FRAMING SPACETIME IN THE MAPPING OF AEROTORY

BY
MENG SHUI

THESIS
Submitted in partial fulfillment of the requirements
for the degree of Master of Landscape Architecture in Landscape Architecture
in the Graduate College of the
University of Illinois at Urbana-Champaign, 2016

Urbana, Illinois

Adviser:
Professor David L. Hays
Abstract:

Mapping is a process of negotiation, and maps have agency in “uncovering realities previously unseen or unimagined” (James Corner, 2011). One “reality” nowadays much experienced but less “seen,” and therefore less mapped, is the territory of air transportation which provide air travelers with distinct experiences of space and time. I call this realm as “aerotory”. Thanks to mass travel, aerotory is a shared memory among modern human beings on a global scale. It is a sort of place we’ve all been to, yet “there are no maps or guidebooks to this other world” (Pico Iyer, 2004).

We are living in a world of the continuum of space and time, an entity of spacetime. However, when it comes to dominant modern measurement of maps, space and time are two discrete ideas. Unlike the ideology of solidity and isolation silently fueled by the modern approach to measurement, which is predicated on the autonomy of things and dichotomies between science and art, culture and nature, objectivity and subjectivity, traditional measurement was integrative; it promoted interrelationship among things: “In medieval Ukraine, for example, farmers would speak of a ‘day of field,’ referring to the area of land that they could physically sow or harvest in one day.” (James Corner and Alex S. MacLean, 2000). Certainly, the actual area would vary according to the condition of the land and the physical capability of the farmer, but a certain consensus would be reached within a group of people, since both of these examples are highly socially derived. Specifically, both are closely bounded by the experience of a specific group with a considerable amount of experience-based knowledge of their land and the temper of local [environmental conditions/weather]. When the field (space) and the day (time) factor through you and reach a recurring rhythm, you are arriving at a state where the object of measuring is neither space nor time but, rather, the event you are performing. In other words, the ideas of space and time get emancipated through focus on the experience.

It’s humans’ ability to integrate space and time through experience. And it was from the perspective of experience, sailors developed tools and methods of sea navigation using time as measurement. Inspired by that I established my way to map aerotory. And the visual product, the aerotory map, in return helps giving shape to our understanding of this experience of spacetime.
Table of Contents

CHAPTER 1: AIR TRAVELING AS A TERRITORY ........................................ 1

CHAPTER 2: THE EXPERIENCE OF SPACETIME .................................. 3

CHAPTER 3: MEASURING AEROTORY WITH TIME .............................. 9

CHAPTER 4: THREE RULES OF MAPPING ........................................ 13

CHAPTER 5: MAPPING AEROTORY .................................................. 15

CHAPTER 6: VISUAL SIMULATION OF THE NEGOTIATION BETWEEN SPACETIME AND AEROTORY ................................................................. 22

CHAPTER 7: SLICES OF REALITY ..................................................... 24

REFERENCES .................................................................................. 25

APPENDIX A: MAPS OF AEROTORY ............................................. 26
CHAPTER 1: AIR TRAVELING AS A TERRITORY

James Corner has long been challenging the orthodox idea and shape of maps. In his essay "The Agency of Mapping: Speculation, Critique and Invention," he states that maps are “analogous to actual ground conditions,” which admits to an initial purpose of recording the world with due objectivity, while at the same time pointing out that [mapping/maps] should not be taken as true or fully objective. Maps are conditioned by “inevitable abstractness.” They are “the result of selection, omission, isolation, distance and codification.” While both of these traits--objectivity and abstraction--are embedded in the nature of maps, when it comes to the arts of design and planning, Corner goes on emphasizing the “strategic, constitutive and inventive capacities” of mapping, describing mapping as a tool for “creating and building the world as much as measuring and describing it.” And in the process of using mapping in that way, we balance the laws of the nature and the needs of humans, the “truth” of the world and the bias of our cognition. Mapping is therefore a process of negotiation, and maps have agency in “uncovering realities previously unseen or unimagined” (James Corner, 2011).

One “reality” nowadays much experienced but less “seen,” and therefore less mapped, is the territory of air transportation. Here I am referencing not the commercial airline industry, with its different carriers and air travel markets. Nor do I mean air traffic as viewed by pilots, such as through aeronautical charts coded with airport facilities and instrument routes. Instead, what I am considering is intimately related to Pico Iyer’s realm of jet lag (from his essay "In the Realm of Jet Lag") and the place where space and time collide (from his essay “Where Worlds Collide”). In other words, I am considering the territory of air transportation from a traveler’s perspective, with special attention to how that territory provides distinct experiences of space and time.

