Discovering the Aesthetic of Flood Control Infrastructure

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ABSTRACT

Infrastructure plays an instrumental role in the shaping of the landscape across many scales and is a critical human component within the landscape, yet these systems have tended to ignore the function of appearance and aesthetics in their design. Consequently, the relationship between our infrastructure, the environment, and us has become increasingly opaque. The majority of the vast infrastructure systems that weave throughout the landscape promote a mono-functional agenda which is relegated to the background of our everyday experiences. By investigating the traditional methods of designing infrastructure, we can begin to understand how to integrate aesthetics into the design of infrastructure. This is explored through one of the largest infrastructure systems in the United States; flood control. Flood control infrastructure in is an extensive system that has formed a protective barrier between human and natural processes for over 200 years. Its largest component, the levee, is an elegantly simple structure that contains many layers of significant cultural and historic aesthetic narratives. This thesis focuses on the levee as an infrastructure that mediates between natural processes and human development and studies how it can perform aesthetically to convey new meaning and value. What is the potential of the levee to become expressive in our lives, and be designed in such a way *to move us*? This new infrastructural paradigm explores the implications of utilizing aesthetics as an expressive and significant function of levee design that can inform and inspire the public and define a new dialogue between man, nature, and technology.

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INTRODUCTION

By virtue of its scale and ubiquity, infrastructure is a highly visible component within the landscape. Yet the appearance of the modern infrastructural landscape does not contribute to a civic identity like it once did. Many of these infrastructural systems emerge from the landscape as mundane and utilitarian pieces of much larger technical networks. The appearance of many common components of the urban environment including curbs and gutters, power lines, and utility boxes embody their functionalist design. These infrastructures have become normalized into everyday experience, forgotten and in many cases left to deterioration. Yet, infrastructure can hold great cultural significance, be considered beautiful, and become publicly revered and inspirational as it has in the past.

Our restless desire for progress and growth combined with a fervent technological prowess has allowed infrastructure to alter much of the landscape to our perceived advantage. As we further re-order the environment to suit our accelerating urban growth; undesired effects present themselves with even greater complexity. The design of infrastructure is intertwined within environmental, social, cultural and economic contexts that have become increasingly ignored by functionalist design. The ubiquitous urban infrastructural environment has been evaluated and considered solely on the technical criteria and somehow exempted from having to function socially, aesthetically, or ecologically (Waldheim 2006 171). The collective infrastructures that support our civilization are a physical manifestation of our progress and achievements, but many of these systems have facilitated degradation to the environment and urban imagery. As Elissa Rosenberg describes, "Since the rise of industrialism in the 19th century, as engineering has become increasingly autonomous and separated from urban design, functionalism has become an end in itself, divorced from civic meaning" (1996 89). This has contributed to a proliferation of unused and wasted ancillary spaces resulting from mono-functional infrastructure that have reduced the quality of urban life and culture. In many cases infrastructure systems have defined a relationship with natural systems that is increasingly tenuous.

Recently, several authors have expressed the need for integrated and multi-functional approaches to infrastructure design that incorporate the social, cultural, and environmental

dimensions of their context (Rosenberg 1996, Strang 1996, Allen 2000, Waldheim 2006, Belanger 2009, Meyboom 2009). However, whether building new infrastructure or repairing old ones, these new directives do not espouse the importance of appearance and visual and spatial experience in the creation of infrastructure. On a practical level, not all infrastructures can be become integrated and multifunctional. However, there are a great deal of infrastructural systems that do exist within environmental, social, and cultural contexts that could respond to integration and multi-functionality, and have the potential to be revealed as meaningful components of the urban landscape through an aesthetic infrastructural experience.

Through examination of the historic evolution and current conception of infrastructure we can better understand the ideology that created our contemporary static and forgotten infrastructures which have become marginalized and disassociated from the public and how aesthetics was or was not utilized in the creation of earlier infrastructures. As Elizabeth K. Meyer, associate landscape architecture professor at the University of Virginia notes, appearance is "the combination of physical characteristics and sensory qualities" that can create a moving experience. Meyer writes in her manifesto about the implications of appearance that, "what is needed are designed landscapes that provoke those who experience them to become more aware of how their actions affect the environment, and to care enough to make changes" (2008 6). This can introduce a new functional layer upon our infrastructural systems to shape and clarify urban architectural form and function.

This thesis proposes that the appearance and aesthetic experience of infrastructure is equally important to its performance and that aesthetics can begin to inform, inspire and direct. Aesthetics can provide the means to understand how the visual and spatial characteristics can enhance the role of infrastructure in our urban environment. Infrastructure landscapes powerfully communicate the collective values of a community that is constructed through a relationship with the natural world. The aesthetic of infrastructure is rooted in its utility, that "reasserts the power of the ordinary landscape to resonate with the real rhythms of daily life" (Rosenberg 1996 89). This thesis focuses on the aesthetic opportunities associated with infrastructure and investigates the implications of an aesthetic of flood control infrastructure. How can the purely functional nature of flood control infrastructure become a meaningful basis for landscape design?

Exploration of the potential of the aesthetic focuses on the levees and flood walls that protect millions of square miles of urban and rural land from flooding. The appearance and form of the levees and floodwall has historically represented a hard edge between man and nature that proliferates wasted and disconnected spaces while reflecting the traditional infrastructural ideology of a dichotomy between man and nature. If the levee is to become integrated and multifunctional, then how can aesthetics begin to redefine the relationship between the city and river, and how can that potential then translate to other infrastructures?

CHAPTER 1

INFRASTRUCTURE

The word infrastructure is relatively new term that has taken the place of "public works" due to a growing complexity and politicization of infrastructural systems in recent decades. During the 1980's, the term infrastructure was adopted as a more socially and politically neutral term, narrowly defined by engineering works, that marginalized the public's understanding of the civic importance that the term "public works" exemplified (Bruegman 1993 11, Rosenberg 1996 90). Today, the term infrastructure is generally defined as *the subordinate parts of an undertaking; a substructure, or foundation and serves as the framework for which a system or organization is built upon* (OED 2012). Infrastructure is all around us and not only includes networks and systems, but also structures and machines, and it is located both above and below ground and forms the sinews of the city (Tarr and Dupuy 1988, Tarr 1984). In terms of the contemporary city, infrastructure supplies water and power, accommodates different modes of transportation in the forms of roads, rails, and sidewalks, and exists as social or "soft" infrastructure in the forms of schools, post-offices, parks, and public space. Other types of infrastructure such as dams, levees, and stormwater pipes serve to protect human settlement from nature's destructive capacity.

