

**ENTROPY AND ARCHITECTURE:
ENTROPIC PHENOMENA ACTUATING DYNAMIC SPACE**

by

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April, 2008

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ABSTRACT

Accepting the second law of thermodynamics indicates that any energy source is not infinite. At the event fossil fuel reserves in Alaska are depleted, the massive infrastructure supporting fossil fuel extraction—including 800 miles of pipeline—is assumed to be obsolete. This thesis endeavors to acknowledge the Pipeline's relationship to energy transfer and create a future plan of adaptive reuse.

This thesis exposes processes of energy transfer or entropy. It acknowledges environmental entropy and utilizes observable phenomena of global warming within Alaska. It argues that since physical systems are universally subject to entropy, and ideal systems are connected to physical systems, ideal systems are as subject to entropy as physical systems.

The exposé of these entropic values occur in a design of an experiential space at the southern most marine terminal of the existing system. It demonstrates the experience of social entropy through spatial configurations affecting communication; it informs a hidden nature of fuel as commodity. Additionally, it exposes environmental entropy by connecting dynamic spatial changes in Valdez to measurable triggers along the Pipeline's corridor.



Introduction: Alaskans and the Pipeline

Social Context

Growing up in Chugiak, Alaska has yielded an overt spectral disparity between acceptance and denial of the United States culture. My childhood friends and I always felt a solid connection to the culture of the United States, and though some of us traveled by airplane to see distant relatives, we perceived no real cultural distance. Perhaps through the ritual of a school day, cartoons on Sunday, language, ethnicity, fast food, proximity to a large city, and a plethora of other subconscious variables, we knew that our artifacts and lifestyle were a congruency of an American life.

But often when Alaskans communicate with out-of-state friends and relatives, both the novelty and distance of Alaska becomes conspicuous. And even talking to international travelers also reinforces this—"Oh, you're from *Alaska?*" The high resident turnover also confirms the tendency to lessen their stewardship of Alaska as most non-native people in Alaska are not born in Alaska, and not many people in the highest populated areas ever consider

retiring in Alaska. “For every three baby boomer leaving the workforce, only two will be replaced.”¹ As a non-native, my lineage of four generations is unusual as Alaskans in the cities usually boast their *years of residency*. Alaskans also reinforce the social disparities themselves by taking the American ideal of individuality to new extremes. When traveling in other states, this author’s father would wear a baseball hat that read “United States of Alaska” in a move of slight antagonism to other non Alaskans. It is not rare for Alaskans to love and boast their geographic novelty.

While the cultural disparity is often not apparent, the geographic disparity is larger than the imagination. Alaskans understand that the area of their state is more than double the size of Texas—though most national weather reporting ignored the state until the 1990s. But most Alaskans cannot *actually* comprehend the size of their own state, and they usually have only visited a small fraction of the entire state. In the 1970s, the television stations in the larger cities received nationally syndicated shows via postal service, and these were broadcast two weeks later than the contiguous forty-eight states. By the

¹ <http://www.ktuu.com/Global/story.asp?S=5801243> Retrieved 9/13/07, Created 12/11/06 by Rhonda McBride for KTUU

1980s satellite technology was available for a wider audience allowing Anchorage television to broadcast in tandem with the lower forty-eight. Geographic distance has become less significant in terms of cultural connection, but it is easy for Alaskans with their individualistic spirit to ignore major events in the rest of their state or nation.

Many Alaskans know that their yearly Alaska Permanent Fund Dividend (PFD) check is a result of oil money, but most have no idea that the state government pocketed \$900 million in one day from the 1968 lease sales of North Slope property to oil companies. The majority of Alaskans will gladly cash their yearly Permanent Fund, yet they are willing to give polar opinions of big oil. Because of the vast, unimaginably large terrain, a majority of Alaskans have never seen oil leave the earth near Prudhoe Bay or get shipped out from the Trans-Alaska Pipeline terminal in Valdez.

The Pipeline itself is thought of as a wonder of the world, and its imagery evokes the emotions of manifest destiny like a great finale of westward expansion to John Gast's 1872 painting *American Progress*. Even before Alaskans received a yearly dividend check, they thought of the pipeline with extreme pride. This is especially true of

those who worked on the pipeline and received unusually enlarged paychecks. The Pipeline has completely integrated into the Alaskan conscious as a symbol of wonder and pride; we believe we possess all the superlatives and those from out-of-state reinforce this myth. The Pipeline's stainless steal skin breeds wonder as it streaks and weaves across tundra and woods. There is an (almost) unspoken pride when mentioning the line or seeing it for the first time. It feels unbearably huge and beautiful. Relative to its construction, the natural space that was disturbed to build the Pipeline appears to have regained itself and the pipeline now appears to belong in its setting. It does not communicate context as to the physical nature of its contents; and the perception of its context is completely controlled through Oil Company marketing. One almost always perceives the Pipeline through public relations imagery prior to seeing it in person. This marketing often contains well-photographed, images of the elevated portions of the Pipeline with a caribou as scale figure depicting the animal's ease of traveling under the line as well as its lack of fear around the line. This marketing does not depict oil spills, show roustabouts getting dirty, or any of the extremely ugly pump stations distributed along

the line. Just as marketing has been repeatedly been proven to influence social consciousness, we remember the images and messages from the oil companies (and fellow Alaskans) when actually seeing the pipeline for the “first time”.

Many Alaskans don't know how much oil has been produced in Prudhoe (over 15 billion barrels), and many don't know that the average daily production has decreased from over 1,000,000 barrels to 400,000 barrels and below. The state of Alaska wisely divested the base investment for the Permanent Fund Dividend early in its life. So while each resident's PFD check is based fractionally on oil prices, it is a poor indicator of current oil revenues. The state itself does profit from high oil and natural gas prices through its Petroleum Profits Tax. It is this relationship that is suspect since the state has a self-sustaining vested interest in the continued exploitation of land. Were it not for the Alaska National Interest Lands Conservation Act, the State of Alaska would surely have sold leases where the Arctic National Wildlife Refuge now lays. Why wouldn't they?

The social culture of the Permanent Fund Dividend (PFD) is itself an anomaly. Every year in October, each Alaskan resident (including babies) receives a dividend

check. This check is almost always over \$1000 dollars per person, and as of 2007, it is approaching \$2000. Large, poor families may gain the funds to accomplish major projects like a badly needed roof while allowing themselves some luxuries through the winter holidays. Other families—typically educated, middle-class—may turn the dividend into a college savings plan. Yet, it is also the norm to find absolutely ridiculous spending within every social class. The bars are busy and trailer courts have new Piranha tanks on display. Local businesses love the dividend season, and the seasonal PFD marketing has become sophisticated since the dividend's inception in the early 1980s. It is the PFD that preempts the holiday shopping in October—not Thanksgiving in November. The concept of the dividend has been an important political topic over the years, but it is truly political suicide to attempt to eliminate the Permanent Fund Dividend for even the most responsible of reasons.

We Alaskans accept our bribe from the oil companies in exchange for fuzzy details. Our investment in the land's best interests tends to be diminutive as only the indigenous natives are truly from Alaska. Most of us choose to live our lives as Americans in Alaska, but we increasingly choose to

die elsewhere. This is the context that reinforces a hyper-modernist, utopian spirit of the Pipeline.

This thesis will analyze the future of the Alaska pipeline with respect to entropy in an effort to show the potential of adaptive reuse. This thesis will demonstrate that the pipeline and other systems are affected by entropy, and perpetually demands energy to be maintained. Since entropy is scientifically defined, then it can be exposed.

To this end, this thesis document will discuss entropy in the Alaskan Pipeline, political economies, and in the built environment. It will analyze the context of Valdez, Alaska—an end node of the existing Pipeline, and with this investigation complete, the thesis will illustrate these systems in the design of a space that experientially exposes entropic conditions. The space shall occur in Valdez, Alaska—the most visible façade of the existing pipeline system. This space shall expose environmental, social, and political entropy.



Entropy: A Case for Adaptive Reuse

entropy \en-trō-pē\: measure of the unavailability of a system's energy to do work².

The Trans-Alaska Pipeline System has a contingency plan to include demolition when the system no longer serves fossil fuels. The useful matter in the system will most likely outlive the system itself. All of the tangibles, except the land occupied by the pipeline, are owned by Alyeska (pronounced al-ee-es-ka) Pipeline Corporation (a consortium created and owned by major oil companies), and most of the land and spatial rights are leased from federal and state governments. The federal agreement³ stipulates:

1.10.1. Upon completion of the use of all, or a very substantial part, of the Right-of-Way or other portion of the Pipeline System, Permittees shall promptly remove all improvements and equipment, except as otherwise approved in writing by the Authorized Officer, and shall restore the land to a condition that is satisfactory to the Authorized Officer or at the option of Permittees pay the cost of such removal and restoration.

This begs the question: once the pipeline system is terminated, do other viable uses exist?

² Daintith, John (2005). *Oxford Dictionary of Physics*. Oxford University Press.

³ United States. Department of the Interior. "Renewal of the Agreement and Grant of Right-of- Way for the Trans-Alaska Pipeline and Related Facilities between the United States of America and Amerada Hess Pipeline Corporation, BP Pipelines (Alaska) Inc., Exxon Mobil Pipeline Company, Phillips Transportation Alaska, Inc., Unocal Pipeline Company, and Williams Alaska Pipeline Company, L.L.C." 8 Jan 2003. <<http://www.jpo.doi.gov/TAPS/TAPS%20Renewal%20Grant.pdf>>

From the viewpoint of a capitalist squeezing the last drops of money out of the site, or an environmentalist who opposes the TAPS system, the conclusion to demolish the TAPS system may seem unanimous. The capitalists will sell the parts that made the pipeline; marketing their efforts as recycling while those components will be shipped to varying parts of the globe. Some environmentalists will laude the closure of the system and those in history who required the original environmental impact statement and its conditions to return the spaces occupied by corporations to natural spaces. Both of these views are emotionally loaded and do not attempt to analyze the actual costs, tangible benefits, or entropy involved in abandonment, removal, or adaptive reuse.