“I often think that I have traveled into a deeply foreign country under jet lag, somewhere more mysterious in its way than India or Morocco. A place that no human had ever been until 40 or so years ago and yet, now, a place where more and more of us spend more and more of our lives” (Pico Iyer, 2004). This evocative observation from Pico Iyer’s "In the Realm of Jet Lag" addresses air travel in a variety of senses, including its foreignness, its hallucinogenic effect, and the fact that it is an experience shared by many of us.

From the moment you step into an airport, as the gateway to this territory, to your experience on the plane, then landing and, finally, leaving the destination airport, you are going through a series of experiences that together form a distinct and unusual whole. The discrete experiences that are typical of
air travel share many characteristics, so the attempt to distinguish them falters as images of airports, shops, lines, and timeless terminal white light merge into an impression of every journey by air. That journey starts like this: given the requirements of the standard procedure of checking in, going through security, and boarding, one almost always needs to be ready at the airport an hour or more prior to the flight's departure. Delays due to weather or air traffic control make the preflight experience longer. Compromised free-will is reflected in how few choices you have when prolonged delays happen. You may not want to be at the airport, but if you want to take the flight in question, in most situations you have to start and wait. This specific condition of air travel may occupy you even before the so-called "real" trip--meaning, traveling from the ground up into the air, which produces a distinct set of sensations. The plane is taxiing, accelerating, soaring into the sky, and you are sitting among compact seats, feeling the speed and turbulence, [overwhelmed by/ embedded in] the droning of the engine(s), enclosed in a tube with limited views. You get fed. Maybe you fall asleep and wake up feeling sore. Every time you need to use the restroom, you apologize to everyone you have to disturb among the people sitting next to you. You keep the conversation with people sitting on your left and right concise and polite, for the space you need to share closely with those strangers for the entire journey is already not very comfortable, so you want to avoid the possibility of starting an uncomfortable conversation that you later wish to escape but cannot. For some people, the experience of air transportation starts days prior to arrival at an airport. Their travel mindset gets turned on before the day of flying; they may start packing, and they may adjust their sleeping pattern to reduce the effect of jet lag, especially if there is a transmeridian flight ahead. However, despite such preparations, jet lag is still somehow unavoidable in long distance traveling. And when that comes, along with remaining for long hours in a bustling transit airport bathed in bright light, one's mind will start to roam, will start to feel dazed by faces and languages of all kinds, demotivated by the worn look on the faces of people sitting nearby in terminal B10 or C61, and feeling sure that those people feel the same. Or, if you happen to need to stay at the airport overnight for a plane early the next morning, being detained in the strange and vast terminal for hours and hours on end can make you feel that the life you were still so familiar with not so long ago is already a universe away. This realm of groundlessness when you are up in the air, anchorlessness when you are on the ground but still haunted by the [conditions of flight/turbulence of the sky], is what I call "aerotory." Thanks to mass travel, aerotory is a shared memory among modern human beings on a global scale. It is a sort of place we've all been to, yet “there are no maps or guidebooks to this other world” (Pico Iyer, 2004).
CHAPTER 2: THE EXPERIENCE OF SPACETIME

Since Albert Einstein advanced the theory of relativity more than a hundred years ago, space and time have proven to be inseparable; they are interwoven as a single continuum. Marcel Duchamp’s 3 Standard Stoppages (1913-1914) was one of the earliest art works that interpreted that new principle. To produce it, Duchamp dropped 3 one-meter-long threads from one meter high onto painted canvases. Then those randomly fallen threads were attached to the canvases to preserve their shapes, and the canvases were later on cut along the thread lines. That created a set of new measurements each of which remains the length of a meter while contradicting the traditional rationale. “Dropping meter-long threads onto strips of painted canvas, the artist produced absurd(ist) new tools for (mis)measuring ordinary things. Duchamp referred to those units as ‘the meter diminished,’ a humiliation of systematic standards by ‘canned chance’—specifically, the twisting of each thread ‘as it pleases.’ That action made manifest the unity of time and space, recasting the meter as a one-dimensional standard” (David L. Hays, 2008). Indeed, in the idea of a “joke” about the meter as noted by Duchamp, traditional scientific method and standard measurement are defied by breaking the isolation of measuring. By framing things “as it pleases,” each falling thread not only brings time into the conversation, embracing externality, but also restores the continuum of space and time.