Fig 1. Murray lock and dam, Arkansas River

Infrastructure networks make up considerable portions of the material, economic and geopolitical fabric of contemporary cities, and they represent long-term accumulations of finance, technology and organizational and geopolitical power (Graham 2000b). Politics and power typically govern the allocation of many of these systems throughout the landscape given their high capital cost and inherent civic necessity. Infrastructure's functionally oriented definition allows it to describe a wide variety of systems. Information and communications technology (ICT) systems have recently appropriated the term to describe their physical and

digital network support structures. A new movement describing the underlying natural systems and structures that work within our cities as a separate entity of urban planning has been termed *green infrastructure* which is generally defined as the interconnected network of open spaces and natural spaces in urban areas (Tzoulas 2007, Wise 2008). Green infrastructure is at the forefront of new understandings that consider natural processes as a form of functional infrastructure which can be integrated with human systems. Infrastructure has thus become a highly complex and dynamic "socio-technical process" that is underlain by political, economic, environmental and social demands (Graham 2000b, p 114).

The modern definition of public works and infrastructure as an underlying structure of a variety of systems evolved primarily with the evolution of technology and the growing complexity of the city. City growth and the evolution of urbanized areas are closely related to a process of technological innovation and implementation that fueled the creation of new infrastructure (Tarr 1984). Infrastructure expanded with urbanization and its constituent population's need for the transfer of goods and services across greater and greater distances. As the extents of the city expanded, so did the extent and the complexity of the infrastructural landscape required to sustain it. Infrastructure is highly correlated with the needs and flux of the city and advancements in technology throughout history, in continual need of maintenance, upgrading, innovation and seemingly perpetual expansion.

Cities and urban regions have become, in a sense, staging posts in the perpetual flux of "infrastructurally mediated flow, movement and exchange" (Graham 2000b, p 114). In many cases the infrastructure required to support a city stretches out hundreds of miles into the surrounding regions as seen with highways, railroads, power lines, and flood control. As Sanford Kwinter writes, "[infrastructure] possesses a critical resonance, a direct reach or extensivity into the adjacent material environment" (2008, p 29-31). Kwinter observes that infrastructures of the city have an extended impact on our built and unbuilt environments due to their scale and robust materiality.

There are many different functions of infrastructural systems, certain infrastructural systems exist to provide good and services for urban dwellers in the form of utilities, such as water, power and communications. We conventionally perceive infrastructure as a mere

collection of these utilities, yet there are other infrastructural systems that are equally important and mis-understood. A separate set of infrastructural systems such as highways, canals, and railroads negotiate the landscape's geography to create essential logistical connections across many scales. A third type of infrastructure in the form of floodwalls, levees, seawalls, and stormwater and sewage systems exist accommodate urban systems within natural processes and to protect from the destructive capacity of nature. All three of these types of infrastructure serve to negotiate and mediate between human needs, geography, and natural processes, all to a different degree. In this respect, infrastructure serves as a mesh or dialogue between the natural environment and the built environment. Traditionally, this dialogue has been representative of a dichotomous relationship between human and natural systems

INFRASTRUCTURE'S CURRENT CONCEPTION

There is an extensive array of modern infrastructure that supports our daily activities from water and sanitation to power and communications systems. Though, according to the latest report from the American Society of Civil Engineers (ASCE), the majority of the infrastructures that support these activities are in dire need of repair. The report gave an average grade of "D" to our major infrastructural systems and estimated an investment need of 2.2 trillion dollars for repair and replacement (ASCE 2009). Unlike buildings and other structures that can easily be removed and replaced, infrastructure cannot Analissa Meyboom describes that infrastructure "is more difficult to excise; it tends to remain in the landscape in modified and expanded forms, some improved, some deteriorated" (2009 73) This disinvestment is largely due to infrastructure's place as a secondary urban landscape in the shadow of more traditional designed urban spaces.

Amidst the formal urban landscape of buildings and parks exists an extensive and forgotten landscape of infrastructure. Railroads, buried utilities, expressways and other infrastructural systems lie in contradiction to the more manicured urban landscape of parks, yards, and plazas that landscape architect Michael Hough has described as the "pedigreed urban landscape" (Hough 1995 8). The "pedigreed" landscape as Hough described is the traditional focus of urban designers leaving many infrastructural systems and abandoned lands out of the focus of civic design. Pedigreed landscapes hold high public value that is expressed through a careful aesthetic and civic care that in many cases expresses a unique sense of place, while the majority of the infrastructural landscape does not.


Fig 2. Utility box masked by shrubs

The traditional responses to infrastructure are often to mask or ornament it to appear not as infrastructure, contributing to the false dichotomy of art and technology as Elissa Rosenberg notes (Rosenberg 1996).

Often, designers are approached with the challenge of hiding infrastructural systems in urban areas without engineering the system itself, with the ultimate goal being to maintain an image of "pedigreed" urban spaces or untouched natural surroundings of an earlier era (fig 2). (Hough 1995 8, Strang 1996 11). Masking infrastructure is a product of political and social pressure to hide the perceived unsightly forms that infrastructure takes in urban areas. Citizen groups such as "NIMBY" (not in my backyard), under the notion that infrastructure projects are ugly or noisome, actively fight against the construction of certain infrastructure projects to protect the value of their property. In many infrastructure projects landscaping is employed to hide and screen out facilities, and art is often utilized in conjunction with these projects to make them more aesthetically palatable (Strang 1996). Strang notes further that "we are still masking a system of infrastructure vastly and impractically expanded beyond the boundaries of the city, multiplying the task of maintenance and renovation beyond comprehension" (1996 12). As Gary Strang continues in the introduction of his article *Infrastructure as Landscape* (Strang 1996 10);

> The potential these infrastructure systems have for performing the additional function of shaping architectural and urban form is largely unrealized. They have an inherent spatial form and order that can serve as the raw material of architectural design or establish a local identity that has a tangible relationship to the region. They can be designed with a formal clarity that expresses their importance to society, at the same time creating new layers of urban landmarks, spaces and connections.