The Trans-Alaska Pipeline System was an \$8 billion construction project. It was the largest, most expensive modern project produced up to 1977. Considering the Consumer Price Index⁴ to adjust for inflation, those 1977 construction costs equivocate to about \$27.52 billion in 2007. One must then account for the massive

⁴ United States, Department of Labor, Inflation Calculator, 2007. Bureau of Labor Statistics, 15 Sep 2007.
< <http://data.bls.gov/cgi-bin/cpi/calc.pl>>.

maintenance costs since implementation. This is significant because all of the TAPS structural members receive transverse loads as oil moves within the Pipeline and creates dynamic loads. With inflation and rising maintenance costs considered, the TAPS system is probably still the most expensive, privately funded project in history. It also rivals the costs of contemporary, major public projects. By analyzing the pure embodied *value* invested into the current system and juxtaposing that information against the mortality of crude oil production, we should ask what is appropriate, regardless of predetermined agreements.⁵ The current system *assumes* an economy of demolition.

A British Petroleum employee told this author in an email:

"I'm sure that by the time the pipeline is obsolete, it will make financial sense (regardless of obligations we have with the state) to recycle it. The price of steel is going through the roof - so much so that estimating project costs has become difficult because it is impossible to predict how fast the steel prices will rise. I imagine that heavy equipment will drive down the corridor to remove the pipe and to recultivate the land as they pass through. There may be some sections of pipe bought by companies that hope to sell hoops of the pipeline to individuals, or make art out of it (like you often see in MT - steel cut with a torch into a 2-D shape and heated until it discolors). *Nothing very exciting architecturally, I'm afraid."*

⁵ Demolition is written into Federal the Right-of-way agreement, but it is not clearly articulated in the State of Alaska Right-of-Way agreements.

The viewpoint of this employee also represents an *assumption* that the value of steel will outweigh the astronomical costs of extraction and shipping. First let us analyze the value of steel to be removed from the site. The autumn 2007 value of \$529 per short ton⁶ of steel yields about 1.1 billion dollars. While this is a huge economic value, this translates to only \$260 income per lineal foot of pipeline. Since the easiest conditions of removal usually fall within a narrow three to four month window between frigid seasons, then the resources to remove the pipeline must organize for this schedule. The main portion of the pipeline is over 4 million cubic feet of steel and the costs to ship this weight must also be factored. Since the rising value of steel is directly connected to energy costs, then both the costs and benefits rise in tandem. As there are only micro-refineries in Alaska, the oil companies must also import refined fuels for major projects such as the demolition of the Pipeline. Therefore even when selling petroleum to themselves they must calculate the expense at market value since it could have been otherwise distributed for income. In addition to the valuable steel,

⁶ SBB. The Steel Index. 10 Sep 2007. The Steel Business Briefing Limited. 20 Oct 2007 <<http://www.thesteelindex.com/>>.

there are millions of pounds of aging equipment and materials to remove from pump stations which have little value. Bare in mind that the pipeline is 800 miles long and is lineated across the most remote, extreme terrains. While some areas of pipe near large cities are easy sources to recycle, the entire line may be a losing proposition. Because of its scale and the Exxon Valdez Oil spill, the Pipeline is so politically loaded that cleanup and demolition methods would likely be intensely scrutinized—adding red tape and increasing the costs of demolition. After accurately accounting for the scenarios of abandonment versus the costs and benefits of demolition, the choice to abandon rather than demolish is realistically more viable for the oil companies. Furthermore, while the economy of fossil fuels is in decline, the guarantee that weakened oil companies will fulfill their 1970's obligations of demolition and restoration is also fallible.

Since the pipeline is an energy-commodity system, it is significant to attempt to conceive of all of the embodied energy that the system has absorbed in its creation and maintenance. Consider the $\frac{1}{2}$ " thick, 4' diameter *custom* steel manufactured in Japan and staged throughout the states of Alaska and Washington, and the custom steel's

overall shipping weight of roughly 2 billion pounds. Consider for the embodied energy of the concrete weight of 75,000 pounds per 40 foot section at over 800 river crossings; and the 18,500 pound concrete weight at each flood plain. Consider the 554 vertical, modulated steel pairs that support the pipeline in its most photographed, elevated views with 39,000 pipe shoes. And then factor in the insulation and stainless steal skin along the entire length. Consider the creation of 225 non-frost susceptible access roads used year round. Consider eleven pump stations evenly distributed along the pipeline corridor. Think of each pump station a small company town with a power plant⁷, a micro-refinery, turbines, massive oil pumps, fire response, an airport, living quarters, food service,⁸ and sometime refrigerated foundations (5 stations). Think of the microwave and satellite communications infrastructure throughout TAPS. And consider the Valdez Marine Terminal and its holding tanks, fire suppression, 12.5 megawatts of steam generated electricity, and oil distribution. On top of this, factor in the infrastructure for the thousands of employees required by the TAPS system for production and

⁷ 1.3 megawatts to 4.7 megawatts

⁸ Some pump stations are now on standby with minimal function.

maintenance, and then consider the over 70,000 employees required to construct the pipeline. Additionally, account for the framework for oil spill prevention, detection, and response. We must also consider almost 10 years of engineering, planning, and design for seismic, permafrost, and politics. Ignoring the subjective monetary value of the pipeline, we face an unfathomably large embodied energy in the Pipeline's creation and maintenance. It is logical and responsible to ask how else 800 miles of continuous pipe could be beneficial. The current plan to demolish the pipe is based on an *assumption* that there is no adaptive use for the pipe in its current configuration.

The concept of entropy is that systems move in time away from their previous state. This is interpreted as chaos by human perception. Energy is required to maintain the present or desired condition of any system. Thus ice melts in a glass, new cars get old, and living things eventually die. Entropy in a dynamic system is more severe than in a static system. An old car that is used for fifty years breaks down faster than assembling fifty-year-old packaged parts to create the same car. Both systems move toward chaos, but the dynamic system is accelerated. Thus more energy is needed to maintain the dynamic system. The phrase

“keep it simple stupid” pays direct tribute to the second law of thermodynamics and entropy.

Though the Pipeline may seem static, the dynamic oil moving through it requires the system have increasing maintenance costs. Recently, the operators of the Pipeline have been increasingly accused of improperly maintaining the system⁹. Considering the nature of entropy, a shortfall in the amount of initial energy required to maintain the Pipeline equivocates to a greater total energy required to bring the system back to a desired state. In other words, it is cheaper to do smaller amounts of maintenance frequently than less frequent maintenance all at once. Thus the nature of the pipeline as an excessively large *dynamic* system is not ideal. While oil companies are notoriously wasteful of money, this has an equivalency in wastefulness of energy. Ideally, rather than adding more costs and energy to demolish the Pipeline, we could replace the existing system with one that tends to be more static and thus less wasteful.

It is not preposterous to ask if there are other projects or disciplines that need 800 miles of continuous pipe for

⁹ Horsley, Scott. "BP Pipeline Maintenance Program Draws Scrutiny." NPR. Morning Edition 08 Aug 2006 12 Sep 2007
<<http://www.npr.org/templates/story/story.php?storyId=5626067>>.

redefined application. What opportunities exist in leaving the Pipeline intact while the system of fossil fuel production dies? What if we gave the Pipeline to physicists? What if we gave it to artists? Even if the Pipeline were eventually to be demolished, the second law of thermodynamics insists that we investigate the benefits of allocating a portion of its life to experimentation and art, before it be destroyed. What if that experiment yielded a beneficial adaptive reuse? Given Alaskan Oil's existing life expectancy of 10 to 50 years, it is our responsibility to analyze the potential of the existing infrastructure in its current location. Compared to the costs of creation and demolition, an adaptive reuse is miniscule in terms of energy consumption or economics.



Context of a Political Economy

Much of western society at the time of the Prudhoe oil discovery believed that the resources humans required to be fruitful and were limitless. We believed that the size of the planet far out-scaled human impact. In terms of exploitation, this philosophy enables the unchecked production of earth into dollars with the belief that nature is either too large to impact or that it will always renew itself. This defines the essence of utopia—the antithesis of entropy and the second law of thermodynamics.

The story of the Alaskan Pipeline itself is one of power, commodity, and spatial process. Almost no one outside of Alaska has visited the Pipeline to see any part of its four foot diameter steel along 800 miles or any of its pump stations, but thinking of the pipeline as a *system*, every person who fills a vehicle with gasoline has knowingly or unknowingly visited the Pipeline. Beyond the obvious energy benefits we demand of petroleum, our entire plastic based economy and its packaging are also the global Pipeline System manifest. As the French philosopher Lefebvre states, “Capitalism and neocapitalism have

produced abstract space, which includes the 'world of commodities', its 'logic' and its worldwide strategies, as well as the power of money and that of the political state." (Lefebvre, 53) This 'abstract space' is the realm of control as oil companies behave Machiavellian to achieve profits and systems of control. Lefebvre also describes the nature of commodity:

The commodity is a social 'being-there', an object irreducible to the philosophical concept of the Object. The commodity hides in stores, in warehouses—in inventory. Yet it has no mystery comparable to the mystery of nature. The enigma of the commodity is entirely social. It is the enigma of money and property, of specific needs and the demand—money—satisfaction cycle. The commodity asks for nothing better than to appear. And appear it does—visible/readable, in shop windows and on display racks. Self-exhibition is its forte. Once it is apparent, there is no call to decode it; it has no need to decipherment after the fashion of the 'beings' of nature and of the imagination.

With this we can think of the roles of plastics industry in marketing and packaging. The packaging of petroleum and petroleum as package both epitomize this idea of commodity while reinforcing the 'abstract space'. The long term results of these commodities are landfills with very high percentages of plastic and air pollution from combustion engines. With this we see the system of the pipeline at work. The commodity of petroleum is constantly demanded in multiple world markets, and this perpetually maintains the power of those who control its supply. Where

we find societies who demand petroleum, we will also find governments who benefit—in the form of taxation—from the economies of production or consumption or both. While global oil companies must pay local governments, they further reinforce the power of their industry and the power of their commodity. Therefore a dichotomy of economy and politics in terms of consumption and production is illegitimate.

The political economy of fossil fuels is a parametric that rewards (or bribes) local authority for the purpose of expanding market potential (of supply and demand) while ensuring global stabilization of the system. Since a matrix of economy and delivery already exists, there are only two things that these companies require: continued discovery of fossil fuels and governmental permissions to extract them. Inherently, the system endeavors to streamline (homogenize) its existing production and delivery methods with the best technology to suit the nature of its commodity. But more than that, the system flexibly organizes itself to understand the political and legal geographies of its intended endeavor. If the potential reward is high enough, then setbacks are merely delays. Road blocks are not

synonymous with failure; they merely determine the nature and size of the bribes.