But Einstein didn’t kill Newton, as Duchamp’s stoppages didn’t replace the meter. Despite the fact that when speed gets really fast and the size of the research focus gets really small, Newton’s laws fail to explain things, classical mechanics is still instructive and highly “true” at the scale of people’s day to day life. That is why modern system of measurement, since its formulation during the Enlightenment, has been performing under a consistent philosophy: namely, that the world can be surveyed and abstracted in order to dissect it for empirical study (James Corner and Alex S. MacLean, 2000). Since 1960, the meter has remained “a length equal to 1,650,763.37 wave lengths of the orange light emitted by the Krypton atom of mass86 in vacuo” (James Corner and Alex S. MacLean, 2000). In the modern system of measurement, the world is absolute and quantifiable. Modern measurement promotes an image of homogeneity which in essence detaches human experience from the phenomenal world.

In traditional measurement, things were starkly different. “Traditional measures possessed two characteristics that are no longer a part of modern convention. The first was the capacity of measure to relate the everyday world to the infinite and invisible dimensions of the universe [...]. The second characteristic of traditional measure was its development through the relationship of the human body to physical activities and materials” (James Corner and Alex S. MacLean, 2000). Unlike the ideology of solidity and isolation silently fueled by the modern approach to measurement, which is predicated on the autonomy of things and dichotomies between science and art, culture and nature, objectivity and subjectivity, traditional measurement was integrative; it promoted interrelationship among things: “In medieval Ukraine, for example, farmers would speak of a ‘day of field,’ referring to the area of land that they could physically sow or harvest in one day. [...] Similarly, in early France, an arpent represented the area that a farmer could plow in one day using two oxen” (James Corner and Alex S. MacLean, 2000). Certainly, the actual area would vary according to the condition of the land and the physical capability of the farmer, but a certain consensus would be reached within a group of people, since both of these examples are highly socially derived. Specifically, both are closely bounded by the experience of a specific group with a considerable amount of experience-based knowledge of their land and the temper of local [environmental conditions/weather]. The fact that traditional, integrative measurements worked proves that they successfully negotiated those factors. When the field (space) and the day (time) factor through you and reach a recurring rhythm, you are arriving at a state where the object of measuring is neither space nor time but, rather, the event you are performing. In other words, the ideas of space and time get emancipated through focus on the experience. “Traditional units of measure therefore derived from the interrelationship of labor, body, and site. Tailors measured cloth using ‘arms’ along its length and ‘hands’ across its width, for example. Horses, too, were so many ‘hands’ high,
though this measure was not used with other animals. [...] The sources of traditional measures were the concrete experiences of everyday life” (James Corner and Alex S. MacLean, 2000).

In more recent decades, an interest in this experience-focused, place-specific way of measurement has been recurring in discussions of the philosophy of measurement. In the 1950s and 1960s, a European group of artists and activists called the Situationists armed their argument through mapping using this unorthodox approach to measurement as a way of critiquing the dominant, capitalist ideology at that time. For them, the conventional “detached” maps forced a lens of viewing and interpreting in which quantitative and rational surveying assumes truth value and the promise of its homogeneous, synoptic perspective fuels a “detached form of surveillance that enabled an unprecedented belief in the human ability to control” (James Corner, 2011). and to predict. Alternative approaches to mapping challenged that dominant idea in part by revealing repressed diversity.

Maps of Paris created by Guy Debord, an important member of the Situationists, recorded his aimless wandering through the streets and alleys of the city. These “psycho-geographic guides” reconfigured
cut-ups of standard maps of Paris as a series of turns and detours. “The resultant map reflected subjective, street-level desires and perceptions rather than a synoptic totality of the city’s fabric” (James Corner, 2011). Debord’s maps were read by American literary critic Frederic Jameson as “Disalienation in the traditional city [...] involv[ing] the practical reconquest of a sense of place and the construction or reconstruction of an articulated ensemble which can be retained in memory and which the individual subject can map and remap along the moments of mobile, alternative trajectories.” Differing distinctly from conventional, homogenized maps, Debord’s maps registered the otherwise repressed experience of the individual and empowered unrepeated events, thereby acknowledging and accommodating the flow of spacetime.

The work of English artist Richard Long reveals a different way through which experience is consolidated to deliver the sense of spacetime. Long is well known for his land art, which is created mostly by walking. The subjects most often touched upon in those works are space and time. Although they are usually framed as two separate ideas, a portrait of interwoven spacetime can be observed. The works Concentric Days and A Walk of Four Hours of Four Circles are both good examples.

