOLVE THE SHORTAGE OF COMMERCIAL SPACE TEACHERS IN JAPANESE SCHOOLS, IAC-22-E1.7.8, 73rd International Astronautical Congress (IAC), Paris, France, 2022, 18-22 September.
- [70] Yasuko Fukushima, Taichi Yamazaki, HOW TO CAPTURE THE COSMIC DIVERSITY THAT IS COMING, IAC-22-E1.9.22, 73rd International Astronautical Congress (IAC), Paris, France, 2022, 18-22 September.
- [71] Chieko Takahashi, Taichi Yamazaki, THE ROLE OF SPACE FLIGHT ATTENDANTS IN LARGE, LONG-DURATION SPACE TRAVEL, IAC-22-B3.2.10, 73rd International Astronautical Congress (IAC), Paris, France, 2022, 18-22 September.
- [72] Kiyomi Shigematsu, Taichi Yamazaki, PROPOSAL FOR A BUSINESS MODEL THAT ENABLES AND ENCOURAGES OLDER ADULTS TO TRAVEL TO SPACE, IAC-22-E5.IP.22, 73rd International Astronautical Congress (IAC), Paris, France, 2022, 18-22 September.
- [73] Taichi Yamazaki, Taiko Kawakami, Fumihiko Oiwa, DEVELOPMENT OF ASTRAX ZERO GRAVITY AIRCRAFT EDUCATION AND TRAINING SIMULATOR, IAC-23-A2.5.9, 74th International Astronautical Congress (IAC), Baku, Azerbaijan, 2023, 2-6 October.
- [74] Taichi Yamazaki, Taiko Kawakami, DEVELOPING TECHNOLOGY FOR DRINKING CHILLED CARBONATED BEVERAGES IN SPACE, IAC-23-B5.1.11, 74th International Astronautical Congress (IAC), Baku, Azerbaijan, 2023, 2-6 October."
- [75] Taichi Yamazaki, Taiko Kawakami, Hiroki Nakaegawa, DEVELOPMENT OF COMMERCIAL SPACECRAFT EDUCATION AND TRAINING SIMULATOR USING THE METAVERSE, IAC-23-D1.1.6, 74th International Astronautical Congress (IAC), Baku, Azerbaijan, 2023, 2-6 October.
- [76] Taichi Yamazaki, Taiko Kawakami, CONSTRUCTION PLAN OF ASTRAX LUNAR CITY SIMULATION FACILITY IN JAPAN, IAC-23-D4.2.9, 74th International Astronautical Congress (IAC), Baku, Azerbaijan, 2023, 2-6 October.
- [77] Taichi Yamazaki, Taiko Kawakami, Kentaro Chimura, DEVELOPMENT OF THE SPACE TOILET CALLED "SPACE BENKING" 2023, IAC-23-E5.4.3, 74th International Astronautical Congress (IAC), Baku, Azerbaijan, 2023, 2-6 October.
- [78] Taichi Yamazaki, Taiko Kawakami, INTRODUCTION OF COMMERCIAL SPACE R&D CENTER "ASTRAX LAB" IN JAPAN, IAC-23-B3.IPB.5, 74th International Astronautical Congress (IAC), Baku, Azerbaijan, 2023, 2-6 October.
- [79] Taichi Yamazaki, Taiko Kawakami, ANALYSIS OF PASSENGERS' NEEDS AND DEMANDS OF ASTRAX ZERO GRAVITY SERVICES AND APPLICATION FOR SPACE TRAVEL SERVICES, IAC-23-B3.IP.1, 74th International Astronautical Congress (IAC), Baku, Azerbaijan, 2023, 2-6 October.
- [80] Taiko Kawakami, Taichi Yamazaki, THE SENSES AND CREATIVITY THAT CAN BE ACHIEVED BY BRINGING ENTERTAINMENT IN SPACE, IAC-23-E1.IP.22, 74th International Astronautical Congress (IAC), Baku, Azerbaijan, 2023, 2-6 October.
- [81] Taiko Kawakami, Taichi Yamazaki, TECHNOLOGY, PROBLEMS AND SOLUTIONS FOR DRINKING ALCOHOL IN SPACE, IAC-23-E1.9.2, 74th International Astronautical Congress (IAC), Baku, Azerbaijan, 2023, 2-6 October.
- [82] Taiko Kawakami, Taichi Yamazaki, TECHNOLOGY, PROBLEMS, AND SOLUTIONS FOR SPACE TRAVEL MEALS AS REPRESENTED BY "YAKITORI", GRILLED CHICKEN, IAC-23-B5.IP.2, 74th International Astronautical Congress (IAC), Baku, Azerbaijan, 2023, 2-6 October."
- [83] Taiko Kawakami, Taichi Yamazaki, THE POSSIBILITY OF DEVELOPING JAPANESE CULTURE THROUGH "NATTO" IN SPACE, IAC-23-E5.IP.17, 74th International Astronautical Congress (IAC), Baku, Azerbaijan, 2023, 2-6 October.

