JOURNEYS INTO THE UNKNOWN: A SERIES OF SCIENCE ARCHITECTURE TASKS AND EVENTS, SPACE-BOUND EXPLORATIONS AND FAR-TRAVELS, DISCOVERIES AND MISSES (NEAR AND FAR), IMAGINATIVE SPACE-GAZING AND RELATED INVESTIGATIONS, OBSERVATIONS, ORBITS, AND OTHER REPETITIOUS MONITORING TASKS

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A thesis submitted in partial fulfillment of the requirements for the degree of Master of Fine Arts at Virginia Commonwealth University.

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ABSTRACT

This thesis expansively and inclusively puts forth the imaginings, research, processes and experiences behind my two thesis exhibitions, *Journeys into the unknown: a series of science architecture tasks and events, space-bound explorations and far-travels, discoveries and misses (near and far), imaginative space-gazing and related investigations, observations, orbits, and other repetitious monitoring tasks and Timed travel: asystematic accounts of regular and geometrical timekeeping, orbital flight, repetitive rotations and other journeys into actual time and slow space*. It begins with an abstract interpretation of the dial: a tool not limited to scientific measurement but, instead, a gauge of an object’s overall position and general status. Equal parts scientific information, abstracted and fictionalized instruments and facts, and the personal experiences which provided these concrete informational elements with psychological and metaphorical meaning, this document is as much a record of time as it is an elucidation of my artistic practice and methodology.
I have been locating the emotional potential of the dial¹. Like so many other informational objects², the dial is both functional and suggestive. An indicator that displays and transcends the display of a measurement, the dial reveals a subject’s particular status. A series of dials, like the abundance found on a control panel or in a control room, provides a larger view: a multi-angled and multi-faceted assessment of overall position³ and general well-being at a specific moment. Such an array reveals the complexity of that moment – of any given moment – and, as follows, the complexity of all moments. The processes of locating, indicating, measuring, and evaluating shift from the scientific to something more visceral. Numbers and units of measure recede and dials become the building blocks of architecture⁴.

¹ The dictionary defines DIAL as a : “A face upon which some measurement is registered usually by means of graduations and a pointer” or b : “a device that may be operated to make electrical connections or to regulate the operation of a machine”.
I define **INFORMATIONAL OBJECTS** as objects or instruments built to collect, process, receive, transmit, analyze and sort information. I also refer to them as **THE ARCHITECTURE OF SCIENCE** (satellites, observatories, telescopes, and related instruments built exclusively to perform scientific tasks or observations: structures that somehow get us closer to understanding and experiencing the unknown) and **IDEALISTIC ENABLERS** (objects that make our outer space dreams come true).

**POSITION** is here thought about in a very broad sense, alluding to an overall or general state rather than a physical location.

I am thinking of a conglomeration of so many (dial-driven) structures in the world that exist but also more than that. I want the (invented) building(s) to become visceral somehow. I’ve begun thinking about myself: dreaming up architectural/intellectual fantasies and experiencing more physicality than ever before. Perhaps my subject matter and my way of seeking it out is a pursuit for the mind, but I’ve also never felt more real in my life.

The arrangement and alignment of dials into a larger formation becomes a control surface, typically communicating with and updating the status of some far-away instrument. These panels covered in dials, monitors, and buttons interact with an external reality, reading signals – inputs – from and making changes – outputs – to the objects within this outer space. They themselves are indicative of the enormous complexity and sensitivity required by recording moment-by-moment or second-by-second events going on inconceivably far away in the universe – developments transmitted through time and space via tuned radio wave frequencies relayed by transmitters on telescopes and receivers until they eventually arrive, turning dials to their appropriate degree.
A DIAL is also a scientific base tool – what I call a SUPPORT STRUCTURE – similar to a rocket launch pad, or a building like the Eglin FPS-85 (a building used by NASA to track orbital debris, continuously gazing up at the sky but never actually able to leave the ground). The dial, too, is an instrument (or structure) that supports another instrument (or structure) which takes off, travels, explores space, and sends back what it finds: support structures never leave the ground, but make possible the flights of those that do. Of course, certain dials are exceptions, such as the ones on satellites or rocket ships going to space and returning to Earth. But those in the control room are rooted to slanted ground-based consoles, the providers of far-away instrument status, measurement and update, performing monitoring tasks, and displaying irregularly repetitive rotations and signals.