“Concentric Days consists of a square Ordnance Survey (OS) map over which five concentric circles have been drawn in graphite pencil. The circles are labeled with printed text: the innermost circle is labeled ‘FIRST DAY’, the second circle ‘SECOND DAY’, the third circle ‘THIRD DAY’, the fourth circle ‘FOURTH DAY’, and the outermost circle ‘FIFTH DAY’. Below the map, on the off-white paper mount, several lines of text have been carefully handwritten, with pencil guidelines visible above and below the letters. The words ‘CONCENTRIC DAYS’ are written in red pencil. Below this the following words are written in graphite pencil:

EACH DAY A MEANDERING WALK SOMEWHERE WITHIN AND TO THE EDGE OF EACH CIRCLE

SCOTLAND 1996” (Tate, 2016).

In each of the five days, the artist walked inside of a circle specific to that day. In A Walk of Four Hours of Four Circles, “Long did not walk within the circles, but around the perimeter of each circle in exactly one hour. The central circle was walked very slowly, and as Long worked his way outwards he adjusted his pace accordingly, so that he walked the fastest on the outermost – and thus the longest – circular perimeter” (Tate, 2016).
In representing these works, conventional maps marked to indicate the actual place of walking are presented, but it is not Long’s intention that others should repeat these walks, since the integrity of the works of art depends not only on a certain place and certain time, but also on the greater nature of the uniqueness of the events. As Long notes, “The surface of the earth, and all the roads, are the site of millions of journeys. I like the idea that it is always possible to walk in new ways for new reasons” (Tate, 2016).

Both of these works of land art involve bodily performance. Using walking to fulfill the agenda of space and time is rather poetic and reconciling. In both works, the body becomes a gauge where time and space are manifest together. The flow of spacetime becomes tangible through physical activity. And the continuum of space and time (i.e., spacetime) to which such work pays respect and which is its essence also determines its necessary irreproducibility.

Unlike “space and time” (i.e., discrete entities), a concept which characterizes the world as static and isolated, where chance is erased or ignored, and where one map could represent all, the synthetic concept “spacetime” immediately suggests the non-stopping flow of events, stressing contingency and non-duplicability. However, examples such as the works of Long discussed here manage to use conventional language (space and time instead of spacetime) to make an unconventional argument (spacetime).

Space is the frame, time is the measurement, body is the tool of conduction---- contemplating the work of Richard Long reveals a brilliant rule of thumb. I would like to call it the “spacetime method.” The great intelligence and minimalism in Long’s plotting of these three factors—space, time and body—transcend the conventional dialogue about them, elevating it from conventional isolation of ideas to provocative integrity of experience. The language Long uses is common, but the syntax is inventive. For that reason, his works are a bridge: a process of negotiation and reconciliation.
CHAPTER 3: MEASURING AEROTORY WITH TIME

In his essay “Where Worlds Collide,” about LAX airport in Los Angeles, Pico Iyer describes how high-speed air travel “has made L.A. contiguous to Seoul and adjacent to Sao Paulo” (Pico Iyer, 2013) While I surely concur this argument, I also think that the vague impression of spatial vacuum in between places that conditions the physical experience of air travel is a function of more than the unprecedented speed of the vehicle. Unlike ground travel—for example, by trains or cars—where there are diverse views along the trip, air travel locates travelers most of the time in the zone of sky above the clouds, where views tend to be less varied, therefore stimulating our mind less. While moving at ground level, images come along, are observed, and are stored in the mind as if in a timeline. That experience often gets flattened during air travel, which dilutes the sense of traveling as the encounter of a sequence of spaces. Within the enclosed, tunnel-like experience of air travel, one can hardly keep the track of one’s position in the space, not only because of the feeling of being enclosed in the airplane cabin, but also because of the homogenized view up in the stratosphere where planes navigate during most of long-distance journeys. Although synchronous airplane maps are now often displayed on a screen in front of every seat to let travelers know their geographic location, this approach is more abstract than the views passengers witness first-hand by looking out a window, and it is thus less effective in simulating sensible connection. Rendered vague in that way, travel by air becomes forgettable after a while, nurturing the impression of jumping from point to point, from one airport to another, where things are more alike than different; it cultivates a sense of collapsed space, creating a perfect illusion of going through a spatial portal. Yet, traveling in a plane can also be monotonous and long, with the traveler, stuck in a container not having a good sense of direction of the journey, feeling like a wanderer in a vast void, detached from the land. In that sense, air traveling most closely resembles sea navigation among common types of transportation.