The current state of US infrastructure has received criticisms by designers, engineers, and the public describing it as "single purpose" (Brown 2010, Hicks 2008 99) "decaying and technocratic" (Belanger 2009 80) and "mundane and utilitarian" (Meyboom 2009 73). The current approach to the design of infrastructure has not only affected its appearance, but also marginalized the ancillary spaces that result from its extensive scale (fig 3). This has depleted the visual and formal qualities of infrastructure to a completely functional level, the implications of which can be in its form and the surrounding contexts. Though infrastructure adapts in a limited

fig 3. linear power line easements

manner to the landscape, it does not consider its appearance and form as another functional layer. Architect Stan Allen, in *Infrastructural Urbanism* (Allen 1999 55), describes that;

> Infrastructures accommodate local contingency while maintaining overall continuity. In the design of highways, bridges, canals, or aqueducts, for example, an extensive catalog of strategies exist to accommodate irregularities in the terrain (doglegs, viaducts, cloverleaves, switchbacks, etc.), which are creatively employed to accommodate existing conditions while maintaining functional continuity. Nevertheless, infrastructure's default condition is regularity – in the desert, the highway runs straight. Infrastructure is above all pragmatic.

The recent emergence of the field of landscape ecology, As Pierre Belanger notes, "contributed to a more in depth understanding of the long term effects of industrialization and urbanization on bio-physical systems" (Belanger 2009 86). This resonates with infrastructural systems that have not regarded ecological systems as an important form of natural infrastructure that can also function as human infrastructure. The significance of infrastructure as a dialogue between human and natural systems does not only lie within its scale and environmental impact, there is an embodied social meaning within infrastructure that draws from its necessity for everyday life. Vernacular infrastructure systems such as flood control and irrigation as Gary Strang notes, "allow for the works of nature and humanity to be revealed in an eloquent way . . . and powerfully communicate the shared values of a community as constructed through a relationship to the natural world" (1996 15). Dennis Cosgrove goes on to say that while infrastructure responded to practical concerns, it was also "inseparable from philosophical beliefs and cultural assumptions about the relationship of a city to its natural surroundings" (Cosgrove 1984 164). Seeing infrastructure in this way can provide new understandings of how infrastructure defines the human relationship with the natural world that is increasingly tenuous and opaque in the contemporary environment.

The pragmatic approach to infrastructure design has left a void where the architectural and informative qualities used to be. A review of literature on the current form and appearance of infrastructure produces two interrelated themes that have affected the quality of our built and un-built environment; First, the vast majority of infrastructures have been designed as mono-functional and interdependent systems resulting in a proliferation of lost and disconnected

spaces; Second, infrastructure's visible connections and civic meaning have gradually been lost to the public that relies on them.

Spatial Impact - The Creation of Lost and Disconnected Spaces

Today's functionalist infrastructure has created ancillary spaces that have become disconnected from the rest of the built environment. The process of introducing mono-functional infrastructures such as highway interchanges, stormwater detention ponds, railroads, and levees have degraded and marginalized the roles of traditional urban spaces. While autonomy and efficiency have improved, the destruction of the landscape fabric to make way for these massive structures has resulted in a loss of connection and a proliferation of unused urban space. Architect Alan Berger, in his book *Drosscape: Wasting Land in Urban America* describes the lost space as an "internal frontier" which is comprised of a mono-functional or undetermined use outside the realm of human interaction (Berger 2006 26). Ultimately, as Berger noted, infrastructure has defined the use and quality of many spaces in our urban environment.

Jonathan Solomon describes the current infrastructural paradigm as part of the "mono-functional, oppressively efficient infrastructures of the twentieth century." (2004 22). Though these infrastructures do contain a purpose within the realm of transportation and flood protection, they have left out other contextual functions within complex social and ecological realms. In addition to their purely mono-functional nature they have resulted in the creation of unused spaces (fig 4). Berger further speaks of 'waste landscapes of infrastructure', including "easements, setbacks, and rights-of-way associated with transportation, electric transmissions, oil and gas pipelines, waterways, and railways."(Berger 2006 170).

fig 4. Highway setback and right of way creating unused space

In addition to the formation of lost spaces, infrastructure has resulted in the creation of multiple, superimposed edges upon the landscape. These edges form barriers within local pedestrian and regional ecological systems among others. Kevin Lynch, in his seminal book

Image of the city, describes the edge as an important component of the image of a city, and its drawbacks to connectivity. He describes edges as "the linear elements not used or considered as paths by the observer." And that they are essentially "boundaries between two phases, linear breaks in continuity: shores, railroad cuts, edges of development, walls . . . Such edges may be barriers, more or less penetrable"(1960 47). The fragmented landscapes created by infrastructural barriers have resulted in the erasure of these spaces and their potential in the minds of the public, and inhibited their inclusion within broader contexts.

A synthesis of these authors' critiques of infrastructure yields three interrelated physical and aesthetic effects of infrastructure on its surrounding environment. First, infrastructure creates wasted space, as defined by Berger, in the form of ancillary or resultant areas of infrastructure including easements, setbacks, and rights of way. These unused spaces are exacerbated by the intersection of other infrastructural systems that also have ancillary space requirements. Second, as Lynch identifies, the infrastructure often forms an edge and creates barriers between spaces that affects movement and visibility. Third, infrastructure creates disconnected spaces that fragment the urban landscape into separate and often disparate uses.

Visual Impact - Growing Invisibility & Assimilation & Decay

Infrastructure is visible in various forms and functions everywhere above, upon, and below the ground. Yet, most of these systems remain unknown or invisible to the everyday person or assimilated into a common vocabulary of landscape. The Latin prefix, *Infra-*, means to be under, down, or below, (OED 2012) and characterizes the current aesthetic quality of many infrastructural systems which have either been hidden from view or marginalized due to their ubiquity in the landscape. The assimilation of infrastructure into the background of our daily experience is due to their mundane and static appearance. While burying or hiding infrastructure is necessary and tactical in some cases, as with sewage systems and conflicting spatial issues, it often discourages a critical response. Social studies and technology author Paul Edwards notes that many of these modern systems of roads, sewers, and stormwater systems "reside in a naturalized background, as ordinary and unremarkable to us as trees, daylight, and dirt" (2003

187). The visible collection of infrastructure in our cities has become ordinary objects within our everyday experiences, void of aesthetic qualities and effectively hidden in plain sight. Their potential as visible and meaningful components of the built environment is unrealized. Roads, dams, and power lines are examples of highly visible even monolithic objects that form a major visual component of the landscape. Robert Thayer expounds in his article *Landscape as Ecologically Revealing Language* (1998 119) on the loss of c larity in modern infrastructural systems saying;

> Technology has been the principle method by which we intervene on the land" and much of the rationale for this is based on "the obfuscation of clarity by technology and the subsequent employment of m ore benign and expressive techniques for bri nging back such clarity. In the ordinary landscape, the instances in which intentional land design aims at higher, symbolic meaning and embodies that meaning in some decipherable form are few when compared to the countless millions of "ordinary" landscapes structured by the dominant, operative, contemporary technological paradigms.