- [84] Hikaru Otsuka, Taichi Yamazaki, LOCAL REVITALIZATION PROJECT TO TURN MY HOMETOWN, KOMONO TOWN, INTO "SPACE TOWN", IAC-23-E1.9.3, 74th International Astronautical Congress (IAC), Baku, Azerbaijan, 2023, 2-6 October.
- [85] Hikaru Otsuka, Taichi Yamazaki, METHODS AND PRACTICES FOR INTRODUCING PRIVATE SPACE EDUCATION PROGRAMS INTO JAPANESE SCHOOLS, IAC-23-E1.2.8, 74th International Astronautical Congress (IAC), Baku, Azerbaijan, 2023, 2-6 October.
- [86] Masahiko Takehara, Taichi Yamazaki, DEVELOPMENT OF A "LUNAR PATTERN OKONOMIYAKI" BAKING METHOD TO HELP PROMOTE TOURISM IN A LUNAR CITY, IAC-23-D4.LBA.1, 74th International Astronautical Congress (IAC), Baku, Azerbaijan, 2023, 2-6 October.
- [87] Masahiko Takehara, Taichi Yamazaki, SPACE EDUCATION AND NUTRITION EDUCATION USING "SOLAR PLANET TAKOYAKI, IAC-23-E1.LBA.3, 74th International Astronautical Congress (IAC), Baku, Azerbaijan, 2023, 2-6 October.
- [88] Masahiko Takehara, Taichi Yamazaki, APPLICATION OF ACTIVITIES ON LUXURY CRUISE SHIPS TO SPACE TOURISM VESSELS, IAC-23-B3.IPB.6, 74th International Astronautical Congress (IAC), Baku, Azerbaijan, 2023, 2-6 October.
- [89] Masahiko Takehara, Taichi Yamazaki, ASTROLOGY IN THE SPACE AGE: WHAT WILL HAPPEN TO THE HOROSCOPES OF THOSE BORN ON THE MOON?, IAC-23-E1.9.8, 74th International Astronautical Congress (IAC), Baku, Azerbaijan, 2023, 2-6 October.
- [90] Ayako Kurono, Taichi Yamazaki, Haruto Kurono, EXPLORING THE CONCEPT AND POTENTIAL OF SPACE MUSEUMS FOR PRESERVATION, EDUCATION, AND TOURISM, IAC-23-E5.5.2, 74th International Astronautical Congress (IAC), Baku, Azerbaijan, 2023, 2-6 October.
- [91] Haruto Kurono, Hikaru Otsuka, Taichi Yamazaki, Ayako Kurono, BUILDING A LUNAR COMMUNITY FOR CHILDREN: CHALLENGES OF COOPERATION AND SIMULATING TEAM BUILDING, IAC-23-D4.2.7, 74th International Astronautical Congress (IAC), Baku, Azerbaijan, 2023, 2-6 October.
- [92] ねぎまの「ま」は「間」じゃない!? なんと元は串料理ですらなかった/毎日雑学 (3.Jan.2021).
<https://ddnavi.com/serial/679049/a/> (accessed 09.17.2023).
- [93] プレスリリース「やきとり缶詰」が「宇宙食」になりました！2020年初頭に期間限定パッケージを全国販売！（15. Nov. 2019）
<https://prtimes.jp/main/html/rd/p/000000001.000051434.html>. (accessed 09.17.2023).