Whether through a sense of compressed space, or through a sense of disorientation within space, the experience of air travel seems to undermine the capability to measurement. But how time might be engaged in measuring in this scenario is exemplified, again, in sea navigation.

In the world of sea navigation, time has long been used as an aspect of measurement. From the beginning of ocean navigation, three main techniques evolved as sailors practiced using tools and clues to help them find their way. Those techniques are piloting (or coastal navigation), celestial navigation, and dead reckoning. Briefly speaking, piloting is a technique using a chart, a compass, and landmarks to determine position. Celestial navigation uses the position of the Sun, Moon and stars to figure out the
navigator’s position (Ana Deboo, 2007). Dead reckoning uses direction and time in a most practical way. It starts from planning where to go on a map and then keeping track of the ship’s speed and the time of traveling to determine position. One way to measure the speed is called the Dutchman’s log, which is by throwing a floating object off the front of the ship and then measuring how much time it takes for the object to pass the back of the ship; is determined by dividing the ship’s length by the given time. Alternatively, one might throw into the water a wedge-shaped log attached to a rope with knots at the interval of 47 feet; counting how many knots passing one’s hands within 28 seconds, sailors calculate the speed of the ship. Usually, after figuring out the speed of the ship, in a day of mild-weather, the helmsman is able to steer the ship steadily at about the same speed; unless the weather and the current change drastically, there’s no need for frequent measuring. Then the work left is to keep track of the time and to use a compass to make sure the ship is moving in the right direction. So, during most of the journey, the gauge is about direction and time (Ana Deboo, 2007).

In the history of ocean navigation, one can find evidence on maps that dead reckoning was a popular navigation technique. Take the Portolan charts, for instance; made mostly between 1300 and 1600 by Italian, Portuguese, and Catalan sailors, they focus on the Mediterranean region and feature detailed pictures of coastlines and the landmarks on them, as well as a wind rose and a scale bar. In addition, such maps are covered with crisscrossed lines radiating from multiple centers. Called rhumb lines, those are drawn to be used together with a compass to plot a course between two ports. With those course lines and dead reckoning, sailors could navigate their way (Ana Deboo, 2007).
In the twentieth century, sea navigation supplied use models for air navigation. In the 1910s and 1920s, when passenger planes first became viable, every pilot had to use landmarks on the ground to navigate, a practice known as “pilotage.” At that time, most planes flew only short distances, so they remained close to the ground (at altitudes below 18,000 feet). In 1927, Charles Lindbergh undertook a flight from New York to Paris, across the Atlantic Ocean, using dead reckoning to navigate. Over the ocean, “pilotage” was impossible, so Lindbergh planned his route carefully on Mercator maps (those of the type developed by the Flemish cartographer Gerardus Mercator in the 1500s) and, since his speed was monitored and indicated on the gauge, he was able to use dead reckoning, using a compass to check and correct his direction on the planned course while measuring time to find out his position (Ana Deboo, 2007).

To summarize, in both sea and air navigation, geo-direction is used as a spatial frame, and time is used as measurement. The fact that sailors and pilots perform navigation means that the body and experience are factored into the equation. In short, such practices are very much a “spacetime method.” As the histories of navigation make clear, the “spacetime method” is not new, having been practiced, in
the case of sea travel, for many centuries. Nevertheless, the way time and direction are used in the method makes it inspiring relative to my effort to articulate the territory of air travel, an as yet uncharted territory lying at the margin of the mapped world. From the perspective of experience, the idea of time as a measure able spatial dimension becomes eloquent when the space gauge becomes mute.
CHAPTER 4: THREE RULES OF MAPPING

Mapping is an open-ended action. It prioritizes plurality instead of singularity; it encourages possibility instead of static conclusion; it appeals to speculation instead of to preconception. It is a process that entails searching, gathering, relating, and unfolding. As James Corner has argued, “mapping precedes the map, to the degree that it cannot properly anticipate its final form” (James Corner, 2011).

Given the large realm of possibility in which mapping is situated, and to help make searching, gathering, relating, and unfolding effective, an operational guideline is needed. In “The Agency of Mapping,” James Corner does not stop at constructing a theoretical basis for mapping; he goes on at length to describe three essential operations of making a map in order to integrate mapping practically as part of an insightful, inspiring discovery process, to realize mapping as a creative activity, to deepen understanding, to reveal new knowledge, and to unleash imagination (James Corner, 2011). Those three essential operations are “fields,” “extracts,” and “plottings”. The field is “the graphic system within which the extracts will later be organized.” It conditions “what and how observations are made and presented,” and it is “the setting of rules and the establishment of a system.” The “extract” is data filtering, the selected result of observations. “Plotting” is the presentation of interpretation, “the drawing-out and the setting-up of relationships.” About “fields,” Corner writes, “The design and set-up of the field is perhaps one of the most creative acts in mapping, for as a prior system of organization it will inevitably condition how and what observations are made and presented” (James Corner, 2011). In light of that, mapping at its threshold, encourages exploration and critical thinking, which aligns with the spirit of landscape architecture to be always open to negotiation with ever-unfolding reality.