Most importantly, landscape architect Michael Hough describes our daily urban existence with infrastructure as "spent in surroundings designed to conceal the processes that sustain life and which contribute, possibly more than any other factor, to the acute sensory impoverishment of our living environment" (1995 23). The marginalization of infrastructure's aesthetic and social meaning is a p roduct of the cultural change as technology and engineering gradually became more autonomous, divorcing social and civic roles from the purely functional (Rosenberg 1996). Consequently, the original connections that infrastructure referenced and facilitated have been lost. In example, the reservoir has become far removed and disconnected from the faucet and the power plant from the light bulb. Similarly, the extensive networks that connect the nodes of interaction between the resource and user remain hidden and essentially "black boxed" from the users and expected to function properly at all times (Graham 2000a). As these systems are physically and metaphorically relegated to the background of our aesthetic experience, understanding, and appreciation, they gradually lose the

fig 5. Highly visible utility boxes along major thoroughfare

attention of the public.

At smaller points or nodes, parts and traces of other infrastructure systems become visible such as the ubiquitous cable boxes at street corners and gutters in the curb which present themselves as mundane components of more complex and buried organizations (fig 5). Though, many of the visible nodes do not consider their potential aesthetic role to the public that sees them every day. And, as science and technology professor Paul Edwards notes, even these partially visible infrastructures also suffer from marginalization by being shifted into the background of our everyday experience (2003). The potential of visible infrastructure is seen in the case of water infrastructure in Rome, the aqueducts were once an important part of public life in the city and had an extensive presence whose form and appearance organized public space and social life.

THE DESIGNERS OF INFRASTRUCTURE

The nature of the pedigreed and manicured urban spaces described by Michael Hough demand that their designers to work within a collaborative environment that produces highly functional and aesthetically pleasing urban spaces. However, the infrastructural landscape is removed from this collaborative design process and has traditionally been left to the profession of engineering. External geo-political and bureaucratic forces have also relegated the construction of infrastructure to separate realms that has proven to be more costly and ineffective in the long-term (Belanger 2009). The established vocabulary defined by engineering, and prescribed by political authorities, have created the vast majority of the infrastructural landscape that we encounter every day. The education and ideology of the engineer in America has played an integral role in the formation of our contemporary infrastructural landscape.

Engineering was a highly regarded profession in the early decades of the United States, and contributed greatly to the growth of the nation. Critical to the diffusion of new technologies in the United States during the 19th century were the engineers. As Historian Daniel Hovey Calhoun writes of the engineer, "Here is one man through whom the early possibilities of "the new America" appeared" (1960 viii). Now and in the past, infrastructure design has been left mostly to the engineering community, particularly civil engineers. While it is typical today to assume that engineers oversaw many of the early infrastructure projects, in fact, there were only a few people that recognized themselves as engineers during this time, the rest were semi-skilled laborers. As Joel Tarr notes, many of the designers of these early systems "were either trained in Europe or had on-the-job training to some extent – and much of the technology had been borrowed from Great Britain"(1984 175). Before the major engineering schools had established themselves in the United States, many engineers had to gain their working knowledge by participating in the construction of other infrastructure projects.

The establishment of The United States Corps of Engineers (USACOE, CoE, Corps) by Congress came on March 11th, 1779 and was the first recognized collection of engineers. During the Revolution, the CoE worked on field fortifications and built defensive infrastructures along the coasts of America to protect against invasion. Composed of miners, sappers, and farmers the

CoE had no formal scientific or engineering education. The early projects of the American engineer included civil works, fortifications, and exploration projects. In 1838, Congress authorized the creation of a separate Corps of Topographical Engineers, and much of the effort on the nation's internal development, such as roads and waterways, was done by the "topogs." The work of the topogs was critical to the surveying and construction of early infrastructure and the growth of the United States. In the 1850s, topogs surveyed several routes for the proposed transcontinental railroad (Roberts 2000). Other infrastructures such as river navigation, flood control, and coastal fortifications, were the Corp's most important peacetime responsibilities. The structure and mission of the Corps remained relatively constant until the turn of the century.

Throughout the 19th century, engineering in America had gradually developed distinct specialties within itself, with the largest specialty being civil engineering which had developed from the work of the topogs. The understandings of physics, fluid mechanics and other sciences that had been borrowed from the Europeans would be incorporated into the curricula of new engineering schools that would produce homegrown American engineers. Engineering schools such as West Point and the new Rensselaer Polytechnic Institute were sending graduates out to work on America's infrastructure projects, over half of their engineering graduates declared themselves civil engineers (Calhoun 1960 9). Not until the establishment of the American Society of Civil Engineers (ASCE) in 1852, and increases in the numbers of engineering graduates, did the work of the civil engineer become entrenched in the design and construction of public works and infrastructure projects (Tarr 1984). The newly educated civil engineers would "provide the 'science' and 'experience' which would assure that works would be built soundly, to accomplish the purpose for which they were intended" (Calhoun 1960 55). Engineers of the 19th century touted themselves as expert project surveyors, managers, and accountants. The discussion of aesthetics or the appearance of infrastructure in contributing to urban and architectural form was practically nonexistent for the engineers. In *The American Civil Engineer: Origins and Conflicts* (1960 57), Daniel Calhoun describes a public discussion of whether or not to ask an engineer if the state of Massachusetts should invest in canals or railroads;

> What method better calculated to resolve all issues of this nature, than by reference to men, expertly taught in mechanics, in hydraulics, in the science of geology, the strata of the earth, the character of soils, - and skilled by observation and experience, in those

> calculations and deductions, by which labour and expense may be correctly estimated, and advantages and results, immediate and prospective, satisfactorily known?

At the time, especially during the industrial revolution of the 19th century and into the progressive era at the turn of the 20th century, the ideology of the engineer centered on economic and social interests of the growing nation. As John Barry describes in his book *Rising Tide* (1997 21) the social climate of the engineer in the late 19th century;

> This was the century of iron and steel, certainty and progress, and the belief that physical laws as solid and rigid as iron and steel governed nature, possibly even man's nature, and that man had only to discover these laws to rule the world. It was the century of Euclidean geometry, linear logic, magnificent accomplishments, and brilliant mechanics. It was the century of the engineer.