Technology, Problems, and Solutions for Space Travel Meals as Represented by "Yakitori", Grilled Chicken

焼き鳥に代表される宇宙旅行での食事に必要な技術と問題点および解決方法

Taiko Kawakami^{a,*}, Taichi Yamazaki^b

^a General Manager, ASTRAX, Inc., 1-1-4-301 Mukogaoka, Bunkyo, Tokyo, Japan 113-0023,
taiko.kawakami@astrax.space

^b CEO and commercial astronaut, International Space Services, Inc. and ASTRAX, Inc., 2-23-17 Komachi,
Kamakura, Kanagawa, Japan 248-0006, taichi.yamazaki@astrax.space

* Corresponding Author

アブストラクト

「焼き鳥」をご存知ですか？一口大の鶏肉を数個串に刺し、甘辛いタレや塩に絡めて焼いた日本料理です。日本の居酒屋ではビールを飲みながら焼き鳥を食べるのが人気です。実は焼き鳥はすでに宇宙食の一つとして、日本人宇宙飛行士によって国際宇宙ステーションなどで食べられています。ただ、その形状は数個の一口代の鶏肉を串に刺したものではなく、串から外された焼き鳥が缶詰に入ったものです。今後宇宙旅行時代が本格化し、多くの人々が宇宙旅行に行きます。そうすると次第に、宇宙に行くだけでなく、宇宙空間で自分が好きなものを食べたり飲んだりしたい、というニーズも高まってくることが容易に予想されます。焼き鳥は串刺しのもの、という形状にもこだわることになっていくでしょう。本論文では、串刺しの焼き鳥を宇宙空間で食べることを一例に挙げ、宇宙空間での豊かな食事について必要な技術や問題点、その解決方法を考察していきます。

キーワード: 宇宙旅行、焼き鳥、宇宙食、ASTRAX

1. イントロダクション

自分の食べたいものを美味しく、見た目も良く盛り付けして、仲間と食卓を囲みながら。地球上では当然のことを宇宙空間で実現するのは難しいことです。ただ、ASTRAXでは、それを無理と決めつけるのではなく、少しでも実現に近づけていくことで、民間宇宙旅行のサービスの向上につながっていくと考えています。そしてそれが必要なことだと考えています。本論文では、既に宇宙食として認定されている焼き鳥を、さらに満足度高く食べられるようにすることに言及し、ASTRAXが考える宇宙空間での豊かな食事について必要な技術や問題点、解決方法を考察していきます。

2. 焼き鳥の紹介

焼き鳥は日本で昔からあるメニューです。居酒屋でお酒、特にビールと一緒に食べることが多

いです。およそ20cmの竹串に一口大に切ったいろいろな部位の鶏肉（モモ肉、レバー、心臓など）を刺して、材料に火が通るまで直接火で炙って作ります。火で炙っている途中で塩や甘辛いタレで味付けをします。ネギマ、と呼ばれる焼き鳥はそれぞれ一口大の鶏肉のもも肉とネギを合計5,6個になるように交互に刺して作ります。ネギと鶏肉が絶妙でとても人気のメニューです。



図1, 火で炙って焼き鳥を焼いているところ



図2. 焼き鳥の例



図3. ねぎま[92]

3. 宇宙食の現状

昔は流動食のようなものが多く、袋状に入ったものを吸ったり一口サイズの固形物を食べたりしていました。離乳食のようだ、と不評だったのですが、だんだんと改善され、今ではスプーンやフォークなどのカトラリーを使うまでになりました。種類も数百種類にのぼり、洋食だけではなく和食もあります。ただ、調理されているもの、お湯を入れて調理をするものは、袋（パウチ）からその都度掻き出して食べるため、地球上で大きなお皿に美しく盛られた主食やスープ、デザートなどの優雅な食事とはかけ離れています。

食事の第一の目的は必要な栄養素を摂取することではありますが、それ以外にも食欲という欲求を満たすことや、食事によって心が豊かになるなど、ただの栄養補給とは違う目的や役割もあることが認識されてきました。それによって、宇宙船の中で食事を摂る環境も徐々に改善

されてきています。

4. 宇宙食としての焼き鳥の現状

2023年現在、日本の宇宙航空研究開発機構（JAXA）が認定している宇宙食の中には、焼き鳥も存在しています。一口大の鶏肉を焼いて味付けしたまま缶詰に詰めたものです。



