

ARTSAT: Chronological Plots

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1 ARTSAT Project

ARTSAT: The Art and Satellite Project is an interdisciplinary initiative based on collaboration between Tama Art University and the University of Tokyo. Involving more than eighty students, researchers, and artists from diverse fields, as well as amateur radio operators, the project reached its most fruitful phase in 2014.

In February of that year, the first art satellite, *INVADER*, was launched aboard the H-IIA Launch Vehicle No. 23. In December, the Deep Space Sculpture *DESPATCH* was deployed onto an Earth-escape trajectory as a piggyback payload with JAXA's asteroid explorer Hayabusa2. Between these two milestones, a piggyback stratospheric balloon experiment was conducted in August at JAXA's Taiki Aerospace Research Field, utilizing the mission onboard computer *MORIKAWA*, which was installed on both spacecraft. Owing to the sustained efforts of the project members, all missions achieved what was described as "extra success," surpassing their originally anticipated objectives.

From June to August 2014, the Museum of Contemporary Art Tokyo hosted the exhibition *Mission [Space $\times$ Art] – Beyond Cosmologies*, which featured the media installation *ARTSAT: On-Orbit*. This work incorporated real operational data transmitted from the *INVADER* satellite while it was in orbit. In the following year, at Ars Electronica 2015 in Linz, the project received an Award of Distinction in the Hybrid Art category.

ARTSAT's activities continued beyond this initial phase. In 2017, in collaboration with the SIAF (Sapporo International Art Festival) Lab, the project realized *Space-Moere* at Moerenuma Park – a site conceived by sculptor Isamu Noguchi as "a single sculpture as a whole." By connecting the park with outer space through stratospheric balloons, the project presented sonic experiences from space, remote improvisational performances, and media installations. This project was later presented at the WRO Media Art Biennale 2019 in Wrocław, Poland, through both an installation and a tele-coding performance.

From 2020 onward, researchers in space engineering and space science involved in ARTSAT began collaborating with artists and students specializing in media art and programming

to pursue the concept of “Orbital Art” — an artistic exploration that treats the orbital data of spacecraft and celestial bodies as creative material.

Like *DESPATCH* itself—released into deep space and continuing to orbit the Sun as an artificial asteroid—the ARTSAT project remains in motion, generating long-lasting reverberations and derivative practices. Twelve years after the launch of the first art satellite, which proposed a dialectic between “space” as site and “Earth” as non-site (after Robert Smithson), this exhibition, *Mission ∞ Infinity: Space + Quantum + Art*, revisits the activities of 2014 once again.

The exhibition is composed of two main sections. On the right-hand side, telemetry data from the art satellite *INVADER* and records of its missions are presented in chronological order, while the timeline of communication audio data is temporally compressed and replayed. By employing highly directional speakers, the spatial position from which the sound is perceived is aligned with the temporal axis of the displayed chronology.

On the left-hand side, the orbital data of the Deep Space Sculpture *DESPATCH* are presented. *DESPATCH* is not only the sculpture located farthest from Earth, but during its approximately two-week operational period it also transmitted generative cosmic poetry that was collaboratively received by amateur radio stations around the world. Ultimately, successful signal reception was achieved from a distance of approximately 4.7 million kilometers from Earth—about twelve times the distance to the Moon—establishing a world record for the longest-distance communication in the amateur radio band. In this exhibition, the received generative poetry is presented together with orbital visualizations showing the positions of *DESPATCH* and the planets during the exhibition period.

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- ARTSAT Project: <https://artsat.jp/>
 - Space-Moere Project: <https://space-moere.org/>
 - Orbital Art Project: <https://oal.artsat.jp/>
 - ARTSAT Project Leader: Akihiro Kubota
 - ARTSAT Project Artistic Director: Norimichi Hirakawa
 - Exhibition System Design: Takanobu Inafuku

I would like to take this opportunity to express my sincere gratitude to everyone who participated in and supported the ARTSAT project. Thanks to your contributions, we are able to revisit and reflect upon the project in this exhibition. I am deeply thankful to you all.

2 ARTSAT1: INVADER (CO-77)

ARTSAT1, the art satellite *INVADER* (INteractive Vehicle for Art and Design Experimental Research), is the world’s first nanosatellite developed primarily for artistic purposes. It was designed, built, and operated mainly by students and alumni of Tama Art University and the University of Tokyo. Though compact—10 cm on each side (a 1U CubeSat)—*INVADER* was conceived as a platform that treats outer space as a new site for artistic expression, enabling a range of art missions. It was launched on February 28, 2014, as a piggyback payload aboard the H-IIA Launch Vehicle No. 23, and inserted into a sun-synchronous orbit at an altitude of approximately 378 km with an inclination of 65 degrees.