These beliefs guided engineering and infrastructure design until the Great Depression. After the depression and the Second World War, cultural and economic shifts in the production of technology standardized and shifted infrastructure into the background our urban landscapes. By World War II most towns and cities had an engineer working for the municipality who was in charge of the development of infrastructure projects (Tarr 1984). The designers of infrastructure deemed standardization and engineering as an end in itself. During this time the interrelationship of environmental and civic concerns was undermined by the increasing specialization of the professions, and the resulting infrastructure became more mono-functional and less integrated due to the autonomy of the engineer (Rosenberg 1996 91). Road, water and sewer infrastructures became centralized and interdependent as specialized engineers focused on each system in isolation from others. The mono-functional approach to infrastructure that engineering utilized separated the basic provisions of water, waste, transport, food, and energy. This was due in part to make infrastructure conflicts less complex which often favored masking and hiding the systems underground.

The significance of the engineering profession on the infrastructural landscape is profound. While greatly important to the design of infrastructure, engineering has left out essential cultural and social dimensions that are traditional considered in other urban landscapes. This contributed greatly to the lack of public attention to the worsening condition of many infrastructural systems. Aesthetics was not a part of the discussion in the education of engineers or in the design of infrastructural systems.

CHAPTER 2

A NEW INFRASTRUCTURAL PARADIGM

As we have seen, the social, environmental and cultural contexts surrounding infrastructure are becoming more complex and engineering is no longer equipped to singularly design infrastructural systems. Infrastructure has an extended impact on our built and unbuilt environment and an early ubiquitous presence in the landscape. A re-focused attention has recently been put on the design and function of infrastructure given its necessity for our development and the need for the replacement our deteriorating infrastructure systems. Annalisa Meyboom describes in her article *Infrastructure as Practice* that infrastructure is "generative and directive" and has the "potential to create place and suggest future growth"(2009 72). Several authors have recognized the importance of considering infrastructure beyond its traditional scope and function. Elizabeth Mossop describes infrastructure "as the most important generative public landscape" (Waldheim 2006 171). With the understanding that infrastructure must perform its purposive function, it is realized that there are other functions that can be layered upon it and integrated within it.

Through a review of literature on new directives and imperatives of infrastructures two main concepts emerged that play an important role in the aesthetics of infrastructure. First, Infrastructure has become an interdisciplinary project; engineers alone are no longer equipped to deal with the complexities presented by the urban landscape. This brings the skills of the designer to the project which can dramatically affect its appearance and function. Second, infrastructure must become integrated and multi-functional to conserve space, resources, and create new spatial forms that incorporate social, cultural, and environmental dimensions. Integrating infrastructure has implications for creating spatial and formal aesthetic properties and experiences. While both concepts intend to redefine the relationship between humans, infrastructure, and the environment, each speaks to a specific aspect of infrastructure design that will enhance its role within social, cultural, and environmental contexts.

Infrastructure as a Collaborative, Multi-disciplinary Project

The contemporary infrastructural project is mired in complex dimensions of the environment, politics, and society. The traditional purveyors of infrastructure – the engineers – are no longer equipped to deal with the magnitude of associated implications of infrastructure design in urban and rural areas. The social and environmental dimensions surrounding infrastructure must be dealt with by other professions. Threats from climate change, dwindling natural resources, and energy reliance is "no longer a question solely for engineers" (Sarte 2010 6). Engineers may also not have all the specific expertise now needed to deal with complex social issues (Sahely, et al. 2005 79). Today, a multidisciplinary and collaborative approach is necessary to effectively problematize and find solutions for these complex issues. The challenge faced by infrastructure in America, as Pierre Belanger writes, "can no longer be resolved by singular, specialized or technocratic disciplines such as civil engineering or urban planning that once dominated 20th century reform" (2009 80). What are needed are multi-disciplinary groups composed of engineers, designers, planners, ecologists, and social and cultural specialists.

The multidisciplinary approach is nothing new, during rapid growth of cities and infrastructure networks during the industrial revolution, urban conditions were dire in many cases, landscape architects and planners worked to resolve many of these issues. The sanitary reformers of the late 19th century, exemplified by the father of landscape architecture Frederick Law Olmsted, realized that the "essential relatedness of the problems of the city" requires multiple perspectives and inputs from planning, engineering and design" and set an early example for the benefits of mutlidisciplinarity. (Rosenberg 1996 91). Olmsted's projects were comprehensive in their approach by recognizing the wide variety of players and uses and their integration within environmental systems. Approaching infrastructure design as a collaborative project "drastically changes the position, contribution, and responsibility of the professional disciplines involved in its creation" (Shannon 2010 9). It also calls for the inclusion of designers to render the form and experience of infrastructure in an aesthetically pleasing way. Landscape architecture, as Annalisa Meyboom writes, "is the most closely connected with infrastructure, having been involved in the booming business of mitigating infrastructure for the last half century" and should have a voice in the creation of future infrastructures. (Meyboom 2009 76).

Designers, as landscape architect Gary Strang notes, "have the ability to generate new and meaningful architectural, urban and regional forms by integrating the estranged disciplines of architecture, civil and structural engineering, landscape architecture and biology" (1996 13). Merging the skills of each of these professions "effectively dissolves the boundaries between design and engineering, nature and technology, and art and function" (Rosenberg 103). Multiple perspectives and inputs will result in an infrastructural system that will better integrate into the surrounding ecological, social, and cultural contexts.

Infrastructure as Integrated & Multifunctional, the "Hybrid Working Landscape"

Integrating infrastructures to be multi-functional looks at integration with other infrastructural systems, ecological systems, and public spaces. Multi-functional infrastructure challenges the traditional notions of mono-functionality to create new spatial forms that incorporate social and cultural, and environmental dimensions. This flexibility can be associated with the post-fordist mode of production that produce smaller sets of customized goods that are de-centralized and can rapidly change with context and demand. This moves beyond the large scale functionalist standardization of infrastructure present during the golden age. Multi-functional infrastructures also capture greater efficiencies by merging diverse functions. The "co-location" of various infrastructural systems is cost effective and promotes a spatially compact system. (Brown 2009 3). As Meyboom describes, "designing infrastructure with a multi-functioning agenda, incorporating both public space and engineering functions, the land benefits society on multiple levels" (2009 74). Layering different infrastructure systems creates nodes of activity and interaction that become centerpieces of public space. Rethinking the mono-functional realm of infrastructure and rescuing it from the limbo of urban deterioration recognizes its role as a part of the formal inhabited city.