The integral failure of the system is that its commodity is not limitless. The rate of new discovery and consumption do not result in a renewable system. As stated by the British Petroleum Statistical Review of World Energy in a 2007 article, "It's no secret anymore that for every nine barrels of oil we consume, we are only discovering one."¹⁰ Furthermore, new technological advances have allowed extraction in locations previously impossible and higher yields in existing oil wells, but these advances are increasingly expensive. Some estimates indicate that the existing global reserves will only last till 2020, the longest estimates indicate only thirty to forty years. If we accept that the globe contains 1.345 trillion barrels in reserve,¹¹ and if we divide that by a very conservative 83 million barrels per day consumption in 2004, then we are left with around 44 years of liquid fossil fuel supply. But the U.S Department of Energy predicts that the daily consumption will rise to 97

¹⁰ Malloy, Gerry. "Cheap oil supply has peaked." Wheels.ca 21 Jul 2007 28 Sep 2007 <<http://www.wheels.ca/article/30092>>.

¹¹ United States. Department of Energy. "World Oil Reserves by Region." 01 Jan 2005. Energy Information Administration. 18 Nov 2007 <http://www.eia.doe.gov/pub/oil_gas/petroleum/analysis_publications/oil_market_basics/sup_image_reserves.htm>.

million barrels per year by 2015 and then 118 billion barrels per year by 2030.

It seems that the existing matrix is so large, profitable, and powerful that it will not change until it is constrained by regulation, termination of supply, or lack of demand. Since governing regulators have an interest in maintaining a fossil fuel economy and the global market is only increasing demand, then we are only left with the inevitable termination of supply. The political sphere of Alaska has not endeavored to master plan for this inevitable event of oil supply termination.



Politics of Environmentalism (Alyeska Pipeline image)



Result of 1989 Exxon Valdez oil spill, photographer unknown
<http://www.wdr5.de/sendungen/morgenecho/417032.phtml?print=1&print=1&i=1>

Political Entropy

The concept of entropy may be expanded beyond physical systems and into more abstract systems including politics. Our language already infers that we think of political economies as political systems. This accepts the second law of thermodynamics with the concept that systems approach the more stable condition of chaos via entropy. Just as thermodynamic systems require energy to maintain a desired state, political systems require energy to maintain a required State. If a political system did not require energy to be maintained, societies would not need taxes, police, or a judicial system. Without the required energy input to counter the effects of political entropy we witness revolution and anarchy. In Alaska, the political economy demonstrates this concept well.

Historically, Alaskan politics is epitomized by the largest earmarks per capita of any state in the Union. While this has annoyed tax payers outside of Alaska, the status quo has been maintained by the power of large oil companies and because energy in Alaska is important to U.S. National Interests. Oil companies seek to maintain

infrastructure of public bridges, roads, and more; while politicians seek the success of jobs created in creating and maintaining infrastructure in tandem with a boosted economy at the expense of the rest of the nation. The politics of Alaska receiving myriad earmarks is embodied by currently serving, republican Senator Theodore (Ted) Stevens. His moniker "Uncle Teddy" has become an affectionate Alaskan nickname. Stevens is the oldest, longest, continuous member of the Senate. He assumed office in December 1968; the same year geologists discovered the significant oil reserves in the North Slope of Alaska. Stevens support for oil companies and powerful talent in directing federal money to Alaska reinforces the concept of politics and economy being inherently one system; in many ways, the economics of oil in Alaska is tandem with the political career of Ted Stevens.

In 2006, politics in Alaska was publicly known to no longer be a scrupulous system. Before 2006, a new natural gas pipeline has been sought to connect large reserves in the North Slope and other locations in Alaska to the lower 48 states via a Canadian route. In addition to this, some politicians and public supporters have gained support for a new pipeline tax (PPT) that increases the payments by oil

companies to the State. The now defunct Pipeline construction and maintenance company VECO (also formed in 1968) has lost face as its former founder and CEO Bill Allen has been indicted for conspiracy, bribery, and extortion in 2006—all related to stratagem against the new tax. Within Alaska, five state politicians have been indicted for corruption because of ties to VECO¹². One more state politician is still under investigation as of autumn 2007. The proposed PPT tax is now law, VECO no longer exists, and its founder, Bill Allen is now in prison.

But just as notorious, is a recently discovered VECO connection to Senator Ted Stevens. On May 28th, 2007, the FBI raided Senator Steven's home in Girdwood, Alaska¹³. The home had undergone a half million dollar remodel supervised by VECO CEO Bill Allen in 2000. As of autumn 2007, no indictments have been made against Senator Stevens, he has refused to resign, and he will seek re-election contrary to the requests of his republican colleagues. As of autumn 2007, the FBI investigation

¹²Lee, Jeannette. "Aides say agents looking for gifts, financial information." Anchorage Daily News 31 Aug 2006

24 Sep 2007

<<http://www.adn.com/news/government/story/8142285p-8034601c.html>>.

¹³ Associated press. "FBI raids U.S. senator's home." CNN.com/politics, 30 July 2007.

18 Nov 2007

<<http://www.cnn.com/2007/POLITICS/07/30/lawmaker.raid.ap/index.html>>.

continues and epitomizes the corruption (political entropy) surrounding the pipeline.¹⁴

As previously mentioned, the physical Pipeline has demanded unusually high maintenance because of inattentiveness to regular maintenance. This epitomizes the concept of entropy dictating that a system will require energy to sustain a specific condition. Just as a garden will grow wild without regular intervention, unaddressed entropy causes the corruption of the system as it seeks the more stable condition of chaos. If we think of a political economy as a system subject to entropy, then we can apply identical rules of entropy to its analysis. Until it was public, some of the energy input had been reinforcing corruption in Alaska. Yet, the political system reasserts itself to mitigate further entropy by investing energy towards the conviction of perpetrators, while a portion of the local economy reasserts

¹⁴ An interesting parallel exists between Alaska and New York politics. Robert Moses, an infamous New Deal Era developer, made fortunes with large scale civil projects. His relationship to New York's Mayor Fiorello LaGuardia is still scrutinized by historians because of "sweetheart" deals favoring Moses projects but at the expense of disempowered, low income communities. In a public speech Moses said, "You can draw any kind of picture you like on a clean slate and indulge your every whim in the wilderness in laying out a New Delhi, Canberra, or Brasilia, but when you operate in an overbuilt metropolis, you have to hack your way with a meat ax." Paying tribute to the success of political economies, the airport in New York was eventually named LaGuardia, while demonstrating yet again an example of the marriage of politics and economy. The fact that the airport in Anchorage is named Ted Stevens Anchorage International should surprise no one.

itself by publicizing and reporting the events around the scandals.

The social production of space is an abstract commodity system. The energy required to sustain the system is both physical and social. Geography and technology determine the accessibility of future resources, but more significant is the social demand for commodity created by 'abstract space' or the space of control. In its highest risk, capitalism may attempt to create new commodity and new markets. In much less risky scenarios it steals, redefines, or fine tunes markets systems already established to exploit profits. But sustaining an existing system is not always the most profitable scenario! Capitalism has the potential impetus to exploit the accelerated mortality of a system. Corporate pirates are defined by the action of acquiring an undervalued system, firing the employees, and selling or redistributing most of the assets for huge profits. While this may be a successful model for individual cases, over an entire economic system it represents the suicide of the economy as it welcomes and employs an entropic value in system mortality.

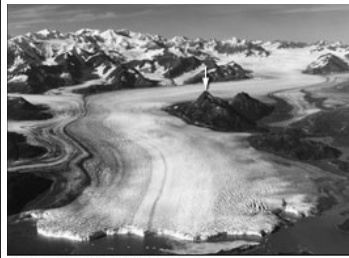
The model of the U.S. government coinciding with the second Bush administration has tended toward

governmental deregulation. This has been the belief that markets could theoretically regulate themselves. The power of the Federal Bank lay in its ability to adjust interest rates or to regulate. With deregulation, we now have billions of dollars over-borrowed in a housing market that cannot pay its loans. Homes are now worth less than their mortgage value and foreclosures are abundant. Billions of dollars in bail-outs are granted in order for major financial institutions to continue to exist. The markets have failed the first test to prove they can regulate themselves. The system did not input the proper energy to counter negative entropy. Chaos and wasted resources result, demonstrating the idea that entropy affects all systems—human or otherwise. Since energy to maintain the system was abandoned by government then that same input should have been accepted by economists to maintain the political economy. But since bail outs are required, then the government is still adding the required energy to maintain the system.

It is possible to imagine a responsible political economy with minimal corruption, but since high stakes capitalists weigh risk and return on investment, it is no wonder that they are tempted to input corruption into the political economy rather than add energy to increase

stability. Based on the similarities in social systems breaking down like physical systems, it is not hard to imagine entropy affecting systems outside of the strict realm of physics.

It is interesting that systems based in the minds of humans behave in a similar fashion to physical systems: a political system is vulnerable to political forces; a political system requires perpetual support like a physical system requires maintenance. Physics has indicated that the boundary of a system may be real or imagined to define the entropic nature of the system; it may follow that the system itself may be physical or imagined. Based merely on observation, the systems of the mind (social, political, money, love, ideas) are just as vulnerable to outside forces as physical system. If this be accepted as true, then the realm of the mind is equally subject to entropy as the physical realms.



Columbia Glacier c. 1980



Columbia Glacier 2005



Abandoned mine shaft

Images from Flickr.com

Entropy at the Human Scale

The acknowledgement of entropy may be applied to other human systems. Categorically considering systems in our human world as being influenced by entropy and thus requiring positive entropy to obstruct negative entropy, then we can analyze the forces and energy or nutrients for these systems. From physical and political models of systems influenced by entropy, we understand that frequent maintenance requires less total energy than infrequent maintenance; and waste is decreased. If we think of our relationships, economies, human plans, and the built environment as systems influenced by entropy, the same rules consistently apply to support or overthrow the system.

A human system is the categorical combination or isolation of time, space, matter, energy, ideas, knowledge, or fantasy. In common vernacular this can include function, and in temporal-spatial terms this is program.