Possible formations for dials: instruments of science, control panels, mission control, synthesizers, televisions, communication devices, video games, aeronautics, general navigation, etc.

The distinction between inner space and outer space: an everyday experience, looking outward, evaluating inward, sending solitary signals into communal situations for expansion and evaluation. The distinction between feeling lonely and quite the opposite. The distinction between physical limitation and physical free reign, between repetitious analyzing and expending pure maximized energy. The distinction between looking out and hearing in. The back and forth between the two, continuous oscillations.

The constant turning and resting of dials make animations develop on a slow scale, the tracking of which is often recorded as gradually forming graphs: records of change over time. I have been scrutinizing graphs for signs of change, trying to find evidence distinguishing an event from the simple passing of time.

The successful back-and-forth between these dials and objects relies on precise signal quality. “How to hear with clarity”, a [here very abbreviated] phrase written by David Toop in Haunted Weather (his exploration of experimental sound and music), suggests more to me about communication than about sound. It is a communication between technologies that I imagine, representing a different kind of listening and of hearing, of sound as signal:
listening redefined. Listening through signal and noise to discern something clear, possibly something containing data\textsuperscript{8b}, possibly something more wide open, or possibly both.

\textsuperscript{8a} This scenario – signal clarity – is embodied in test cards and tuning signals used by television stations in the mid-20th century to ensure picture quality. The proper recreation of these geometric images across wave frequencies indicates functioning technology, strength of signal, and overall successful transmission and communication, something sent and received. Particularly striking are a few used by the BBC, NBC, and the Independent Independent Television Authority (ITA) – the BBC’s Test Card H (never broadcast, but used for testing purposes); NBC’s 1941 test pattern from early commercial TV broadcasts in the United States; and an early ITA test card, showing pure “frequency gratings in a cross layout.”

\textsuperscript{8b} What constitutes data, anyway? Data (information) and the collection of data (narratives surrounding information) can be interpreted emotionally, psychologically, expansively.\textsuperscript{10}

What happens if you launch a group of dials into space – a dial as spacecraft, satellite, monitoring instrument, rocket ship? An expanded floating control panel traversing the sky, blinking like stars, gradually emerging from hiding points within constellations only to disappear back into the distance. I wanted to make these space-bound console dials real; to turn them into satellites and characters within the finite infinite space of a planetarium (already a place of fantasy); to show satellites as expanded dials gauging their surroundings; to suggest their appearance, presence, disappearance, their truth and complete fiction\textsuperscript{9}.

\textsuperscript{9} Thus developed \textit{TIMED TRAVEL: ASYSTEMATIC ACCOUNTS OF REGULAR AND GEOMETRICAL TIMEKEEPING, ORBITAL FLIGHT, REPETITIVE ROTATIONS AND OTHER JOURNEYS INTO ACTUAL TIME}

\textsuperscript{10}
AND SLOW SPACE, a series of three-channel animation projections onto a small planetarium dome at a high school in Richmond, Virginia. The 35-minute show begins and ends with the dazzlingly simple star sky from the planetarium’s star projector. The longer animated middle section starts with dials slowly approaching from tiny, distant points of light into full-fledged objects playing out slow, cyclical narratives – only to eventually disappear back to isolated vanishing points of light. The soundtrack (a complexly composed collection of synthesizers, field recordings, and the sounds of time) provides the invisible tenor surrounding these objects: unlimited activity invisible to the eye but quite ‘visible’ to the ear, auralizing this imagined space of patience, tension, action, emptiness and anticipation.