This encouraging idea influenced how I set up a system for mapping aerotory. As mentioned, air travel has a timetable that is conditioned by factors such as weather and air traffic control. Because of that, the difference borne in the nature of each flight has a programmatic aspect manifest in time. Just as each farmer of the past would carry out a unique “day of field,” each “meandering walk somewhere within and to the edge of each circle” would be a unique journey, and every operation is a piece of negotiation of spacetime. In aerotory, regardless of other factors, each flight is an unrepeatable piece of spacetime simply by the fact that it’s an independent experience. When we use “spacetime method” to map aerotory, the fact that the durations among flights between two points are more often than not different, means that this difference in nature, this unrepeatability, has a detectable dimension that can be demonstrated. While knowing at the same time, the temporal differences (e.g., delays due to

13
scheduling overlaps, variability in flying routes) are all results of the working mechanism of air travel industry.
CHAPTER 5: MAPPING AEROTORY

In undertaking this thesis exploration, I began by framing the mapping of aerotory as a case-focused activity, following the “extracts” operation described by Corner. Case-focused means here that I mapped out the abridged aerotory of Chicago O’Hare International Airport (ORD), the 8th largest airport internationally and the 3rd largest one in the United States. The large and diverse air traveling activities linked to ORD make it a great resource for such mapping. Given that scope, however, it was also necessary to narrow down the focus. Therefore, I abridged the scope by limiting data collection to international flights departing from ORD during one 24-hour time frame. The day was picked at random: October 29, 2015. Only flights departing that day were considered and mapped. Usually, the duration of flights departing from ORD and arriving at international final destination airports varies from less than a couple of hours to between two and three days for transit flights (i.e., trips involving more than one flight), assuming no exceptional incidents of flight delay. For direct flights, the fastest one is about 50 minutes, to London International Airport (YXU) at London, Ontario, Canada. The longest direct flight takes 14 to 15 hours and terminates at Hong Kong International Airport (HKG), located on the island of Chek Lap Kok, Hong Kong (Wikipedia, 2016).

Following the logic of the “spacetime method” described above, more detailed rules were established. First, I adopted the strategy from sea navigation: geo-direction as a spatial frame, time as measurement. I set ORD as the center of the map and used its direction toward every destination airport as the direction of measurement. I used flight duration as the time measurement to map out every destination airport of every flying event—meaning, every trip from ORD to the planned destination airports, including those of both direct and transit flights. By laying out the spatial frame and designating flight time as the measurement, I established a spacetime structure.

In order to find the direction to go from ORD to all destination airports, I firstly located on a 3D model of a globe built in Rhino all gateway airports involved in this scenario—meaning, transit and final destination airports, active on October 29, 2015. Actual latitude and longitude of all those airports exported from Arc GIS were used to simulate their positions on the model of the globe as in geo-space. Afterwards, I connected a dot representing ORD with dots representing all of the gateway airports, following the shortest lines on the sphere, then I connected those dots with lines to represent flights undertaken (Figure 6).
In real-life flights, the actual courses are almost never identical. The courses planned out based on aeronautical charts can vary significantly depending on the input of air traffic control, let along the fact that, during the actual flight, both direction and altitude will vary. In spite of that, flight paths were mapped as if straight lines connecting two dots. Keeping true to the perspective of the mapping, which is that of travelers, such technical details are omissible.
With the 3D model linking ORD to all transit and destination airports, I began to translate the flight directions into 2D representations by casting curves onto a tangential plane relative to the location of ORD on the globe (Figure 9).

As for the time data, I gathered it from FlightAware, a website with detailed flight information. To map the time data collected, I set a scale of 1 minute equals 1 inch. Here, the essence of using time to
measure was not sacrificed by incarnating it in a spatial unit; instead, rendering time that way is a requirement of “plotting”—the presentation of interpretation.