Entropy is the measured process of change within a system. Applied to human systems and other systems, if unchecked, entropy increases the perception of exponential chaos within the system. Humans experience this when

categorizing space to be an uncluttered system. To keep a bedroom clean, frequent maintenance is less overwhelming than maintenance once per ten years (a roommate of this author once accomplished the latter). Entropy may be obstructed, but it is perceived as chaos when ignored. This is consistent with our physical bodies, relationships, jobs, and future plans. Energy is perpetually required to weigh the probabilities towards human goals. While entropy may be obstructed for millions and millions of years, eternal obstruction remains in the realm of Utopia.

Entropy as Experience

As previously mentioned entropy is integral to the second law of thermal dynamics and the nature of our universe. It governs the relationships between form and space and time. The second law indicates that “energy spontaneously tends to flow only from being concentrated in one place to (chaotically) becoming diffused or dispersed and spread out.”¹⁵ In addition to this, the second law dictates that entropy (unusable energy within a system) gradually increases with time. Physically, this is a measured degradation of form across time.

Among other things, the second law governs the one-way transfer of heat from warmer systems to colder systems (prohibiting the opposite), as well as the chaotic distribution of matter from burning wood. Furthermore, the second law dictates that a physical system cannot be (or contain) a perpetual motion machine (more energy output than input) for that would indicate a lack of the presence of entropy and violate both first and second laws of thermodynamics. As stated by astrophysicists Sir Arthur

¹⁵ Lambert, Frank. "The Second Law of Thermodynamics!." Aug 2007. Occidental College. 24 Jan 2008 <<http://www.secondlaw.com/index.html>>.

Stanley Eddington, “The law that entropy always increases, holds, I think, the supreme position among the laws of Nature. If someone points out to you that your pet theory of the universe is in disagreement with Maxwell's equations — then so much the worse for Maxwell's equations. If it is found to be contradicted by observation—well, these experimentalists do bungle things sometimes. But if your theory is found to be against the *second law of thermodynamics* I can give you no hope; there is nothing for it but to collapse in deepest humiliation.”¹⁶

At the human scale, we understand that skiing down a hill may result in a broken leg, but reversing the order of events and considering a person with a broken leg skiing up-hill and having a mended leg at the top, resides in the realm of fantasy. Reiterating this idea, a car wreck results in wreckage and chaotically dispersed matter, but the concept of a car fixing its dents after impact can only be witnessed in video reversal.

We humans are destined with a negative connotation toward entropy. Yet, a beautiful aspect of Life is that while individuals are universally subject to entropy and mortality,

¹⁶ Eddington, Arthur. The Nature of the Physical World. 1st ed. U.S.A.: The Macmillan Company, 1928.

the process of evolution has allowed (or forced) species to utilize entropy as a tool in the success of the species. The plant variations of the *Callisia* genus (Wandering Jew) of Central America and Mexico exemplify this. While the plant may flower and procreate, it is increasingly successful when its stalk is broken by outside forces from animals or weather. Like the sacrifice of a pawn to win the game, the plant actually aids this process by the acute thinning of its stalk when the stalk becomes exceedingly long for the transportation of nutrients and water. The humid climate allows the independent stalk to maintain water levels while it roots itself. Once rooted, it focuses its energy on growth. The individuals may receive damage, but the overall species is highly successful. The plant kingdom exemplifies the usefulness of entropy and chaos as they welcome the distribution of reproductive matter by animals and weather. For all life forms, sex is the obstacle to entropy of the species and it increases the probability of the species success—though it is no guarantee of course. And even for the individual organism, the absorption of nutrients is an entropic process; one system loses energy, another gains it.

The philosopher Plato promoted the concept that the idea of the object was dominant over the physical matter that made the object—a universal truth. Any or all of the identifiable parts with a specific chair need not be in any other chair, thus even a boulder may become a chair. The fact that the object *acts* as a sitting tool is all that is important. But this is contradicted by the philosopher Aristotle who rejected this by simply arguing that without the physical matter and physical act of sitting there would be no chair at all. Regardless of dominance of idea or matter, the coexistence of the two defines at least some of our human reality. If an idea is manifest with a physical counterpart, then it follows that both are subject to entropy.

Architecture is the creation or capture of a spatial experience. This is reified in the built environment. A music room may be designed to optimize an experience of music, while it may also capture an existing experience in the natural environment. Since ideas and matter jointly define our human perspective of space, form, and time, then it follows that the experience of architecture—both physical and ideal—is dynamic and subject to entropy.

Entropy						
Entropy is the measured transfer of energy Joules/Kelvin; (energy/temperature) Entropy is a process, not an effect						
System typology	energy typology	energy source	energy loss to	entropic +	cause of energy transfer	entropic process
physical system A	mechanical electromagnetic thermal chemical nuclear	system B warmer system B	system C cooler system C	direct contact conduction radiation reaction reaction/decay	internal/external forces	loss of energy (entropy increase) 2nd law of thermodynamics
political system	support (taxes/contributions)	populous	other political system/ anarchy	corruption experience	competitive factions, retirement, scandal, illness, death	mortality of those in power
polar bears	food	marine habitat	other organisms/ increasing prey populations	global warming/ habitat decrease	pollution from fossil fuels	global warming
stellar sea lions	food	habitat	other organisms/ increased prey populations	Eaton Volcanic spill habitat decrease	conflict of industry and habitat space	global warming
life	nutrients	habitat	other life/environment	illness, death	entropy	• environment/ - evolution
economic system	commodity	environment	environment	deregulation inflation	competition, supply/demand	resource limitations
built environment	mechanical electromagnetic thermal chemical nuclear	resource environment	environment	water, weather, fire, corrosion, poor design/ construction	increased population, home as trade commodity, poor craft physical environment	entropy increase 2nd law of thermodynamics
(time) space	matter	matter in future	matter in past	+ gravity/volume	curvature from mass/volume relationship	mass converted to energy ($E=mc^2$),
architecture	experience	future/fantasy	past/environment	glimpse lack of demand	architecture as built environment, architecture as documented idea	mortality of built environment, mortality of architect
				- gravity/volume		expanding universe
						education of new architects renewable materials/ material longevity/ material longevity/ geometry

Entropy

The Rules of Entropy

Entropy is a measurement regarding the second law of thermodynamics which indicates energy spontaneously tends to flow only from being concentrated in one place to becoming diffused or dispersed and spread out. It is a process.

Entropy is *not* synonymous disorder; it *is* concerned with a measured distribution or transfer of all forms of energy. A city may be destroyed by an earthquake, and appear disordered, but the actual transfer of forces destroying the city may be measured, and thus entropy occurs during the destruction of the city. A messy house has been demonstrated as an example of entropy, but it is not the disorder that is entropy, rather is it the use of the objects (external forces) by humans that is entropy. The process of food digestion (chemical oxidation) also represents a transfer of energy. The second law of thermodynamics is the basis for both life and mortality, and its measured process of energy exchange is entropy. Hence the connotation of entropy as good, bad, ordered, or

disordered is irrelevant. Entropy simply exists and may result in any subjective human interpretation.

Entropy is *not* an omnipresent force within the universe akin to gravity. Rather its process is concerned with the transfer of energy caused by forces. The second law indicates that the distribution of energy within a system is chaotic, but this is the result of real forces in a cause-process-effect cycle.

Internal and external forces act upon a system in accordance with the laws of thermodynamics and tend to cause entropy.

The boundary of the measured system may be real or imagined.

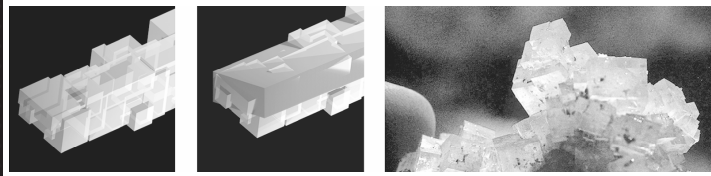
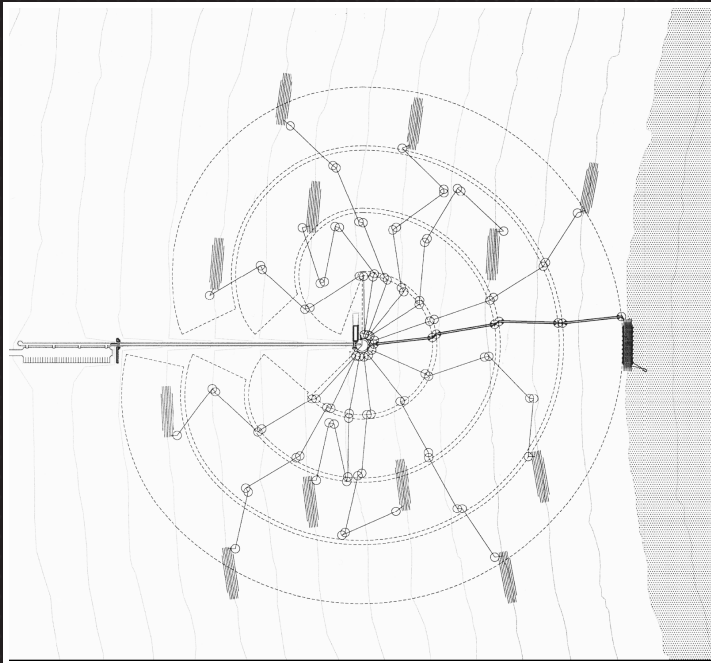
A perpetual motion system—a system which produces more energy than it consumes—shall not exist.

Relatively warmer bodies will only transfer heat to cooler bodies. The existing heat within a cooler body cannot be extracted toward a relatively warmer body.

The dimensions of entropy change are joules/Kelvin or energy/temperature.

Entropy may be obstructed, and thus the measure of entropy may be equal to 0.

Every system within the universe (all that is real), including the universe, is subject to (unobstructed) entropy; a system merely need to exist to be subject to entropy. This enables a paradox within classical physics regarding entropy and the laws of thermodynamics; if entropy is a measure of energy transfer and the universe is a physical system, then where could entropic energy transfer to? Is the universe not subject to the laws of thermodynamics? Is the “perfect” obstruction to entropy represented by having no real place for transfer energy to? This is problem regardless of a finite or infinite universe. One solution may be that the universe transfers energy to itself albeit to different time-spaces.



Precedence Study: Salt Chapel

Measuring in Architecture

Randall Ott, Architect

The Salt Chapel figuratively and literally explores and tests the dichotomy among wet and dry boundary conditions. While the design of the chapel is mobile, the theoretical chapel is uniquely sited on the beach of the Great Salt Lake in Utah. It is intended as a non-denominational spiritual space.