Merging infrastructural and natural systems is also an important aspect of this directive. Many of our modern day infrastructural systems were informed in their design by understanding natural systems. Waste water treatment and stormwater infrastructure in essence mimic the flows and sequences of the natural hydrologic cycle, but in an engineered and isolated context. As Hillary Brown states in her article *Infrastructural Ecologies*, "Once we recognize that our built infrastructures are in essence man-made extensions of natural flows - we might more closely

model our own constructed networks on complex organic ecosystems" (2009 4). Landscape as infrastructure seeks to reinstate natural processes within infrastructural systems that function within them to reduce the negative environmental impacts of human development. It also challenges the notion of city versus nature in that, "The strict lines of human geometry and production efficiency should be allowed to deform to incorporate, rather than neutralize, biological networks" (Strang 1996 14). The resulting new interactions will integrate human and natural systems.

Landscape and infrastructure share the qualities of a system, but have traditionally been considered as separate since the industrial age. As John T. Lyle describes in his book *Regenerative Design*, "the industrial age replaced the natural processes of the landscape with the global machine while regenerative design seeks now to replace the machine with the landscape" (1994 29). Lyle's concepts around regenerative design originated with the emergence of landscape ecology in the 1980's and 90's which finds its roots in the environmental movement of the 1960's. Most importantly, this new knowledge introduced a hierarchical "systems approach" to understanding landscape. The emphasis on nature as a system, "breaks down the false dichotomy of city and nature that was deeply embedded in the nineteenth century thought" (Rosenberg 1996 89). A new hybrid working landscape diverges from the traditional picturesque notions of nature, and recognizes nature's ability to do work as a piece of human infrastructure that both functions and becomes part of the visible landscape.

Integrated, multi-functional infrastructure advocates a functional engagement with landscape processes which function as both a human and natural system, creating richer public spaces. The merging of infrastructure and landscape can create hybrid versions of single systems that can begin to function at levels beyond their respective parts and incorporate an aesthetic component. The hybrid landscape creates a dialogue between technology and natural processes that blurs the line between city and nature. As Elizabeth Mossop describes in *The Landscape Urbanism Reader* that, "This does not deny the reality of technology. . . but recognition of the importance of place and recognition of connection to natural systems" and that it is an "instrumental engagement with ecological processes as well as the social and cultural needs of the community" (Waldheim 2006 171-172). A hybrid infrastructural landscape will also produce pragmatic benefits as well. Hybrid landscapes bring together complex social, cultural, and

economic factors, as well as issues related to urban wildlife and water management. Merging stormwater and open space infrastructure, for example, confines two systems in one space, and appropriates funding for one combined project instead of two and provides the ecologic and social benefits of open space. These new hybrid landscapes not only have the ability to solve obvious utilitarian problems, but also to create highly functional urban spaces that create rich aesthetic experiences through their multifunctional and integrated design.

Shortcomings of the New Directives

Many of these new conceptual positions do not address the appearance or visual form of infrastructure, and its ability to inspire and inform as an important aspect of infrastructure. The concepts presented by these authors run the risk of becoming prescriptive, in a way that conventional infrastructure design has already done. Integrated and hybrid infrastructure hold great potential for also integrating a visual component that can express meaning, inspire and inform. This thesis proposes that the appearance, or visual form be as important to the design of infrastructure as being integrated and multi-functional. The potential of infrastructural systems to perform the additional function of shaping architectural and urban form through the infrastructural aesthetic is largely unexplored.

THE AESTHETIC

Modern Aesthetics and Engagement

The study of the appearance, or the look, beauty and ugliness of something is generally contained within the study of aesthetics. In its classical definition, aesthetics was limited to formal compositional properties like harmony, balance, and unity (Berleant 1993, Parsons 2002). Traditional notions of aesthetics focused on the "disinterestedness" of a viewer of an art object, such as a painting, that required a frame or enclosure of the object for it to be completely viewed (Berleant 1993). An aesthetic appreciation of the designed landscape emerged in the late 18th century with studies on the somatic experience of landscape gardens (Meyer 2008). European philosophers such as Edmund Burke and Immanuel Kant realized that the same emotions elicited by paintings and "framed objects" could be found in nature and designed landscapes. Glenn Parsons and Allen Carlson examined the range of properties which are the true focus of aesthetics of nature, sensual experience and knowledge based aesthetic experience. Sensual experience, similar to formal aesthetics, focuses on formal properties of nature like scenic views, unity and balance. Knowledge based aesthetics, or cognitive aesthetics focuses on properties far removed from the formal aspects that rely on existing knowledge of the natural world by the viewer (G. Parsons & Carlson 2004 363). Both of these notions of aesthetics are equally important and have contributed to a new understanding of aesthetic experience.

The new notion of aesthetics moved beyond the "disinterested" viewer of a framed and enclosed object, and moved toward engagement and experience. While the formal aspects of aesthetics are still important, modern interpretations of aesthetics have moved beyond static descriptions and into an experiential process of engagement and immersion, a combination of formal and cognitive properties. (Spirn 1988, Meyer 2008, Phillips 1998, Mozingo 1997, Gobster et al. 2007, Thayer 1998, Berleant 1993). Modern aesthetics focuses upon experience and, as Anne Whitson Spirn notes, "attending and reflecting on a thing's intrinsic properties and meaning which requires not only visibility but the capacity for it to be available to contemplation" (Spirn 1988). Spirn's definition includes the object viewed and the subject viewing as being engaged in a cognitive and sensual nature, an important aspect of the understanding of aesthetics that marks a shift from the constructive to the receptive theories of

aesthetic experience. The engagement, as she notes, produces a dialogue between subject and object that is dynamic and continually unfolding.

Within the study of aesthetics are attendant notions of the sublime, picturesque and beautiful. Kant and Burke elaborated at great length these ideas that categorized our emotions when experiencing the natural and man-made world. For Kant and Burke, aesthetic experience produced feelings that ranged from fear and astonishment to overwhelming ecstasy. It is aesthetic experience, as Elizabeth Meyer notes, that has transformative power and can "alter ones physical and mental state"(Meyer 2008 6). The power of aesthetic experience within the designed landscape holds potential for reviving a marginalized infrastructural landscape that embodies functionalist design. This thesis proposes to use aesthetics not as an end in itself but as a means to construct meaningful experiences with infrastructure and focuses on the notions of the sublime and beautiful to accomplish this.