図4. 宇宙焼き鳥缶

これはほぼ同じものが日本国内でも一般的に販売されています。



図5. 宇宙焼き鳥にも認定されている焼き鳥缶

5. 現状の問題点と改善点

日本では、通常串に一口大の鶏肉を炭火で焼いてタレや塩で味付けをして食するものを「焼き鳥」と呼んでいます。

味については、地球上で味付けしたものを缶詰に詰めているので、決まった美味しさが提供されています。ただ、地上で行うように、一口大の鶏肉を串に刺した状態で「焼く」ことを宇宙で行うのは難しいです。なぜなら、まだ、宇

宙で焼くための道具が存在しません。

そこで、焼き鳥を宇宙空間でも焼ける道具の開発を考えています。

5.1 コイル型焼き鳥焼き器を開発

直径約5cm長さ約30cmの空洞ができるようにコイル巻きでイメージで電熱線を巻き、肉を刺した状態の串をその内側に入れ、熱を加えて焼いていきます。コイル巻きの中では、熱は焼き鳥の外側から全面に加わるため、焼き鳥に均等に熱が入ります。焼き上がったら、コイルから取り出せばそのまま食べられます。



図6. コイルイメージ

地球上で焼き鳥を焼くと肉から油が落ちたり、煙が出たりします。無重力状態でどのような動きをするかは、無重力飛行機などを使って実験をする必要がありますが、串についた焼き鳥を焼いて美味しく食べられる技術が開発できることになります。

この技術は、無重力状態で串についたものを焼くことができるようになります。チーズフォンデュなどもできるようになるかもしれません。

一方、既にステーキなどの平たいお肉を焼くための専用のオーブンは国際宇宙ステーションにも設置されていて、レトルトとしてあらかじめ調理されているものを温めて食べています。今回の焼き鳥を作る道具を応用することで、ステーキを温めるだけではなく、焼き色をつけることで食卓を見た目から豊かにすることができるのではないかと考えています。

5.2. 市販の焼き鳥焼き器を利用

5.1とは逆の発想で、棒状のヒーターの周りを焼き鳥の串を回転させ、加熱していく方法も使えそうです。

ASTRAXは、日本で市販されている焼き鳥焼き器に注目しています。ガラス張りのケースの中で、棒状のヒーターの周りを3本の焼き鳥の串が自動で回転し、じっくりと焼き鳥を焼いていくものです。焼き鳥を焼くときは、煙と油が出ますが、煙は外に漏れないようになっており、油は油受け皿があって、テーブルを汚すことはありません。そしてコンパクトな形状なので、卓上に置いて使うことができます。

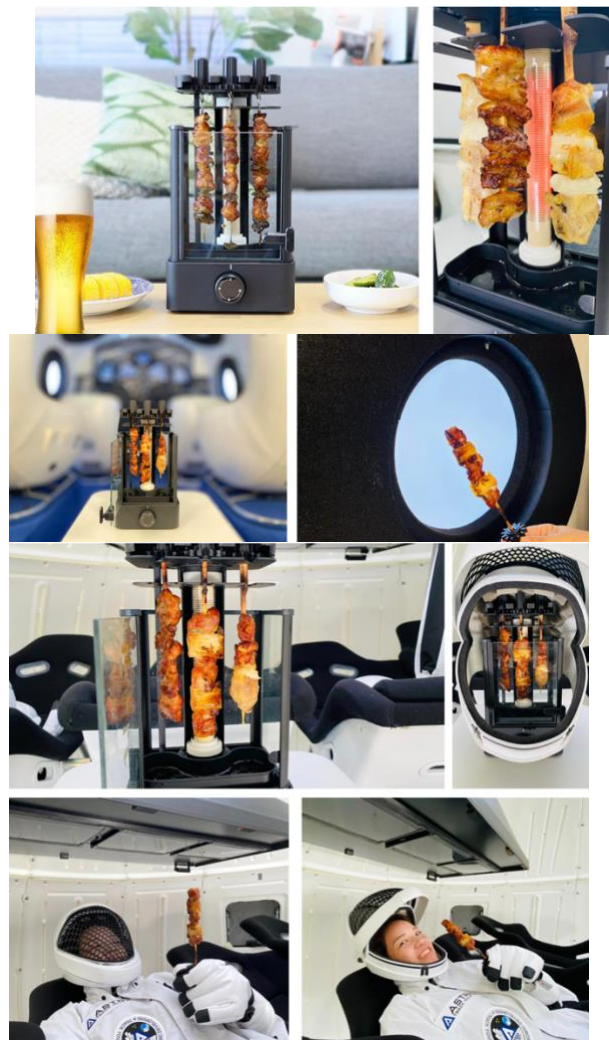


図7. 宇宙船シミュレーターでの市販の焼き鳥焼き器使用例

宇宙船教育訓練シミュレーターを使って、この焼き鳥焼き器の実験を行いました。油は出ずに、余分な油が下に落ち、美味しい焼き鳥を作ることができました。ただ、煙や油は重力によ