In response to its site, the rectilinear geometries are reminiscent of natural halite (salt) formations with articulations of cubes irregularly joined. This geological reference manifests itself in central body of the chapel in plan and elevations, but consistently manifests itself in detail. This formal characteristic thematically extends to the spatial qualities at the human scale; it feels as if the one were inside a halite prism.

The chapel explores static and dynamic space as a great, segmented arm extends from a central dwelling to the roving chapel and defines its large, arcing path. "Repeat visitors will never encounter the roving space in the

same precise spot.”¹⁷ The segmented leg of the great arm, punctuated by the chapel, literally measures the landscape and the passage of time.

The Salt Chapel poetically observes and responds to a natural resource while demonstrating measuring in architecture. Like a sundial, this project demonstrates measuring through movement. The project celebrates both static and dynamic architecture, and its experience epitomizes qualitative measuring rather than quantitative measuring. While the presentation of the project fails to depict scale figures (ironic in a project that incorporates measuring), it informs future projects that wish to dynamically communicate time and space. Because site conditions are not static, a change in environment can trigger a meaningful change in architecture.

¹⁷ Ott, Randall. "Salt Chapel." Journal of Architectural Education 57(2004): 10-17.



<http://futurefeeder.com/index.php/archives/2005/01/16/wind-powered-transport/>

Precedence Study: Kinetic Sculpture

Entropy and Mortality

Theo Jansen, Designer

In the Netherlands, artist and physicist Theo Jansen designs mega-creatures in an exercise to create life. Jansen himself refers to his creations as animals and applies Latin monikers consistent with biological convention. Interestingly, the purpose of his exercise is to create self-sustaining systems before his own death.

The creatures Jansen designs are powered by only by wind, mobile, and made up of thousands of moving parts. Their appearance seems to be of the scale of medium size dinosaurs as they lumber across the beach with dozens of legs reminiscent of many variations of living creatures. Each species is a dual exploration in the poetry and efficiency of harnessing wind power. Jansen has even developed a simple binary brain that allows the creatures to keep track of their own location in space through the number of steps the creature takes between dunes and ocean. Many of Jansen's animals have the ability to sense water through a small wind powered pump, and then turn

themselves around. Another system senses when the wind is too strong, hammers a stake into the sand, and protects the creature from being overturned. He has also developed passive methods to store wind energy such that the animals may move themselves out of a tidal zone, even when the velocity of wind drops to zero. Each exploration is a play in increased possibilities of harnessing wind energy while determining that the limits of efficiency are elastic.

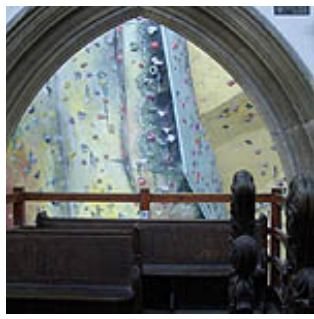
The form and motion of the creatures is a morphogenetic exploration and is directly inspired by existing and extinct animal life. While the wind powers them, they walk in the manner of life. His Animaris Rhinoseros moves both like a tarantula and a rhinoceros. His Animaris Percipiere feels like a giant, crawling lobster complete with tail. To human eyes their form and movement is alive. Jansen also captures the wind uniquely in each creature. Sometimes the wind flaps giant wings atop the creature's back and thus adds energy to the system. Other times, the method of wind capture is reminiscent of existing mechanistic systems like anemometers. In each case the overall system is an exploration in the poetry of place as the creatures are

designed for the beach-boundary condition at land and water.

The study of Jansen's work is an interesting exploration of poetic innovation in the development of a physics based system. With an understanding of entropy, he develops systems with an emphasis on sustained survival; and while accomplishing this, he has eliminated the imaginary boundary between art and physics. Knowing full well that Jansen himself is a mortal system, he seeks the creation of systems that explore and extend the limits of mortality.

Jansen's work demonstrates basic thermodynamic principles. When energy is converted from one medium to another—like burned coal becoming thermal energy and then electrical energy—then energy is lost with each conversion and entropy is increased. While thermodynamics indicates that some level of entropy is omnipresent, efficient systems attempt to utilize energy by minimizing energy conversion and optimizing energy use. Jansen's animals epitomize this concept by utilizing wind (kinetic energy) with only one conversion to mechanical energy. These animals do not convert kinetic energy into electric, thermal, or other types of energy. Within the

animals, each system (like pumps, legs, brain, et cetera) works directly from the capture of wind and Jansen increasing stretches the boundary of this accomplishment with the design of new systems.



Precedence Study: St. Werburgh, Bristol Mitigation of Entropy in Adaptive Reuse

According to Christian tradition, Saint Werburgh was of 7th century royalty in the Saxon kingdom of Mercia. Her lineage was pagan from her father and Christian from her mother. Both her mother and her mother's mother were canonized, and her father converted to Christianity. Against her father's original plans of betrothal, she abandoned a royal life for one of Christian ordination and sacrifice. She eventually became head abbess over the realm of Mercia and was instrumental in reforming and expanding Christian communities. Her success led to her fame, miracles were attributed to her after her death, and she was eventually canonized.¹⁸

Nearly 800 years after her death, the community of Bristol consecrated a gothic cathedral to her at its town center. The choice of the gothic style remained in fashion in the 15th century, and since the style was founded by Abbot Suger centuries before, it was a favorable choice for abbeys throughout Europe. Since the patron saint of the new

¹⁸ Casanova, Sister Gertrude. "St. Werburgh." New Advent, The Catholic Encyclopedia. 1912. Robert Appleton Company. 15 Nov 2007 <<http://www.newadvent.org/cathen/15588b.htm>>.

cathedral was herself an abbess, the choice of the gothic style was consistent.

In the late 19th century, the Cathedral was painstakingly relocated to a suburb due to increased development in Bristol. By the 20st century, the populations in these suburbs waned and the diocese closed the cathedral.

But in the 21st century, a new proposal allowed the public to reenter the sanctuary of the Cathedral, albeit with a new program. With a lease from the diocese, the Bristol Climbing Centre converted the interior of the space into a giant wall climbing arcade. Additionally, the adaptive reuse included the conditions to not touch existing walls or ceilings, thus allowing the space to potentially return to its original function. As stated by Michael Cockram in a 2006 visit:

Standing outside, you would never suspect what lies within . . . — wooden bridges span across upper ambulatories, and an ancient sarcophagus protrudes from a wall encased in glass. At times the blend is less than graceful, but the overall effect is a wonderfully dynamic time warp.¹⁹

The existing dwelling acts as a shelter for the innovative program as new climbing walls ascend and cantilever

¹⁹ Cockram, Michael. "Postcard from Bristol." Architecture Weekly 304(2006): C1.1.

within vertical gothic space. It is possible the idea of this transformation is consistent with the mission of Saint Werburgh as the grandiose transitions into the humble. The life and message of the Saint still weaves with new ascending paths and the structure has regained a patron to maintain the space.

The descent of the Bristol diocese and patronage is itself an example of social entropy. But it is the action to adaptively reuse the cathedral space, while respecting the history and artifacts of the cathedral, which is of interest. Initially, the choice to adapt the space may be startling, but allowing this change ironically protects the both new and old space and architecture while respecting the cathedral's historical context and embodied energy.



Near Valdez, photographer: Rahel Zürcher
<http://www.panoramio.com/photo/675309>



Port of Valdez, photographer: shamie
<http://www.panoramio.com/photo/2653406>

Site Analysis

61° 07 ' N 146 ° 18 ' W

Valdez, Alaska is a port town nestled on a small plateau and surrounded by glaciated mountains. Its city center and main port is north of Dutch Harbor, its airport is west of the Harbor, and the Trans Alaska Pipeline system terminates at a reserved sea port on the south of the harbor. Many of the 4,000 people live here because they are part of the infrastructure that ensures North Slope crude oil leaves the southern sea port. Valdez was chosen for the pipeline terminal because its port does not freeze. It became known throughout the world in 1989 when the oil tanker Exxon Valdez struck Bligh Reef in Dutch Harbor and spilled 10.8 million of its 53 million gallons of crude oil. Valdez had significantly established itself as a tourist destination before the oil spill and became nationally known after the spill.

For thousands of years Valdez was unsettled, but it was frequently visited by traders and fisherman from the Ahtna Athabaskan tribe who lived mainly on the nearby Copper River Basin. These indigenous people spoke Na-Dené and were well known by neighboring cultures to mine

and trade copper. They also were known to trade fur and jade.

In 1778, English Captain James Cook mapped Dutch Harbor and named an island and the reef that would eventually be struck by the Exxon Valdez after the ship's Master, Captain Bligh, of Cook's third voyage. Cook originally named Valdez Sandwich Sound after his patron the Earl of Sandwich, but the name did not catch. Soon after, in 1790 the Spanish staked claims; the land was named Valdez after Admiral Antonio Valdez, and the neighboring coastal region to the southeast was named Cordova.

Over the next century, Russia laid claim to all of Alaska. Their main interest was to capitalize on the fur trade and they sometimes enslaved the indigenous people to accelerate this purpose. A main point of operation was south of Valdez on Hichinbrook Island. But at the end of the 19th century, The United States claimed Alaska, and rumors of gold led thousands of fools through valleys surrounding Valdez toward the Yukon and Nome. It was falsely rumored that Valdez was already a town with a road when in fact it had neither. Ironically, these rumors lead Valdez to become

a port city because the gold seekers passed through and other capitalists settled.

In Valdez, the average wage is high and crime is low. Just like the quantity of oil leaving the southern port, the population is in a slow but steady decline. The main employer is still Alyeska Pipeline, but shipping, commercial fishing, and tourism has expanded throughout the years. And since the oil spill, the United States has invested heavily in marine biology and other sciences to measure the after effects of the Dutch Harbor oil spill.