2.1 Basic Concepts and Functions

2.1.1 The Satellite as a Medium

INVADER functioned as a “personal medium orbiting the Earth.” By downlinking data acquired in orbit and executing commands and programs uplinked from ground stations, it provided a platform on which artists and programmers could run diverse missions in space. By reimagining the satellite not as an object reserved for scientific or engineering specialists, but as an extension of everyday objects, the project sought to democratize access to space and satellite technology. Through an everyday aesthetics of data, it aimed to connect physically unreachable locations with human perception and consciousness.

2.1.2 An Open and Flexible Design Philosophy

INVADER carried *MORIKAWA*, an Arduino-compatible mission onboard computer widely used around the world. A range of input and output devices—including a camera, multiple sensors, and speech synthesis hardware—were connected to this system. In addition to transmitting diverse sounds and sound poetry, photographing the Earth, and enabling interaction with a space-based chatbot built on *ELIZA*, the satellite incorporated a virtual machine (VM) that provided access to all onboard sensors and devices. This architecture made in-orbit reprogramming possible.

2.1.3 The Ground Station as an Interface

The ARTSAT ground station, established at Tama Art University’s Hachioji Campus, was designed to transmit commands and data to the satellite, and to receive, archive, and distribute data downlinked from orbit. Implemented as a web-based system with a custom graphical user interface, it also supported remote operation over networks. Telemetry (sensor data) transmitted from the satellite was made publicly available via a Web API, enabling anyone to access and use satellite data.

2.2 Overview of the Artistic Missions

2.2.1 Dialogue with the Satellite

Text strings transmitted from the ground were read aloud by an onboard speech synthesis chip, and the resulting audio was sent back to Earth. Scheduled transmissions were also conducted from Europe. Through a chatbot function, users on the ground engaged in pseudo-dialogues with the satellite.

2.2.2 Self-Portrait Photography with the Camera

INVADER carried a 160×120 -pixel camera and transmitted images of the Earth that included its own antenna. Because the downlink rate was 1200 bps, it took approximately 20 days to receive the data for a single photograph.

2.2.3 Creation Using Telemetry Data

Using the publicly released telemetry, artists produced data-driven artworks, including visual poetry and plotter prints.

2.2.4 Generative Missions in Orbit

Program code (bytecode for the VM installed on *MORIKAWA*) was transmitted from the ground. By algorithmically processing internal temperature, attitude, and other sensor data, the satellite generated melodies, speech, and sound poetry, which were then transmitted back to Earth.

ARTSAT1: INVADER (Project Manager: Toshiki Tanaka)

- Size: $100 \times 100 \times 100$ mm (1U CubeSat standard)
- Mass: 1.85 kg
- Operational period: February 28, 2014 (launch) – September 2, 2014 (terminated by atmospheric reentry)
- International Designator (COSPAR ID): 2014-009F
- OSCAR Number: CO-77
- Call Sign: JQ1ZKK

3 ARTSAT2: DESPATCH (FO-81)

DESPATCH (DEep SPace Amateur Troubadour’s CHallenge), developed as the second spacecraft of the ARTSAT Project, is the world’s first “deep space sculpture.” It was launched on December 3, 2014, aboard the H-IIA Launch Vehicle No. 26 as a piggyback payload with the asteroid explorer Hayabusa2. *DESPATCH* is a small spacecraft with an overall envelope of approximately 50 cm on each side and a mass of about 32 kg. Its distinctive spiral form was fabricated using a 3D printer. The spiral has long symbolized the dynamism of the cosmos and of life itself. *DESPATCH* is the first artwork in history placed into a heliocentric orbit, extending the lineage of land art—environmental sculpture—into outer space.

3.1 Basic Concepts and Functions

3.1.1 Freedom Gained Through Simplification

After launch, *DESPATCH* traveled almost linearly away from Earth, reaching distances of up to approximately 75 million kilometers over about 200 days. The design therefore limited the radio transmission period to roughly one week, up to the point at which the spacecraft reached approximately 3 million kilometers from Earth, and adopted a system powered solely by primary batteries. By eliminating the need for solar panels, the spacecraft’s external form was freed from technical constraints related to power generation and attitude control, enabling a highly flexible sculptural design realized through 3D printing.

3.1.2 Autonomous Computation and Generative Function

Except for emergency shutdowns in abnormal situations, no commands were uplinked from ground stations. All missions were executed autonomously by the onboard system *MORIKAWA*. Computation based on sensor inputs decoupled artistic generation from direct human operation, while allowing the spacecraft to respond automatically to unforeseen conditions, such as increases in internal temperature.