って、煙は上に向かい、油は下に落ちました。無重力になった時に、煙と油がそれぞれ上と下にいくことはないの、掃除機のように吸い上げる機能を付けるなど、なんらかの対策が必要ですが、今後継続して実験・検証していきます。

6. 考察（宇宙空間での豊かな食事をもたらすには）

宇宙空間での豊かな食事をもたらすために、全ての食べ物を地上と同じように食べる必要はないかもしれません。ただ、宇宙空間だからこのようにしかできない、焼き鳥の例で言えば、焼いた鶏を味付けして缶に詰めて宇宙に持って行って食べることはできるけれど、串に刺した状態の鶏肉を宇宙空間で焼いて食べるのはできない、と決めつけて挑戦しないのは、これからさらに人類の生活が宇宙にまで広がっていく時に、生活を豊かにするサービスを作り出す障壁になってしまいます。食べ方を徹底的に追究することによって、宇宙空間でもレトルト食品を袋や缶から食べる、というようなところから、より豊かな食事を実現できると考えています。

また、日本では、焼き鳥といえばビール、ビールといえば焼き鳥、というくらい焼き鳥とビールは居酒屋では、一緒に食する定番メニューになっています。ASTRAXでは、宇宙でも同様に焼き鳥を食べながらビールを飲むために、焼き鳥の研究をするとともに、宇宙で飲める宇宙ビールを開発しています。宇宙ビールの開発についての詳細は別の論文を参照ください。
[74,81]



図8. ASTRAX宇宙ビール

7. 結論

本論文では、焼き鳥を例に挙げて宇宙空間での豊かな食事について考察してきました。ASTRAXでは、引き続き宇宙空間での豊かな食事についてのサービスを提供できるようサービス開発を進めていきます。

References

参考文献

- 【1】 民間商業宇宙飛行士と新規宇宙ビジネスの展開について
- 【2】 Overview Of ASTRAX Space Services Including Over 50 Space Businesses, 50以上の宇宙事業を含むASTRAXの宇宙事業の概要
- 【3】 ASTRAX Zero Gravity Flight Services In Japan, 日本におけるASTRAX無重力飛行サービス
- 【4】 ASTRAX Lunar City Development Project, ASTRAX月面都市開発プロジェクト
- 【5】 ASTRAX Space Services Platform By Using Blockchain Technology, ブロックチェーン技術を活用したアストラックス宇宙サービスプラットフォーム
- 【6】 ASTRAX Universal Service Platform By Using Blockchain Technology, ブロックチェーン技術を活用したASTRAXのユニバーサルサービスプラットフォーム
- 【7】 Mission Control Center To Support

Commercial Space Missions And Passenger'S
Activities Inside Of The Cabin,
商業宇宙ミッションと乗客の機内活動を支援す
るミッションコントロールセンター

【8】 ASTRAX Academy And Space Business And
Space Flight Support Educational System,
ASTRAX ACADEMYと宇宙ビジネス・宇宙飛行
支援教育システム

【9】 Mission Support Control Center And
Suborbital Spacecraft Simulator To Support
Commercial Space Missions And Customer
Activities,
商業宇宙ミッションと顧客活動を支援するミッ
ション支援管制センターとサブオービタル宇宙
船シミュレータ

【10】 Zero G-Naut And Mission Commander To
Support Commercial Space Missions And Customer
Activities Inside Cabin,
Zero G-Nautと商業宇宙ミッションと顧客活動を
支援するミッションコマンダー（船内）

【11】 “Space Scooter”: Space Mobility System
Used In Space Hotels And Space Stations,
「スペーススクーター」宇宙ホテルや宇宙ステ
ーションで使用される宇宙移動システム