146 ° 18 ' W

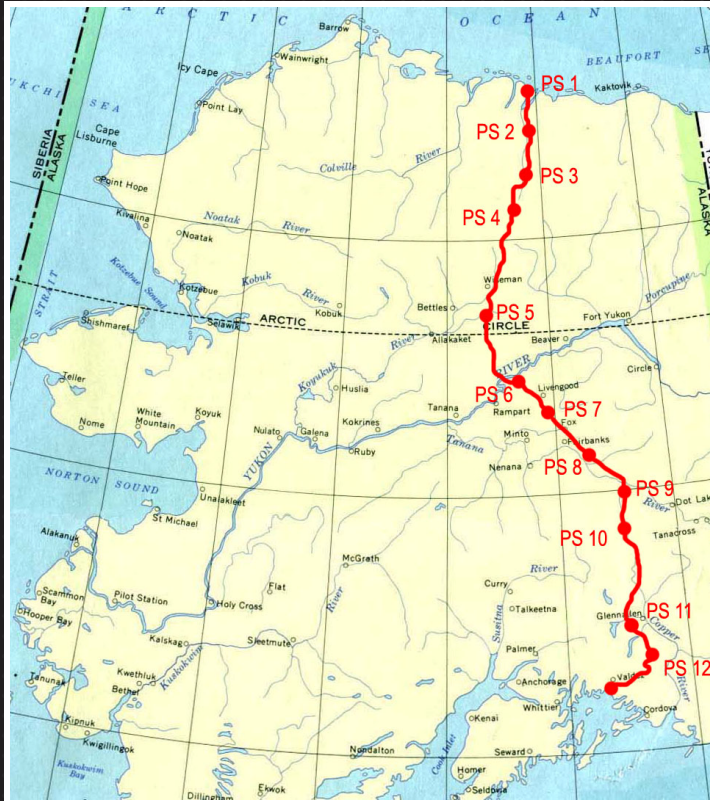
The pipeline corridor defines a north-south cross-section of Alaska. Hundreds and hundreds of migratory bird routes cross over it, thirteen rivers cross under it, its expanse is beyond the ever changing permafrost zones, and it contacts oceanic waters at each of its extreme nodes.

The pipeline's steel has become magnetized over its thirty years of use with crude oil moving through it at four miles per hour. Changes in the magnetic field are measured by a Pipeline Inspection Gauge (PIG) passed

through the line along with the crude as an indicator of corrosion.

Its job has been to turn the earth into dollars. From north to south the potential value of its contents is directly proportional to the realized value. The pipeline is a measuring stick of value as crude in the North Slope equates to potential dollars while crude in Valdez is considered to be realized dollars; anyone with enough money, political savvy, and a tanker can acquire it..

Since its fossil fuel commodity is a limited resource, the mortality of the system is likely to occur before the mortality of most of the tangible infrastructure.



Alyeska Pipeline image

Program

This project is an exploration in exposing entropy. The Pipeline has been chosen for this exploration because it is within a system that has attempted to ignore entropy. Since the current ambition of the Pipeline system is to consume and deplete a limited resource, and the Pipeline is planned for demolition, then the eventual mortality of the Pipeline system is its own suicidal goal. This thesis accepts the mortality of the existing Pipeline *system*. This design is intended for the future event of terminal oil in Alaska. It will adaptively reuse the Pipeline and redevelop it as a measure of global climate change—entropy on the global scale. As stated previously, an architectural space in Valdez shall measure and reveal environmental, political, and social entropy.

The pipeline itself shall have unpopulated, measuring nodes along its 800 mile corridor to render a comprehensive image of climate in time along this north-south transverse section of Alaska. It shall connect to existing systems that use GPS and radio tracking to indicate the return of migratory birds. It shall measure river and ocean temperatures in relation to historic averages. It shall use

existing infrastructure to indicate permafrost and soil temperatures along the pipeline corridor. These external triggers will coordinate to locations within the architecture and spatially inform the visitor as to entropic conditions along the cross-section of Alaska. Additionally it shall inform the visitor as to a dimension of his or her own entropic value.

Based on discourse with the Mustafa Daif (MSc Electrical Engineering, University of Leicester, UK)²⁰, the pipeline's magnetism and orientation toward magnetic north is ideal for it to be converted into an earth battery similar to the 1875 J.C. Bryan, U.S. Patent 160,152 earth battery. The addition of a double coil conductor around the pipeline and its ends connected to buried nodes allows for the pipeline to act exactly like a transformer on a power pole. But rather than converting one voltage to another, the system utilizes telluric currents on the surface of the earth, the potential difference in the earth's magnetic field, charged particles from solar winds, the magnetic relationship of earth and moon, and changes within the magnetic field of the earth's iron ore to create an electro-motive force. Each of these forces are incredibly small (but

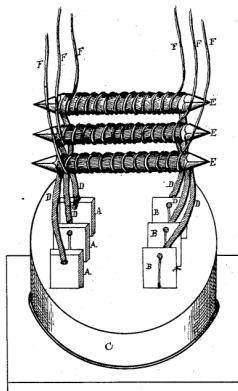
²⁰ <http://msdaif.googlepages.com/msdaif>

measurable) at the human scale, but over the pipeline's 800 miles, Mr. Daif conservatively calculated that 750 amperes were feasible. The voltage is contingent upon the number of conductive coils added to the line. The pipeline corridor in Valdez is near the hydro plant and the earth battery would ideally be connected to this existing electric supply path.

J. C. BRYAN.
Earth-Battery.

No. 160,152.

Patented Feb. 23, 1875.

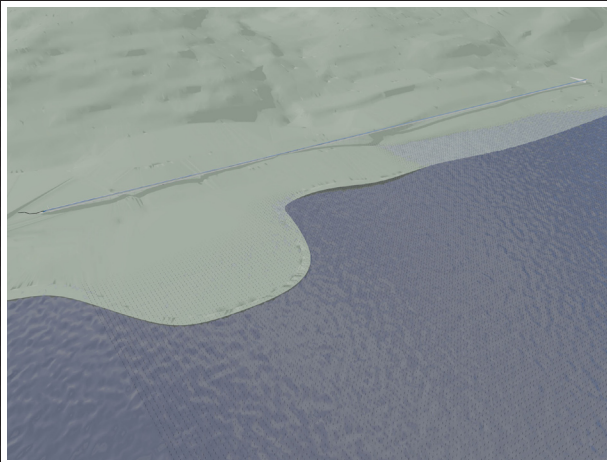
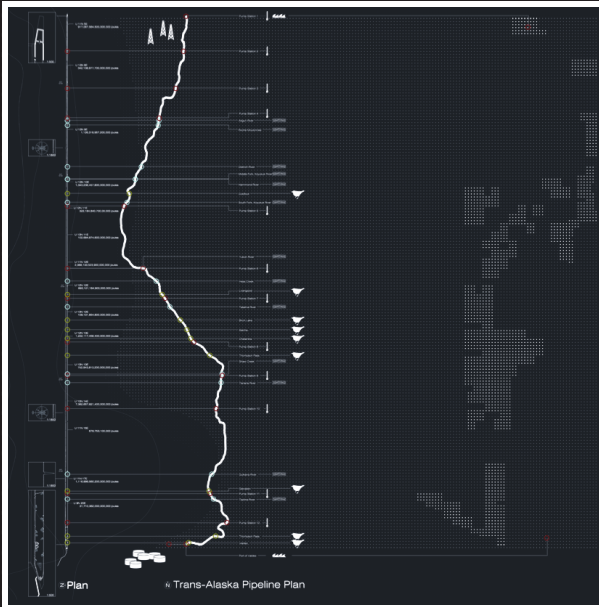


WITNESSES

Jos. T. K. Hunt
Theophilus S. Kimball

Jas. C. Bryan
 INVENTOR

THE GRAPHIC CO. PHOTO-LITH. 39 & 41 PARK PLACE, N.Y.



Reification

This project is an alternative to the existing plan to demolish the Alaska pipeline at the obsolescence of its current system. As of 2008, the Dismantling, Removal and Restoration (DR&R) fund is set aside to remove the pipeline and restore its corridor to a *natural* state. In 2003, the oil company Tesoro estimated “that as of 2003, the after tax accumulated value of DR&R funds already collected may exceed \$10 billion.”²¹ This project utilizes these funds in the creation of a new system exposing entropic values while adaptively reusing the existing pipeline as a large earth battery.

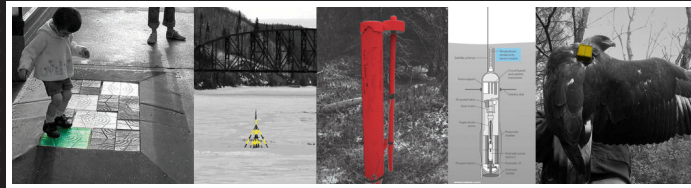
This plan begins by creating a square, two mile by two mile space in Valdez, Alaska at the current Port of Valdez pipeline terminus. In plan, the southeast corner of the four square miles begins on land at the visible location of the pipeline. This space is defined by a Cartesian grid comprised of vertical carbon fiber rods set at twenty feet above sea level and spaced twenty feet apart. The distance of twenty feet above sea level is predetermined by the end

²¹ Alaska. Regulatory Commission of. P-97-4(168)/P-97-7(127)/P-03-4(21). Anchorage. [2003]

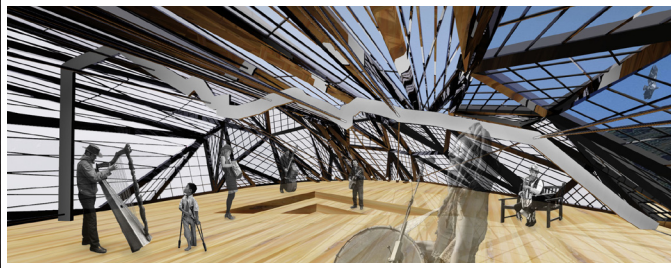
scenario of twenty foot sea level rise due to complete ice cap and glacial melting from global warming. The four square mile space created by the grid allows the visitor to experience the geopolitical space of just one of the hundreds of historic (and present), four square mile arctic lease sales from September 10, 1969 for the purpose of extracting fossil fuels. This exposé realizes only a small consumption of space necessary for the production of crude oil but allows this defined space to be experienced by the public. It contrasts against the present scenario which ignores the hidden variables of a seemingly endless commodity.

The land-based, southern two mile leg of the square grid defines an enclosed, experiential path of global entropic values. This project is defined by global phenomena triggering spatial changes to indicate climate conditions across the cross-section of Alaska. These triggers are located in tandem proportions from the pipeline to human space in Valdez. To demonstrate this: if an environmental trigger occurs at a node 42% up pipeline's length, then a trigger invokes a spatial change at a node 42% along the two mile, Valdez experience path.