The Sublime

The development of the sublime notion of aesthetics resulted from the shift from a constructive to a receptive engagement, specifically with nature. Traditional aesthetics had difficulty in describing the emotions brought forth by the magnitude of nature which was not a discrete object like a work of art or sculpture. Throughout the development of the notion of the sublime as Berleant notes, "there persisted the sense of boundless magnitude and power" that was not found in the aesthetic appreciation of art (1993 235). Kant and Burke formed the theoretical foundations of the sublime, but it was Kant who articulated its applicability to nature and landscape. The new notion of sublime developed by these authors focused on the visual character of a landscape or object, and its vastness or magnitude perceived through sight.

David Nye summarizes Burke's characterization of the sublime aesthetic as an "ecstasy of terror that filled the mind completely" (Nye 1994 6). Burke's description did not speak to the magnitude of the object, or natural world, and relied on self-imposed restraint and control. Kant moved beyond restraint and spoke of the fear and astonishment associated with the sublime in which "the mind is able to conceive something larger and more powerful than the senses can grasp." (Nye 1994 7). Kant breaks the sublime into further categories of the *mathematical*

sublime which dealt with vastness or magnitude and the *dynamic sublime* which focused on experiences of terror due to destructive natural phenomenon. (Berleant 1993). The satisfaction and emotion felt from both the dynamic and the mathematical sublime comes from our ability to grasp them in two ways. First, our ability to comprehend the magnitude of the object, and second, our contemplation of nature from a secured position that would turn fear into pleasure (Berleant 1993). Yet, Kant's "secured perspective" may not allow the full engagement take place, and as Berleant and others noted, engagement is essential for the new understanding of the sublime aesthetic experience of the landscape.

David Nye spoke further on the *technological sublime* of human achievements when he discussed the magnificent engineering projects of the "golden age" of infrastructure (Nye 1994). The technological sublime relied on engagement as an essential aspect of the experience and the public works in terms of bridges and dams often could be contemplated and were accessible to human experience. The bridges and dams of the golden age paradoxically balanced the threat of the natural sublime and the magnificence of the technological sublime that elicited a dual aesthetic experience. As Berleant notes of the sublime nature of grand engineering projects that "terror is the appropriate response to a natural process that exceeds our power and confronts us with overwhelming force, the ultimate consequences of a scientific technology where humans have become the inescapable victims of their own actions" (Berleant 1993 236). The possibility of a dam or levee failure creates an essential sublime experience. Manmade structures often subdue the sublime notion of nature, but they can also create natural and technological sublime experiences themselves.

The Beautiful

Beauty, at the other end of the emotional spectrum, elicits feelings of love, empathy and respect. The Oxford English Dictionary defines beautiful as "that quality or combination of qualities which affords keen pleasure to other senses (*e.g.* that of hearing), or which charms the intellectual or moral faculties, through inherent grace, or fitness to a desired end" (OED 2012). The Oxford definition points out that beauty is not purely visual or formal but composed of sensory experiences that draws out pleasurable emotions. David Nye notes Edmund Burke's notion of the beautiful which "inspires feelings of tenderness and affection" and is function of

"smoothness, gentle curves, and the delicacy of nature" (Nye 1994 7). As opposed to the sublime, beauty includes sensory experiences along with visual characteristics. Arthur Danto elaborates, "beauty is not found or discovered, immediately through the eye, and in relationship to known tropes, rather it is discovered through a process of mediation between the mind and body, between seeing and touching/smelling/hearing" (Danto 1999 192).

Elizabeth Meyer takes this notion further and speaks of how beauty is "not simply an act of pleasure, but possibly one of transformation" (2008 8). Considerable debate surrounds the notion of beauty and whether it is intrinsic to a particular form or associated with particular emotional responses. Hence the definition provided by Meyer supposes that beauty is not within the object, but the experience of that object and the resulting emotive response. The poly-sensual experience of beauty, and indeed of other aesthetic notions, minimizes the subjective nature of judgment and opinion. Whether or not one describes something a beautiful, the *sensory experience* of the object is the important aspect of beauty.

The New Aesthetic

Aesthetic concepts are highly applicable to the infrastructural landscape given its traditional place in the background of our everyday experiences, and this thesis's proposal to bring them forward as meaningful components of the landscape. Land artist Robert Smithson used visual forms and aesthetic experience to bring complex dimensions of the landscape to the surface, and tell a story. Smithson saw the man-nature relationship as part of dialectic of transformation. His project, *Spiral Jetty* (1970), documented the natural processes that continually occur around traditionally static human development. His projects reveal, as Ann Reynolds notes, "fundamental formal and structural connections between reading and viewing... that remain invisible to established hierarchies", in other words seeing a problem from a new perspective within the landscape that is as an aesthetic experience (2003). The landscape, and infrastructure, offers many layers for aesthetic experience which are traditionally not revealed.

As Elizabeth Meyer notes, the role of aesthetic experience "is a necessary component of fostering a sustainable community, and that beauty is a key component in developing an

environmental ethic" (2008 16). The role of appearance and beauty outlined in her manifesto is equal to the traditional functions of design and infrastructure. Robert Thayer expounded on this notion by speaking of a *visual ecology* which is a new aesthetic that will teach people about the value of nature and the possible symbiotic relationship between culture, nature, and design (Thayer 1976). Thayer's visual ecology resonates with the infrastructural landscape that lies at the intersection of culture, nature, and design.

Instead of utilizing aesthetics as a stylistic or ornamental coating, it must be informed by existing site processes and connective experience. Elizabeth Meyers has shown that the role of the aesthetic within the landscape can create an "immersive experience that can lead to recognition, empathy, love, and respect for the environment" (2008 7). The participatory experiences can break down the barriers between subject and object and can change and provoke one into action. Aesthetic design that contrasts and juxtaposes natural and human forms can prompt contemplation and care, something that the contemporary infrastructural landscape traditionally does not do, but has in the past.