3.1.3 Communication and Transmission

DESPATCH transmitted unmodulated CW signals at an output power of 7W in three phases:

Phase 1 Up to 180,000 km: Housekeeping data in Morse code at 6WPM

Phase 2 180,000 km to 1.86 million km: Space-generated poetry in Baudot code at 1BPM

Phase 3 Beyond 1.86 million km: Beacon transmissions with intervals that varied according to spacecraft temperature

3.1.4 A Micro-Sculpture as an Unknowable Archive

DESPATCH—whose purpose was, in a literal sense, “to go far away”—also incorporated a time-capsule function. With the cooperation of the University of Tokyo Nanotechnology Platform, an ultra-miniature MEMS memory device was installed. This memory consists of micro-sculptures etched onto a silicon chip, containing photographs and messages. The archived content includes *DESPATCH* design drawings and circuit diagrams; 8-level grayscale images of the spacecraft and its development team; and pencil drawings and illustrations of *DESPATCH* created by students of Tama Art University.

3.2 Overview of the Artistic Missions

3.2.1 From Spacecraft as Object to Sculpture as Entropy

The twisted spiral sculptural element inherits formal references from Vladimir Tatlin’s unfinished Monument to the Third International (1919) and Robert Smithson’s Spiral Jetty (1970). At the same time, *DESPATCH*—an irretrievable entity released into deep space—takes distance, delay, and other conditions of the cosmic environment as constituent elements, translating an irreversible, entropic conception of space-time into the realm of imagination.

3.2.2 Collective Reception of Poetic Readings via Radio Waves

The space-generated poetry transmitted by *DESPATCH*—carried on radio waves that weakened over time—was collectively received through the cooperation of amateur radio operators around the world. These cosmic poems, realized through transnational collaboration, constitute records of events that were transmitted, lost, and reconstructed as fragments. They form a faint yet vast “social data sculpture” that invisibly connects outer space with locations across the Earth.

ARTSAT2: DESPATCH (Project Manager: Naoto Usami)

- Size: 500 × 500 × 500 mm (overall envelope)
- Mass: 32.72 kg
- Orbit: Heliocentric orbit (currently orbiting as an artificial asteroid)
- Operational period: December 3, 2014 (launch) – December 14, 2014 (final reception)
- International Designator (COSPAR ID): 2014-076C
- OSCAR Number: FO-81
- Call Sign: JQ1ZNN

Appendix: Cosmic Poem of DESPATCH

Table 1: *DESPATCH* Poem Format

Row Label	Start Marker	Col 1	Col 2	Col 3	Col 4	Col 5	Col 6	Col 7	Col 8	End Marker
CP0	11111 (LTRS)	J	Q	FIGS	1	LTRS	Z	N	N	00000 (NULL)
CP1		Loop count		Main board Temperature		RSSI		Battery Temperature		
CP2		Transmitter Temperature (Color)				Keel Temperature (Color)				
CP3		Battery Temperature (Color)				Aluminum cover Temperature (Color)				
CP4		Angular velocity A (Rhythm)				Angular velocity B (Rhythm)				
CP5		Angular velocity C (Rhythm)				Main board Current (Rhythm)				
CP6		A	R	T	S	A	T	FIGS	2	
CP7		D	E	S	P	A	T	C	H	

The transmission of the generative cosmic poem consists of repeated units labeled CP0 through CP7, as shown in the diagram. Each unit comprises a 5-bit header, a 5-bit footer, and 40 bits in between, all encoded using Baudot code (except that CP7 does not include a header). Because Baudot code represents one character with 5 bits, each unit corresponds to ten characters in total: one character for the header, one for the footer, and eight characters in between. In CP1, however, the 40 bits between the header and footer contain raw data from the spacecraft’s primary sensors.

The portions that constitute the generative space poetry derived from onboard sensor data are CP2 through CP5. In CP2 and CP3, spacecraft temperature is converted into a four-letter “color code.” This code symbolically represents colors using four characters—for example, “white” is encoded as “whit.” As in thermography, higher temperatures are translated into brighter color codes.

In CP4 and CP5, the spacecraft’s angular velocity and electrical current consumption are converted into four-letter “rhythm phrases.” These phrases are generated by cutting up fragments from *Gadji beri bimba*, a sound poem by the German poet Hugo Ball. The resulting rhythm phrases function as sound poetry generated by the spacecraft’s rotation and electrical activity.

The signal rate of the generative space poetry is 1 bit per second. Because each unit consists of 50 bits, transmitting one unit requires 50 seconds. A 10-second interval is inserted between units; consequently, transmitting a complete poem from CP0 through CP7 takes a total of 8 minutes.