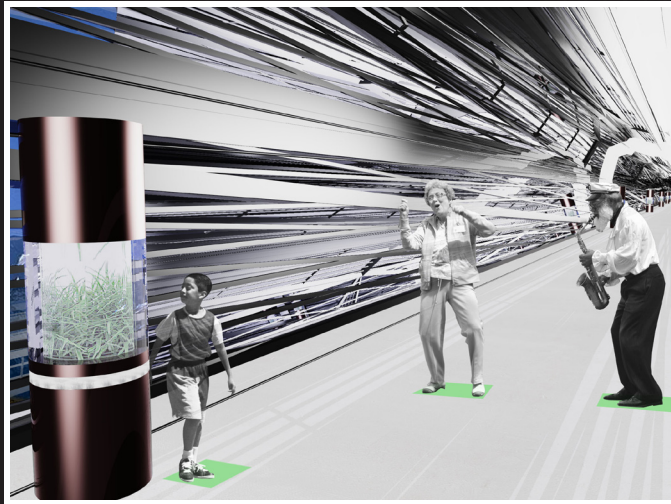
As stated previously, indicators of global warming defined by the Intergovernmental Panel on Climate Change include earlier arrivals of migratory birds, receding ice caps in tandem with the increase in sea temperatures, decreases in glacial and permafrost regions, and earlier melting of rivers and streams. Migratory bird routes, rivers and creeks, permafrost zones and two oceans intersect or touch the pipeline corridor. These four triggers are indicated by nodes along the pipeline and manifest by tandem changes within the Valdez spatial experience.



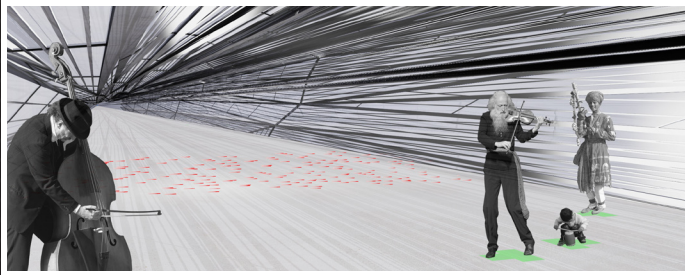
The measuring of migratory birds via satellite and radio currently exists and its global positioning data is accessible. When a bird with the global positioning equipment flies over the pipeline, the arching ceiling of the Valdez experience changes from translucent to transparent with the aid of automated Switchlite glazing. As the bird increases its distance from the pipeline, then the material returns to its translucent state.



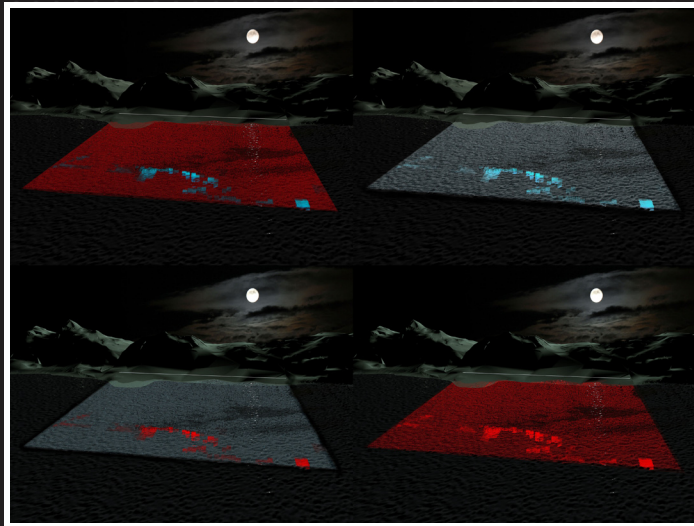
The pipeline corridor has existing infrastructure to measure soil and permafrost conditions. The maintenance of equipment and collection of data is performed by the University of Alaska at Fairbanks. This trigger connects these nodes along the pipeline corridor to terrarium nodes in Valdez. The terrarium nodes are set at a temperature in tandem with the temperature of their counterpart along the pipeline. The growth of grass within the terrarium nodes compared to historic conditions indicates climate conditions. For example: grass growth of an Alaskan region in a winter season may indicate climate changes. If many of these nodes indicate this, then the likely hood of climate change increases.



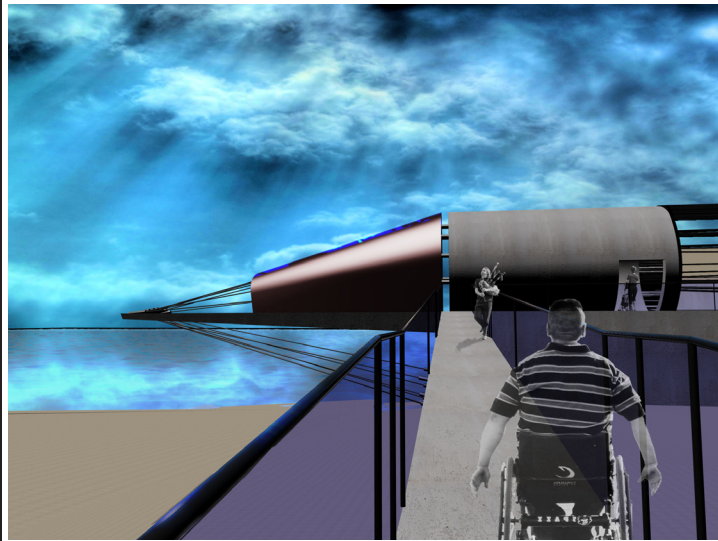
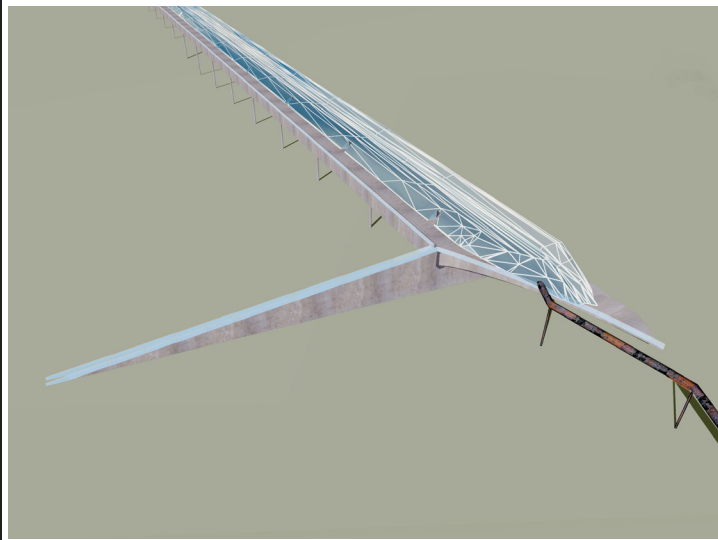
The pipeline bridges over several rivers that intersect its path. These bridges may be retrofitted with motion sensors set to a large tolerance. If the river below is moving then the motion sensor is triggered and the floor lights up via Chromos Chronos concrete at its spatial counterpart in Valdez. If the river melt occurs before the historic average, then the lit floor moves in a red light. If river melt occurs after the historic average, then the lit floor moves in a blue light. When the rivers are frozen, then the floor is not lit.



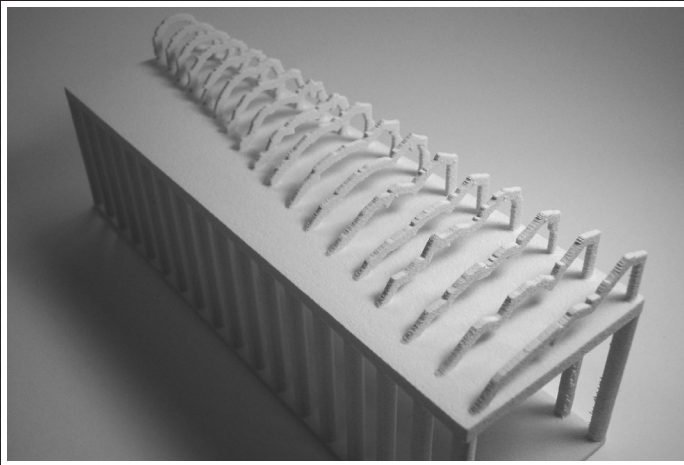
The pipeline corridor is very near Arctic and Pacific Oceans. These nodes are measured by floating ARGOS that collect temperature and salinity data. The temperature data from both oceans is transmitted to the Valdez site and its information is manifest at highest tips of the carbon fiber grid in the form of marine grade Light Emitting Diodes capable of red or blue light to indicate warmer or cooler conditions. The North end of the carbon fiber grid maps the original lease sale 23 from 1969 and indicates the current Arctic Ocean temperature relative to historic climate, while the surrounding grid indicates temperature relative to climate of the neighboring Pacific Ocean. The low voltage LED grid is powered by small-scale, kinetic-electric wave generators.



The addition of a fifth trigger realizes that a human is an entropic system. The Valdez site's interior floor space is lined with PowerLeap tiles. As a person walks along the space, the floor lights up green. The relationship of choice and physics is directly connected as a person's path (choice) is indicated by the green floor tile. It is interesting that almost all choice results in an entropic relationship. Only the choice not to enter the space or the choice not to move will indicate the lack of entropy. Perhaps this is indicative of the entropic nature of consumption or the choice not to consume.