For personal reasons I became fixated by comparing stillness and motion, a fascination with identifying the smallest amount of movement or change. How little can something move and still be understood as being in motion? How little action can happen and still be narrative? Nearly two years ago and in the midst of early space-based research, I had surgery for a broken jaw, fractured in a bike fall. The break required an intricate operation, passing by a variety of delicate facial systems – primarily the facial nerve, responsible for all motor function on that side of the face. The operation ended badly, setting off a tailspin of all theoretical side effects: a cleanly severed facial nerve and an unresolvable infection of the bone. The latter required two more operations and having my mouth wired shut for six weeks (among other things) to see to an acceptable conclusion; the former took a fourth surgery, performed by a rare specialist in Boston who grafted sensory nerve from my ankle and patched it into a new facial motor nerve connection which, in turn, took six months to show signs of success (signs of signal, signs of motion) but ultimately, thankfully, did. The four-surgery time-frame was just over three months, a period of time elongated by the constant analyzing (dedicated, hopeful, patient, anxious, careful) of the face, the jaw; looking for signs of change (improvement, movement, bite alignment, muscle strength); a period of enclosure, being contained inside a headspace that was suddenly a very limited interior space of which I had very limited control; a period of distinct separation between the inside and the outside. It was a
real-life, real-world JOURNEY[S] INTO THE UNKNOWN that went on (and on and on), punctuated by anticipating and arriving at different marking points in time while unabashedly (but secretly) humorining myself by comparing myself to the monitoring machines, the science architecture, sent out to space equipped with only what they have to perform only as well as they can. And finally reaching the end of the four-surgery timeframe to begin the post-nerve-surgery timeframe: six months of waiting, of looking for something, anything, questioning every sensation for an indication of movement, of successful signal transfer. And eventually feeling it, first, and then seeing it, and then following exact instructions to methodically draw it out and make more change: twice a day for roughly a year or more (nerves heal one millimeter per day, and the facial nerve is long, with many branches to the different facial muscles, each responsible for its own region of signal and strength, requiring, of course, strength of signal to perform motion with any kind of gradually improving dexterity), task by task, facial massage and strengthening bit by bit, patiently, critically, examining the result. Ending up with partially restored muscle function (gradual signs of change just about everywhere with the exception of the frontalis, depressor labi, and depressor angularis oris muscles; enough motion for the average person to most likely not notice any irregularity beyond a slight asymmetry), and a newly understood perception of slow time, imagined time, real time.

Including: Journey into the unknown machines attempt a construction of the skies, Activities in actuality^d [1-3] (space architecture in the Metabolist^e style, dedicated sensoring^5, phase characteristic light codes^f, time service rotations, centripetal forces, airglow/nightglow^g, games, stars, and orbits), and Dedicated sensors/the architecture of science.

^d “Actuality is when the lighthouse is dark between flashes: it is the instant between the ticks of the watch: it is a void interval slipping forever through time: the rupture between past and future: the gap at the poles of the revolving magnetic field, infinitesimally small but ultimately real. It is the interchronic pause when nothing is happening. It is the void between events.” —George Kubler, The Shape of Time, page 15.
“Unlike the architecture of the past, contemporary architecture must be changeable, moveable and capable of meeting the changing requirements of the contemporary age. In order to reflect dynamic reality, what is needed is not a fixed, static function, but rather one which is capable of undergoing metabolic changes.” —Kiyonori Kikutake, architect in the Metabolist group, quoted in William J. R. Curtis, *Modern Architecture Since 1900*, page 510.

More specifically, I am (visually) referring to the 1972 Nagakin Capsule Tower, Tokyo, designed by Kisho Kurokawa, which justifiably looks like it could be a building made out of architectural dials.

Light signal patterns, like those from a lighthouse or beacon, to provide identification for that lighthouse.

“Airglow (also called nightglow) is the very weak emission of light by a planetary atmosphere”.

Control rooms are often made up of rows of console stations and a larger, more centralized, set of monitor displays: a common point of visual status providing larger-scale images of the monitored object(s) at hand. It is on these screens where the actions mirrored by the dials on consoles across the room return to a familiar and accessible kind of imagery: video inside a spacecraft, satellite orbit maps, the like. Here begins the circuitous relationship between the consoles and the control room screens: an information-driven circular loop of activity as changes are observed in one place, made in another, and reflected in again another – only to be observed again, changed again, reflected again, and so on.