【12】 ASTRAX Lunar City Development Project
2020,
ASTRAX月面都市開発プロジェクト 2020

【13】 ASTRAX Lunar City Economic System By
Using Blockchain Technology,
ブロックチェーン技術を活用したASTRAX月面
都市経済システム

【14】 ASTRAX Space Service Catalog System For
Space Tourism,
宇宙旅行のためのASTRAX宇宙サービスカタロ
グシステム

【15】 ASTRAX Universal Service Platform By
Using Blockchain Technology,
ブロックチェーン技術を活用したASTRAXユニ
バーサルサービスプラットフォーム

【16】 Experience And Lessons Leaned From The

Covid-19 Problem In Japan And Application To
Space Travel,
日本のCOVID-19問題から得た経験と教訓、そし
て宇宙旅行への適用

【17】 Zero-G-Naut And Mission Commander To
Support Commercial Space Mission And Customer
Activities Inside Cabin,
ゼロG飛行士とミッションコマンダーが、商業宇
宙ミッションと顧客活動を機内でサポートする

【18】 Creating A New Business Of Space Flight
Attendant Service & SFA Academy,
スペースフライトアテンダントとSFAアカデミ
ーという新しいビジネスの創出

【19】 The Importance Of Kimono In Space, 宇宙で
の着物の重要性

【20】 What Women Need For Space Travel,
女性が宇宙へ行くために必要なこと

【21】 ASTRAX Lunar City Development Project
2021
ASTRAX月面シティ開拓プロジェクト2021

【22】 Commercial Space Mission Support Control
Center and Suborbital Spacecraft Simulator to
Support Commercial Space Missions and Passengers
Activities in Space
商業宇宙ミッションと宇宙での搭乗者の活動を
サポートするための商業宇宙運用支援管制セン
ターとサブオービタル宇宙船シミュレーター

【23】 Initiative of development of the Solar System
Economic Bloc by Using Blockchain Technology
ブロックチェーン技術を活用した太陽系経済圏
構築構想

【24】 Space Fashion and Space Culture in the Age
of Space Travel and the Possibilities of “Space
Hagoromo”
宇宙旅行時代の宇宙ファッションと宇宙カルチ
ャー及び“宇宙羽衣”の可能性

【25】 Making ASTRAX ACADEMY Online and
Multilingual
「ASTRAX ACADEMY」のオンライン化と多言
語化

【26】 Potential Future Plan of Space Izakaya as a Place to Create New Private Space Business
新たな民間宇宙ビジネス創出の場としての宇宙居酒屋の将来性

【27】 Fostering Universal Human Resources and Super Newtypes for the Space Age
ユニバーサル人材の育成と宇宙時代のスーパーニュータイプの養成

【28】 Demand and Supply Matching by the ASTRAX LUNAR CITY Business Community and Residence Club
ASTRAX月面シティのビジネスコミュニティとレジデンスクラブによる需要と供給のマッチング

【29】 Outline of ASTRAX Private Space Business Creation Education and Training Center
ASTRAX民間宇宙事業創出教育訓練センターの概要

【30】 Prototype plans for various commercial spacecraft training simulators
さまざまな民間商用宇宙船訓練用シミュレータの試作計画

【31】 Experiments on Coloring Soap Bubbles under Microgravity
微小重力下でのシャボン玉の着色に関する実験

【32】 Study of the selection of location for commercial spaceports in Japan
日本における商業宇宙港の立地選定に関する研究

【33】 Space Radiation Shielding by Water Dome in ASTRAX Lunar City on the Moon
ASTRAX月面シティのウォータードームによる宇宙放射線の遮蔽

【34】 Introduction of a practical example of ASTRAX Lunar City mapping with Minecraft and its linkage to Economic Activities on Earth
マインクラフトを使ったASTRAX月面シティのマッピングの実践例と地球上の経済活動との連携の紹介

【35】 Development of a Civilian Spacecraft Interior Simulator Using Minecraft
マインクラフトを用いた民間宇宙船内部シミュレーターの開発

【36】 Proposal to Add a Space Economics Subcommittee to the UN Office for Outer Space Affairs' Committee on the Peaceful Uses of Outer Space(COPUOS in UNOOSA)
国連宇宙局の「宇宙空間の平和利用に関する委員会」(COPUOS in UNOOSA)に「宇宙経済小委員会」を追加する提案