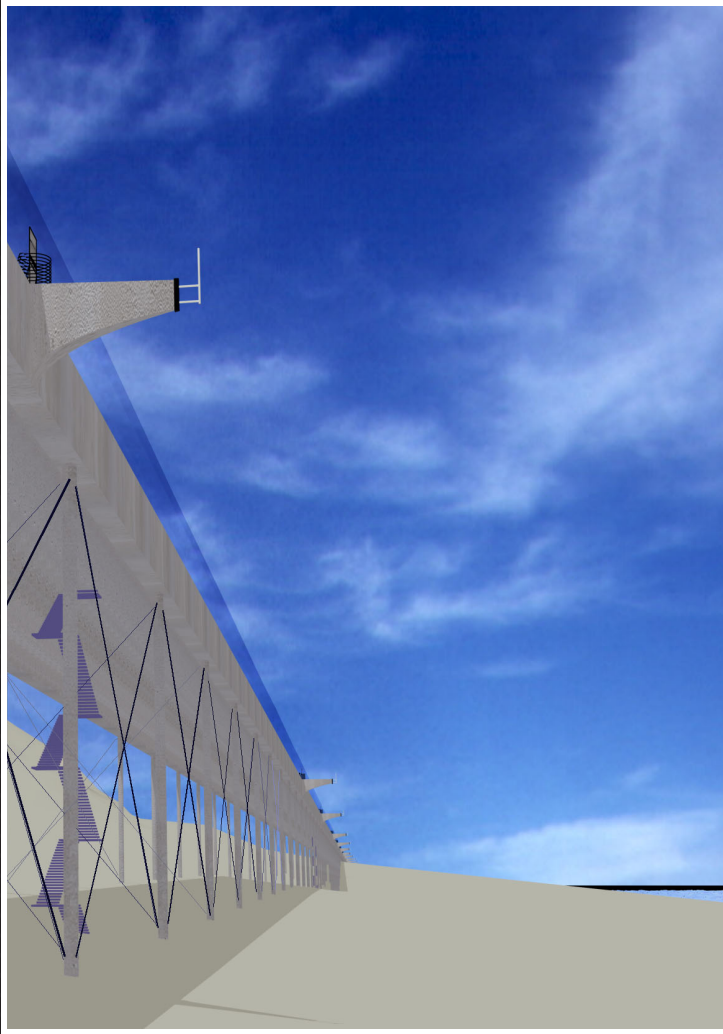
To augment these physical indicators of entropy, the character of the Valdez interior space transitions (in section) from an acoustically pleasant space that encourages dialog to an acoustically unpleasant space that increasingly makes dialog harder. This is a spatial configuration experiencing the science of information entropy-the amount of energy necessary to allow the passing of information. The east end of the interior, two mile space is visually chaotic, but no facing surfaces are parallel and the wood floor material allows an appealing absorption of sound. This space also encourages dialogue with the addition of a small amphitheatre. The cross-section of the two mile interior space slowly transitions to a circle in which the foci of sound is centered at an average ear height of 5'-4" and the materials are hard and reflective. This circular space is excellent to create an echo (to hear one's own voice), but poor for dialog. It is an interesting coincidence that this shape is identical to the space within a pipeline. The path then terminates into an anechoic chamber in which sound is almost perfectly absorbed like a recording sound booth. This final space is acoustically disorienting as both dialogue and monologue are debilitated.

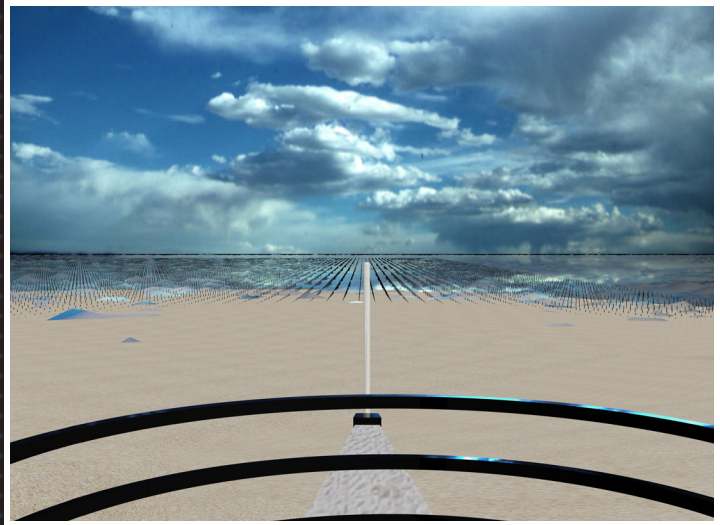


The connection of enclosed space and land art are experienced by the location of cantilevered lookouts that intersect the eye of the viewer through the top of a pole at the end of the cantilever and outward to the grid beyond. As previously stated, the north end of the grid encompasses the map from the original lease sale ²³. The top of the pole visually connects the viewer to the original Sections of the lease sale while the pole itself is inscribed with the amount of crude oil energy in joules that left each Township surrounding the original Sections. ²² ²³

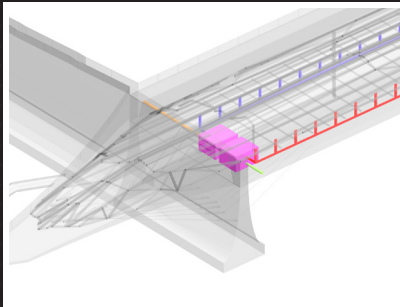
²² A Township is six miles by six miles and is comprised of thirty-six, one square mile Sections.

²³ Oil and gas data are available by month from 1969 to the present at <http://www.state.ak.us/local/akpages/ADMIN/ogc/publiccdb.shtml>

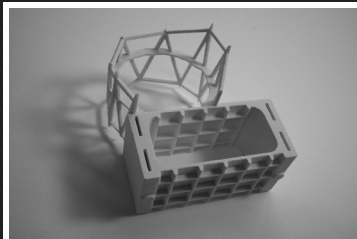




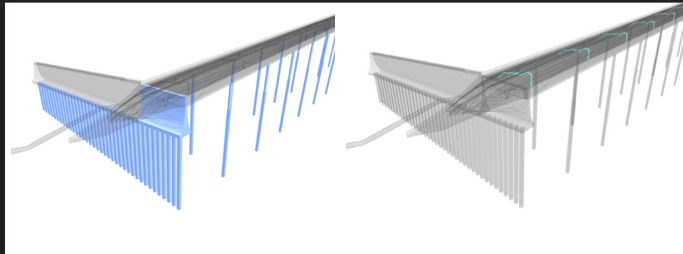
The systems required to support this project are a two mile post-tensioned girder platform. The above space is a public, served space; the below space is a utilitarian, servant space. From East to West only the first 100 yards of the project require utilities, while the rest of the two mile path is an enclosed experience requiring support primarily from electricity.



Fresh Air Intake
Air Exhaust
Heat/Air Supply
Return Air
Enthalpy Wheel and HVAC

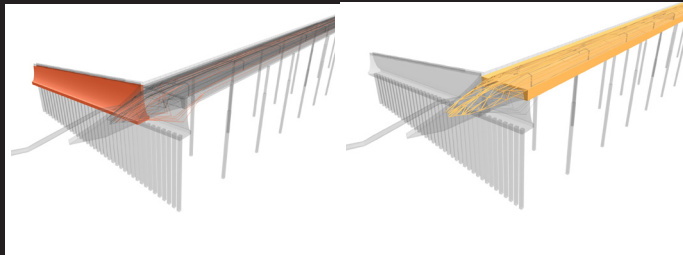


Typical section of served (above) and servant spaces below



Structural Bearing

Structural Lifting

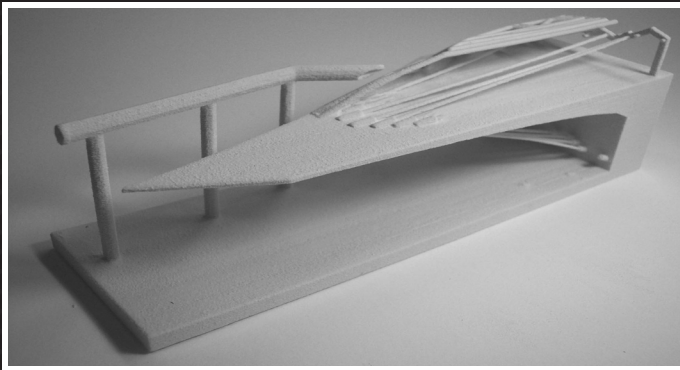


Structural Bracing

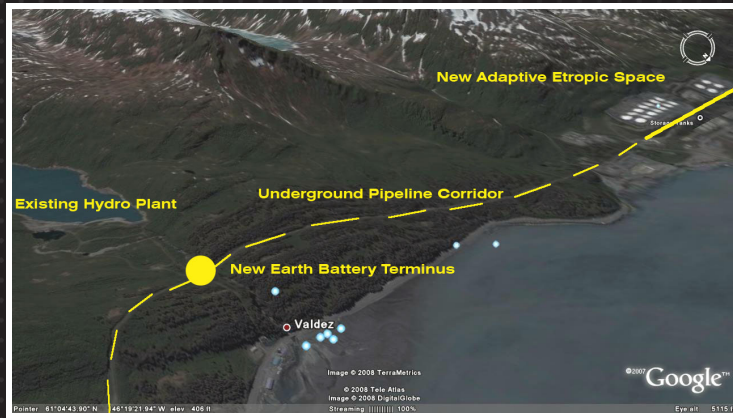
Structural Spanning

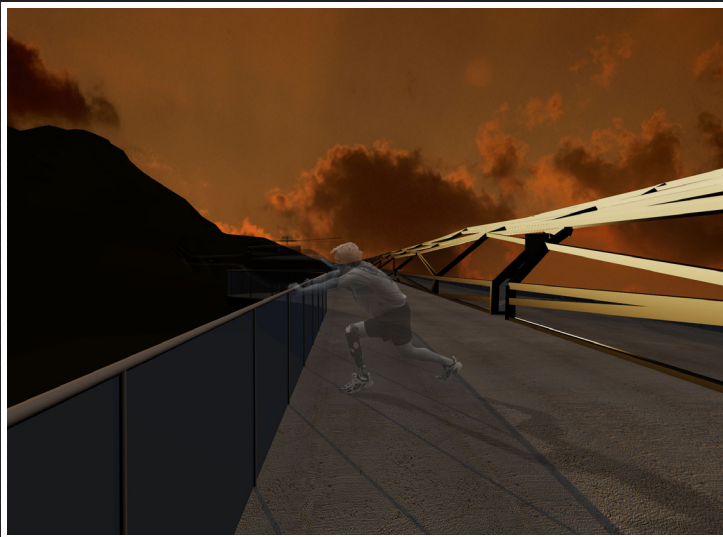
The Post-tensioned platform is supported by concrete piles on caissons at 105.6' on center. This number is reminiscent of the 10,560 feet (two mile) leg of the original four square mile lease sales. Within the served, public space are arching support beams (bents) that transition from the visually dynamic dialogue space to the static, circular monologue space. The post-tensioning continues from within the girders through the beams above like a

large belt loop. The upper and lower deck aligns with the top and bottom of the girder beams. These decks are comprised of a waffle slab. Above the beams are six by six HSS tube steel. This framework allows for an extruded aluminum mullion structure infill between tube steel members.



To complete the master planning, the project is punctuated with the adaptive reuse of the pipeline into an earth battery similar to the style patented by J.C. Bryan mentioned earlier. Infrastructure from an existing hydro plant two miles east of the new entropic space is an ideal terminus for the conditioning of power generated by the earth battery.





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