I had consoles built for my *JOURNEYS INTO THE UNKNOWN: A SERIES OF SCIENCE ARCHITECTURE TASKS AND EVENTS, SPACE-BOUND EXPLORATIONS AND FAR-TRAVELS, DISCOVERIES AND MISSES (NEAR AND FAR), IMAGINATIVE SPACE-GAZING AND RELATED INVESTIGATIONS, OBSERVATIONS, ORBITS, AND OTHER*
REPETITIOUS MONITORING TASKS exhibition. They were designed to cross between Star Trek-inspired slanted consoles and museological display cases made of wood, painted white, and covered in plexiglass. They housed a collection of drawings: drawings as information, drawings as abstraction, and slowly moving drawings (Animations on small screens). The relationship between these consoles and the corollary group of “monitors” (in reality, twenty-eight framed digital prints and drawings) on the wall was not scientific nor linear, but instead indicative of my own circuitous relationship between information and image-making. If in a real control room, all images are generated from some information or data, in JOURNEYS INTO THE UNKNOWN it was nearly the opposite. Typically, a piece of information or collection of data suggests to me an abstract narrative, something most successfully rendered as a drawing. In turn, this drawing reveals its own set of visual tensions, textures, relationships and narratives, and the abstraction itself becomes a jumping-off point for imagining, interpreting, and remaking information. At a point, the information has been separated from the images – a problem solved only by creating a new context for the drawings (control room installation; planetarium show; printed newspaper – all questions of design) so they can indicate their source, but not be closed off by it. To reveal this process, the control panel display cases contain equal parts information and abstraction – making both the information abstract and the abstract informational.

10a Drawing, for its relationship to the imagination – a process inspired by avant-garde architectural blueprints, in which a theoretical building (an idea for a building) can only exist in the mind, suggested by what is drawn and rarely actually constructed.

11 Twenty-eight drawings and prints make up the control room wall of “screens”. These images put forth a flurry of fantastical information-driven activity: a collection of invented space architecture made from dial-inspired drawings, seen both in their natural state of ink and graphite and being floated into images of space (taken by the architecture of science), time/GPS-based graphs, and digital color (sky) fields.
This arrangement suggests the motion, action and communication that is happening afar, but is frozen in time: a carefully composed pause amidst exploration, quantification and reflection.

Also present are: three television test cards; abstract rotating shapes based on the locations of US Naval Observatory NTP Network Time Servers nationwide; a signal from the NOAA-16 weather satellite found at 1544.5 MHz, originally imaged by Tom Hutter; satellite/space probe detections from the SETI League; the “deepest ground-based [telescope] image,” taken by the William Herschel Telescope located on La Palma, Canary Islands; the first light image from the Kepler spacecraft on its search for habitable planets; the center of the galaxy; abstractions based on the Hubble Space Telescope’s mirror arrangement and a generic diagram of the mirror structure of a standard telescope; time-service related graphs; the Rosetta asteroid; the UGC6697 galaxy taken by the Chandra X-Ray Observatory; a “wide-field star image of the region around the HD189733b” star taken by Hubble; three images made from my redrawing online tracking maps of GPS satellites visible from Richmond, VA over a three-hour period; a version, made from blocks of drawn dials, of the Metabolist Nagakin Capsule Tower, Tokyo, 1972; a drawing based on conflating two computer screens from the Large Hadron Collider; and a drawing inspired by a Cassini space probe image of Saturn’s rings.

Over the course of making JOURNEYS INTO THE UNKNOWN, I spent a great deal of time searching the internet for informational source texts and images. After a long time of only making drawings based on these scientific starting points, I finally decided to use some of them directly, so began incorporating found internet images captured or generated by space architecture into my printed projects. I felt that giving more context was important, allowing access to my ongoing processes rather than only the end result: frequently ambiguous geometrically abstract drawings (illuminating in their own right, but not communicating anything concrete). To put a drawing of abstracted science architecture into the space it was “made” to occupy, then, seemed usefully absurd, allowing me to provide these informational objects (support structures) the experiences for which I imagined them
constantly longing. And it felt similar to make a printed newspaper displaying scientific facts rewritten as headlines, abstract drawings feigning relationships to that information, and found diagrams and graphs that are in and of themselves abstract images, all presented side-by-side without any designation whatsoever between fact or fiction. This newspaper, a free takeaway in the exhibition, was a collision point.