【37】 The Gender Gap and Its Impact in Manga, Anime and Other Space Creations
マンガ・アニメなどの空間演出におけるジェンダー・ギャップとその影響

【38】 Career Design in Space - From Challenged to Challenging
宇宙でのキャリアデザイン - 挑戦者から挑戦者へ

【39】 The Effects of Using Minecraft to Teach Children about Space
マインクラフトを使って子どもたちに宇宙を教える効果

【40】 Maintaining the Health of Pilots and Crew
パイロットとクルーの健康維持

【41】 Consideration on the Creation of a Chicken Egg Market at the Moon Village
月面ビレッジでの鶏卵市場の創設についての検討

【42】 Consideration of the future prospects of the Space Flight Attendant (SFA) profession with the expansion of space travel marketing
宇宙旅行マーケティングの拡大に伴うスペースフライトアテンダント (SFA) という職業の将来性についての考察

【43】 Problems and Solutions that are Preventing More Women from Becoming Space Tourists
宇宙旅行者になる一般女性を増やすことを妨げている問題点と解決方法

【44】 人工衛星を使用した宇宙時代の平和思考

と社会経済学（ワンスマイルファンデーションシステム）

【45】 最新型宇宙サービスアクセスアプリケーションツール「ASTRAX U2U (Universal User Interface)」

【46】 Development of a Teripper for intra-spacecraft transportation,
宇宙船内移動用テリッパの開発

【47】 Possibility of Zero-Gravity Flight Service by MRJ (Mitsubishi Regional Jet),
MRJによる無重力飛行サービスの可能性

【48】 Development of ASTRAX commercial spacecraft education and training simulator,
ASTRAX民間宇宙船教育訓練シミュレーターの開発

【49】 Development of Space Shower,
宇宙シャワーの開発

【50】 Production of space suits and replicas for space travel,
宇宙旅行のための宇宙服とレプリカの製作

【51】 ADVANCED SPACE SERVICE ACCESS APPLICATION TOOL ”ASTRAX UNIVERSAL USER INTERFACE (ASTRAX U2U)”,
先進の宇宙サービス利用アプリケーションツール「ASTRAX Universal User Interface (ASTRAX U2U)」

【52】 ASTRAX Solar System Economic Bloc Concept using NFT and Metaverse Technologies,
NFTとメタバース技術によるASTRAX太陽系経済圏構想

【53】 Development of a Real-life (Analog) ASTRAX Lunar City Construction Project in Japan,
日本におけるリアル（アナログ）ASTRAX月面シティ構築計画

【54】 Multilingualization of ASTRAX ACADEMY,
ASTRAX ACADEMYの多言語化

【55】 Possibility of zero-gravity flight and space flight by people with disabilities,

障がい者による無重力飛行と宇宙飛行における可能性

【56】 Development of Space Toilet "Space BENKING" in Japan,
宇宙用トイレ「宇宙ベンキング」の開発

【57】 Disaster prevention and evacuation technologies on Earth and their application to space travel,
地球上の防災・避難生活技術と宇宙旅行への応用

【58】 Cleaning Methods for Reusing Clothes in Space,
宇宙で衣類を再利用するための洗浄方法

【59】 How to Go to Space with Different Hairstyles,
さまざまなヘアスタイルで宇宙へ行く方法

【60】 Research on Psychological Changes and Growth of Children through Education Related to Commercial Space Business,
商業宇宙事業に関連した教育による子どもの心理的变化・成長に関する研究

【61】 What do they need for a space museum?,
宇宙ミュージアムに必要なものは？

【62】 Establishment and development of a lunar community and activity space by children for children,
子どもによる子どものための月面コミュニティ・活動空間の構築と発展

【63】 video editing services for space travellers,
宇宙旅行者のためのビデオ編集サービス

【64】 technologies on a transparent restroom could be used for lunar habitats,
透明なトイレの技術は、月面基地にも応用できる

【65】 ASTRAX Lunar City Project 2022,
ASTRAX月面シティプロジェクト2022

【66】 The need for a space version of hand signals, a communication tool for space travelers,
宇宙旅行者のコミュニケーションツール、宇宙

版ハンドシグナルの必要性

【67】 Photography services and techniques required for space travel,

宇宙旅行に必要な写真撮影サービス・技術

【68】 On images of the universe influenced by manga and anime,
マンガやアニメの影響を受けた宇宙像について