When both the spatial frame and the measurement were incorporated on the map, there were still a couple of issues to be addressed. When mapping a direct flight, I could simply lay out the measurement (i.e., time) following the direction line between ORD and the destination airport (Figure 10). However, transit flights were more complicated, even given the fact that there were no flying events on the day studied with more than one transit stop. In the case of transit flights, the method adopted was to map the first flight (from ORD to the transit airport) following the given method for direct flights. Then, I mapped the second flight from the endpoint of the first line but maintaining parallel with the direction line between the transit airport and the final destination (Figure 11).

![Figure 10](image1.png)

Figure 10, Diagram showing determination of destination airport of direct flights.

![Figure 11](image2.png)

Figure 11, Diagram showing determination of destination airport of transit flights.
Figure 12, Map of abridged aerotory of ORD in October 25, 2016 (abridged international flights of ORD in October 25, 2016)
To generate the “plottings,” I mapped the course of every flight with a light grey line, and the spacetime line (i.e., the one treating course and duration synthetically) with a colored dotted line on top of the light grey one. At the end of the dotted line, I marked the location of each direct-flight destination airport—or, more specifically, the spacetime location of the destination airport, which differs from its “mere” spatial location—with a solid dot, in color, while the spacetime location of each of transit-flight final destination airport was marked with a colored dot having a tail. Alternatively, every transit airport of a transit flight was marked by a colored circle with two short colored lines extending outside of the circle to mark the directions of the previous and the next flights. The number of concentric circles in radical distribution represents how many times the airport in question served as a transit airport. Finally, all those dots (i.e., unique spacetime locations) representing the same destination airport were connected together with the “spline” command in AutoCAD, with the resulting from representing that airport. For clarity, the graphics were color-coded according to different airports being represented.

To expand several points here: as mentioned, my data extraction and mapping focused on one day of flying events, namely international flights departing from ORD on a random-choosing day, October 29, 2015. First of all, the focus of the time span, one day, emphasizes both its general representation and randomness. The data generated within one day is representative how the day is usually envisioned as one unit with a set of scheduled flights. Between ORD and each of its busiest gateways, there are usually
about 30 to 40 flights each day, including direct and transit flights, and the pattern of that, with due adjustment, recurs every day. In contrast, international gateways having little traffic with ORD will have less than 10 and sometimes as few as 5 flights every several days with some adjustment here and there. And at a time scale bigger than days, the pattern of flights, the arrangement of their times and frequency, will fluctuate significantly in response to many factors, including markets and weather. So, for those reasons, the time span of the data pool, one day, processes randomness; like travel, the mapping is subjected to unavoidable contingency in planning and inherited chances in its externality, for which it’s unrepeatable.

Besides the time window of my examination, I chose international flights as the scale of focus, rather than domestic ones. To keep consistent with that scale, I did not map the terminal legs of transit flights when those transited to domestic airports. Finally, concerning the effectiveness of the data, when there was more than one flight traveling from ORD to a specific destination airport following the same route (e.g., 3 flights go from ORD to IST; 2 flights go from ORD to PEK to DXB), only one of them is mapped, and the selection process was unbiased. The reasons behind both of these data isolation decisions will be elaborated in the following section.
CHAPTER 6: VISUAL SIMULATION OF THE NEGOTIATION BETWEEN SPACETIME AND AEROTORY

Reflecting on the final form of the map generated and on the methods used to produce it led to some revelations, and some decisions were affirmed.

The resulting map is a visual simulation of the negotiation between spacetime and aerotory. The reason to call it a simulation is because, as noted above, each flight is admittedly an unrepeatable piece of spacetime simply by the fact that it’s an independent experience. The method I used to map aerotory, with geo-direction as the spatial frame and time as the measurement, was an attempt to realize a figural demonstration of the unrepeatability of spacetime in aerotory, which is predicated on the variable duration of flights. Mapping was pursued with the hope that the portrait of this parallel could be an insightful metaphor of the negotiation between spacetime and aerotory.

Mapping began at one point, ORD, as the airport from which all flights originated. The differential between the actual spacetime and my mapping simulation is clear at this stage, for no matter when each flight departs—so, despite the truth that they are all different spacetimes—there will only be one starting point for the mapping. That single point obeys the mapping method completely, for it serves as a base point relative to which both traveling direction and traveling time create a new point. Yet, ORD does not exist on the map as a result of traveling; instead, it marks only the beginning of the travel and thus has no plurality of its own. The remnant effect of this can been seen from the multiple cycles around one dot (one transit airport) as well. That could be interpreted as one dot often serving as the transit airport for more than one transit flight. However, data would reveal that those are all different spacetimes. For instance, the flight from ORD to MAD (Adolfo Suárez Madrid–Barajas Airport, Spain) and ultimately to CPH (Copenhagen Airport, Denmark) was departing at 5:16pm, and arrived at MAD at 12:41 am the next day, and the flight from ORD to ZRH (Zürich Airport, Switzerland), which also transited at MAD, departed ORD at 1:55pm and arrived MAD at 9:20pm. There are two portraits of spacetime involving MAD there. However, since the duration of those two flights were both 7-hour and 25-minute, and the method only maps direction and duration, there is no visual distinction between these two versions of MAD, and that goes for all transit flights with the same duration.