Most compelling about the Large Hadron Collider is the fact that its several independent structures are each completely covered in sensors. These sensors are tuned to extreme sensitivity, looking to discover clues about the history of the universe by colliding the tiniest of particles (protons and lead ions) with one another at very high speeds (circling the 17-mile track 11,245 times per second, nearly the speed of light) and recording the tiniest bits of data possible from the resulting explosions. These ‘buildings’ covered in sensors are radiant with expectation, built for discovery, for anticipated collision moments. They are surely and reliably dedicated to their repetitious processes and searches, perhaps limited in the scope of what they can perceive and comprehend, but uncommonly thorough in what they can.

ATLAS (151 feet long, 82 feet high, 82 feet wide), is a general purpose detector; CMS (70 feet long, 50 feet high, 50 feet wide), another general purpose detector; ALICE (85 feet long, 52 feet high, 52 feet wide), studying a “liquid” form of matter believed to exist immediately after the Big Bang; and the LHCb (70 feet long, 33 feet high, 43 feet wide), looking for the “missing” antimatter created by the Big Bang.

Repetitious processes performed by science architecture are referred to as cyclical MONITORING processes.
TIMED TRAVEL: ASYSTEMATIC ACCOUNTS OF REGULAR AND GEOMETRICAL TIMEKEEPING, ORBITAL FLIGHT, REPETITIVE ROTATIONS AND OTHER JOURNEYS INTO ACTUAL TIME AND SLOW SPACE

18 What characterizes an event, what defines change.

There are two types of time. The first is official: an atomically exact time characterized by nanosecond precision. The other time is slow and variable, though repetitive: it makes narrative somewhere in-between regularity and unpredictability. It is a fictional time grown from fact and science; a slow time intercepting both massive galactic time and minute precision time. Unpredictable and evocative, somewhat anxious and seemingly empty, it requires thorough attentiveness to detail and sensitivity to the slightest change. These repetitive processes create slow time: a cyclical yet irregular time characterized by long stretches of low activity interrupted by the occasional event in the subtle expanses of space.

19 Official time is kept by comparing the atomic clocks on land to those on orbiting GPS satellites. The master atomic clock for the United States, and the systems used to cross-check it against the satellites’ clocks, are kept at the US Naval Observatory (USNO) in Washington DC inside a small building labeled TIME SERVICE.

The sound of time: sound as an audible byproduct of invisible processes also based on frequency. Sound as evidence of orbits,
satellite constellations and technology, cyclical monitoring processes, and precision measurements for navigation and identifying location.\textsuperscript{21,22}

I wanted to record the sound of time, so requested and was given permission to visit the USNO and see the clock first-hand. The master clock is kept in a climate-controlled room with a glass window so visitors can look in from the hallway. To record the sound of time I was allowed to leave my hard-disk recorder on a tripod in the climate-controlled room housing the master clock. I put the equipment in as quickly as possible, minimizing the amount of time the door was open in order to preserve the sensitive temperature system keeping the clock “on time.” During the twenty minutes it recorded, a USNO GPS expert showed me an oscillator he had built to analyze discrepancies between the atomic clocks on satellites and the master clock, accurate to the picosecond (one trillionth of a second). He zoomed in and out on the waveforms, revealing small inconsistencies to be problem-solved: nanoseconds can get lost inside this complex process of receiving millisecond-long pseudorandom noise codes and data signals via radio frequencies.