【69】 A space education program to solve the shortage of commercial space teachers in Japanese schools,
日本の学校における民間宇宙講師不足を解消するための宇宙教育プログラム

【70】 How to capture the cosmic diversity that is coming,
これからやってくる宇宙の多様性をどう捉えるか

【71】 The Role of Space Flight Attendants in Large, Long-duration Space Travel,
大規模・長期間の宇宙旅行におけるスペースフライトアテンダントの役割

【72】 Proposal for a business model that enables and encourages older adults to travel to space,
高齢者の宇宙旅行を実現・促進するビジネスモデルの提案

【73】 Development of ASTRAX Zero Gravity Aircraft Education and Training Simulator
ASTRAX無重力飛行機教育訓練シミュレーターの開発

【74】 Developing technology for drinking chilled carbonated beverages in space
宇宙で炭酸飲料を飲むための技術開発

【75】 Development of commercial spacecraft education and training simulator using the Metaverse
メタバースを利用した民間宇宙船教育訓練シミュレーターの開発

【76】 Construction plan of ASTRAX LUNAR CITY Simulation Facility in Japan
日本における

ASTRAX月面シティシミュレーション施設の構築計画

【77】 Development of the space toilet called "Space Benking" 2023

宇宙用トイレ「宇宙ベンキング」の開発2023

【78】 Introduction of commercial space R&D center "ASTRAX LAB" in Japan
日本における民間宇宙開発センター「ASTRAX LAB (アストラックスラボ)」の紹介

【79】 Analysis of passengers' needs and demands of ASTRAX Zero Gravity Services and application for space travel services
無重力飛行サービスに対する乗客のニーズ・要望の分析と宇宙旅行サービスへの応用

【80】 The senses and creativity that can be achieved by bringing entertainment in space
宇宙空間でエンターテインメントを実現することで得られる感覚と創造性

【81】 Technology, problems and solutions for drinking alcohol in space
宇宙空間でお酒を飲む際に必要な技術と問題点および解決方法

【82】 Technology, problems, and solutions for space travel meals as represented by "yakitori", grilled chicken
焼き鳥に代表される宇宙旅行での食事に必要な技術と問題点および解決方法

【83】 The Possibility of Developing Japanese Culture through "NATTO" in Space
宇宙空間における納豆を通じた日本文化の展開の可能性

【84】 Local revitalization project to turn my hometown, Komono Town, into "space town"
故郷の菰野町を「宇宙の町」にする地方活性化プロジェクト

【85】 Methods and Practices for Introducing Private

Space Education Programs into Japanese Schools
民間宇宙教育プログラムを日本の学校現場に導
入する方法と実践

【86】 Development of a "lunar pattern
okonomiyaki" baking method to help promote
tourism in a lunar city
月面シェイの観光振興に貢献する「月面模様お
好み焼き」の焼き方開発

【87】 Space Education and Nutrition Education
Using "Solar Planet Takoyaki"
「太陽系惑星たこ焼き」を利用した宇宙教育と
食育

【88】 Application of activities on luxury cruise ships
to space tourism vessels
豪華客船内アクティビティの宇宙観光船への応
用

【89】 Astrology in the Space Age: What will happen
to the horoscopes of those born on the Moon?
宇宙時代における占星術 月生まれの人のホロス
コープはどうなるの？

【90】 Exploring the Concept and Potential of Space
Museums for Preservation, Education, and Tourism
保存・教育・観光のための宇宙ミュージアムの
コンセプトと可能性を探る

【91】 Building a Lunar Community for Children:
Challenges of Cooperation and Simulating Team
Building 子どものための月面コミュニティづく
り：協力への挑戦とチームビルディングの模擬
体験

【92】 ねぎまの「ま」は「間」じゃない!? なん
と元は串料理ですらなかった/毎日雑学
(3.Jan.2021).

<https://ddnavi.com/serial/679049/a/> (accessed
09.17.2023).

【93】 プレスリリース「やきとり缶詰」が「宇
宙食」になりました！2020年初頭に期間限定パ
ッケージを全国販売！（15. Nov. 2019）
[https://prtimes.jp/main/html/rd/p/000000001.0000
51434.html](https://prtimes.jp/main/html/rd/p/000000001.000051434.html). (accessed 09.17.2023).