Ture spacetime is about uniqueness and non-duplicability, the dot of original airport(ORD) and dots of transit airports on my map of aerotory failed to visually simulate that. However, when looking at destination airports, the result is delightful, for there is considerable variation in direction or time or
both in flights that lead to a great amount of differential in dots of destination airports. And visually, what that looks like is those stretched patches in color representing each destination airport. This variation of dots of destination airports, illustrate a kind of discrepancy that promotes a sense of uniqueness and non-duplicability, and that sense is evocative to spacetime.

As noted, the variation of dots of destination airports resulted from different directions or duration, or both is in fact due to diverse routes as a consequence of combining different flights together for one destination airport. And that ultimately is caused by an important mechanism of the industry of air travel, the hub-and-spoke system, through which many small airports use large airports as hubs and the thresholds of their international connections. While most of large airports are big gateways as far as international flights are concerned, the economic benefit of the hub-and-spoke system remains, which is that consolidating flight choices at a hub makes each flight more profitable. At the international level, that becomes manifest in even more diverse matching of transit flights. And that casts back to the mapping case here the guarantee of destination airports’ composition of diverse routes (meaning transiting at different airports). As the result of those diverse routes, destination airports with rich plurality appear, an imitation of spacetime starts to emerge. A two-dimensional map using the “spacetime method” creates a simplified simulation of four-dimensional spacetime.

Therefore, using the “spacetime method” ultimately works, and it works better, in this case, at an international scale. It also works most efficiently when only one set of data is used for one route (in contrast to mapping out all flights going from ORD to MAD to CPH in October 29, 2015); at this point, it is clear that what contributes most to the visual simulation of spacetime is the diversity of routes. Although the same route with different duration (as the real situation would be) would also provide different dots of destination airports that will inflect the shape of the final figure, those dots tend to have less impact on the shape of the figure, so mapping them is less effective to the argument.
CHAPTER 7: SLICES OF REALITY

“The surface of the earth, and all the roads, are the site of millions of journeys” (Tate, 2016). The way Richard Long talks about his walking artworks exhibits his reading of every single event as unique. While he may not think about spacetime as this term of space and time continuum the way he framed his two works described above—with space and time as two interlocked factors channeling the creation of the work and with Long making sure the walk is restricted in space and time—capture this unnamed tension that is otherwise left out when the world is abstracted through space and time as detached ideas.

Although each of Long’s works is a single walking performance, those works bring forward the rich unperformed ones. In contrast, Long’s maps seem relatively mute in articulating the layered aspect of his work, despite the fact that Long believes them to be straightforward tools for documenting and presenting his walking art pieces. In his maps, land (the geographical map) is still presented as an indiscriminate setting, non-deconstructed, which defeats the “cutting” nature of walking, in which each operation generates one non-duplicable slice of reality.

The map of aerotory attempts to stay true to that idea that each experience is a unique event. Because each journey is unique in terms of time and direction, they generate distinct end points on the map, representing different spacetimes, different slices of reality, even when keyed to one place. By stating that, I am stressing again the importance of the individual event, which leads us back to the ability of humans to integrate space and time through experience. And it was from the perspective of experience, old tool of sea navigation practiced. It is from the same perspective, the method of mapping aerotory developed. Finally, the visual product, the aerotory map, in return helps giving shape to our understanding of this experience of spacetime.
REFERENCES


APPENDIX A: MAPS OF AEROTORY

A1, Map 1-Map of abridged aerotory of ORD (Chicago O'Hare International Airport) in October 25, 2016 (abridged international flights of ORD in October 25, 2016).
A2, Map 2-Map of countries of abridged aerotory of ORD (Chicago O’Hare International Airport) in October 25, 2016.
A3, Map 3-Map of continents of abridged aerotory of ORD (Chicago O’Hare International Airport) in October 25, 2016 (in which each route line is indicated in gradient color representing the change of time)