Atomic clocks keep time by stimulating atoms to produce specific stable and repetitive microwaves of radiation. Once this “natural resonant frequency” has been achieved, a certain number of wave cycles is used to define one second. The atoms used in the two most common and accurate atomic clocks are cesium and hydrogen. Cesium atomic clocks are known for their long-term accuracy, but are less reliable for short-term measurement. Hydrogen masers are the opposite. Therefore, these clocks are typically used in tandem – combined by the “mean timescale” to generate a timekeeping system for maximized accuracy and longevity. There are 45 clocks currently in use at the USNO: 33 cesium clocks and 12 hydrogen masers.

For cesium atoms, the natural resonant frequency is $9,192,631,770\text{Hz}$. For hydrogen atoms, the natural resonant frequency is $1,420,405,752\text{Hz}$. 
Maintaining the master clock’s temperature and its consistency with the satellite clocks is crucial: time precision equals location precision. As the USNO website states, “Modern electronic systems, such as electronic navigation or communications systems, depend increasingly on precise time and time interval (PTTI). Examples would be the ground-based LORAN-C navigation system and the satellite-based Global Positioning System (GPS). These systems are based on the travel time of the electromagnetic signals: an accuracy of 10 nanoseconds (10 one-billionths of a second) corresponds to a position accuracy of 10 feet.”

Elsewhere in the TIME SERVICE building are several other time-related machines: one cross-checks outputs of various time-keeping systems for cross-platform consistency; another provides the official telephone time to any caller dialing in (202-762-1401 or 202-762-1069 although “time may be delayed on long distance calls”); and several respond to requests from servers across the internet for the official network time. I put contact microphones on these other machines in the TIME SERVICE building to get different time machine soundings. Each has a slightly different hum, from the pleasantly abrasive to the rhythmic to the background bassy undertone. These hums were most likely produced by the fans keeping these machines cool, rather than by any moving parts or timekeeping processes. I had been told on a previous recording trip to an engineering lab that this was true of much modern equipment.

In the imagined space of slow time (a space of journeys into the unknown, where control panel dials – providers of status and overall position – are sent, repetitively rotating), sound\textsuperscript{8} is used to render the fluctuations and events that create a more discernible narrative. It makes accessible the otherwise invisible tenor surrounding this space architecture: expanding the orbits, cyclical monitoring processes\textsuperscript{17}, signal broadcasts, and time travels into the gradual shifts, changes, movements and pauses, which, in turn make up slow time, actual time.
**IMAGE CAPTIONS**

pages 16–21:
*Journeys into the unknown: a series of science architecture tasks and events, space-bound explorations and far-travels, discoveries and misses (near and far), imaginative space-gazing and related investigations, observations, orbits, and other repetitious monitoring tasks*

Anderson Gallery, Richmond, VA April 23–May 2, 2010

Drawings (ink and graphite on paper), digital inkjet prints, CAD prints, LCD screens, wood, plexiglass, sound.

pages 22–25:
*Timed travel: asystematic accounts of regular and geometrical time-keeping, orbital flight, repetitive rotations and other journeys into actual time and slow space*

Thomas Jefferson High School Planetarium, Richmond, VA April 30, 2010

Three-channel digital animations with sound, star-projector
A NOTE ON RESEARCH

As outlined in this document, my artistic process incorporates a great deal of research, much of which is done and logged online. For this project, my research materials included reference and news articles, scientific diagrams, charts and logs, many types of images, and didactic scientific texts. Each web-based source I find is catalogued, and thus available for the curious reader at the following URLs:

http://delicious.com/leahb/space
http://delicious.com/leahb/thesis_project
http://delicious.com/leahb/science

These categories will continue to grow as new and relevant articles and pages are added over time.
Leah Beeferman was born on June 01, 1982, in Boston, Massachusetts, and grew up in neighboring Cambridge. She graduated from Cambridge Rindge and Latin High School in May 2000, and went on to earn her B.A. in both Visual Art and the History of Art and Architecture from Brown University, Providence, RI, in May 2004. She worked as graphic designer at *Cabinet* magazine and as an independent artist in Brooklyn, NY before returning to graduate school at VCU in 2007, where she has spent the three years of her MFA exploring (in substantial imaginative and informational depth) the architecture of science, outer space, and multiple systems of time.