THE AESTHETIC OF INFRASTRUCTURE IN THE PAST

Introduction

Looking into historic infrastructure sheds light on how historic infrastructure utilized aesthetics and the aesthetic layers present within infrastructure itself. Infrastructure's ability to endure as an expression of culture has been seen all around the world. The Roman aqueducts are an excellent example of a specific culture's ideals about how to manage an essential resource with beautiful infrastructure that still stands today. Today, much of our infrastructural landscape is not meaningful to the average person and does not acknowledge the role of appearance and aesthetics as seen with some historic infrastructures. Throughout the evolution of infrastructure in the United States there have been examples of beautiful and sublime infrastructures like the Brooklyn Bridge and the Hoover Dam that shed light on the existence of an infrastructural aesthetic.

To look at infrastructure is to look into complex layers of history developed over the course of the existence of public works. A brief re-examination of the changing aesthetics of the American infrastructural landscape over the past 200 years will reveal how the relationship between man, nature, and technology has evolved to create the contemporary infrastructural landscape. From the discovery of the "new world" and settlement, to the "golden age of infrastructure" and through to the Modern Era, the American infrastructural landscape has evolved to become the primarily utilitarian, hidden, and mono-functional systems of today. This examination identifies the major narratives that are contained within infrastructure including its greater civic meaning, its necessity for growth, and its designer's ideologies and how those narratives have or have not been expressed through aesthetics. The documentation of the evolution of public works in America draws correlations between cultural and technological trends that shaped the way current infrastructural landscape appears. The current infrastructural paradigm in America was greatly influenced by two broader cultural themes: utilitarianism and the dichotomy of city and nature.

These two narratives manifested themselves in form and appearance over the course of three eras of infrastructure building. The first, the settlement era, occurred during pre-industrial

settlement of the American landscape which is rooted in an ideology of dominance over nature and utilitarian function of the landscape. This ideology can be traced to the writers of the American Constitution and the philosophy of Manifest Destiny, which forms the foundational framework for many of today's infrastructural landscapes. During the settlement era, and after, engineering assumed the primary role of designing infrastructure, and would forever change the appearance and function of infrastructure. The second "golden age" of infrastructure began during the industrial revolution in the mid to late 19th century and culminated with the New Deal and the massive infrastructural projects planned after WWII. The "golden age" created some of the most impressive and technologically sublime public works in American history, and contributed to a national pride that strengthened and organized the country around progress. Third, the Modern era of infrastructure saw the gradual primacy and autonomy of engineering from other professions in the design of infrastructural systems and the quest for clarity and standardization which led to their mono-functional purpose and inevitably to their visually mundane presence within the landscape. All three eras imparted a different meaning and value on the greater infrastructural landscape that is visible today.

The Settlement Era of Infrastructure - The American Landscape Sublime & the advent of the American Civil Engineer

The settlement era of infrastructure was an era of foundations which form the framework for many of our current infrastructural landscapes. The discovery of North America introduced to the Europeans a vast and seemingly endless landscape with great potential that would be characterized by Walt Whitman as a "yet unproductive landscape that had the potential to grow enough wheat to feed the world" (Whitman & Stoval 1963). The European conception of the new world was as Leo Marx describes one of boundless immensity and seeming emptiness, or ahistorical character (1989 8). The contrast between the "new" and "old" world defined a boundless, unordered expanse that was unlike the politically organized map of Europe, and many believed that it should be settled and exploited by early forms of rail, road, and canal infrastructures.

Early attempts to describe the new world in maps and writings produced patterns of expression and judgment that were similar to each other. Many of the natural wonders in Europe did not compare in scale to those found in America, wonders that produced myths promulgated by early explorers of great beasts and mountains 50 miles high. One of the founding fathers of the United Sates, Thomas Jefferson, described the Natural Bridge in Virginia as "the most sublime of nature's works . . . it is on the ascent of a hill, which seems to have been cloven through its length by some great convulsion." (Jefferson 1800 75). Other wonders such as the Grand Canyon and the Mississippi River had the same effect on early explorers, and caused them to write extensively on their experiences with these natural phenomena.

The American landscape introduced a scale and grandeur that the Europeans had not seen before, and it would define a new man-made scale as the vast frontier was transformed and conquered by technology for settlement. All that the nation needed was a means to exploit the land which lay across wide rivers and behind massive mountains. From the first large scale systems of railroads and canals that would span the continent, infrastructure has mediated between our desire for progress and the natural barriers that stood in its way.

Founded upon ideals of entrepreneurship and liberty for profit and gain, the American ideology of space and the infrastructure needed to subdue it is predicated on the constitution and the values of its writers. Educated in the terms of the Enlightenment and the new found powers of rational geometry and organization, America's founding fathers saw the American continent as a blank canvas fit for new settlement schemes and exploitation for the pursuit of "life, liberty, and happiness." (Corner 1996 8). After the American Revolution, land ownership in the new world became even more attractive because it was now free from English land tenure restrictions; any individual could buy or sell land freely and enjoy the social respect associated with being a property owner (Richmond 1993). One can hardly look at the growth of the American nation in the mid and late 19th century without coming across the term "Manifest Destiny." Coined in a congressional meeting Washington in 1846 and now widely used as a convenient statement of the philosophy of territorial expansion in that period, Manifest Destiny embodied the control and ownership of nature that was now open for settlement (Pratt 1927). In this utilitarian interpretation of the American landscape as Leo Marx describes, "the landscape's manifest destiny is to be discovered, subdued, and settled"(1989 5). Manifest Destiny applied no restriction to the development of human enterprise for the growth of the American nation, and defines the *utilitarian* ideology of the infrastructural landscape of the time to settle and subdue wild nature.

Even before Manifest Destiny had established itself within American culture, Thomas Jefferson had already developed an organized means for settling and subdividing the American continent. Jefferson idealized agriculture as a most venerable occupation and believed that farmers represented the highest virtue and nobility among Americans (Jefferson 1800, page). For Jefferson, farmers would build the foundations of the American nation. His support of the grid of surveying the public domain established by the Land Ordinance of 1785 and his scheme for the creation of new states with rectangular boundaries affirmed his commitment to the application of the Euclidean grid. Jefferson's grid would disregard the natural forms of the American landscape to accommodate the farmer in a democratic fashion. The formal organization of property would also allow settlement to occur at a rapid pace and increase the nation's agricultural productivity. A product of rational geometry, the graticule of latitude and longitude, as James Corner notes "represents an abstract, intellectual inscription of measure

across the globe" (1996, p 5). The Land Ordinance of 1785 and Jefferson's grid thus became the first major foundations of a n infrastructure that would eventually organize new roads and railroads. Before the ordinance, little in the form of pre-determined land apportioning and allocation existed in the United States. From these abstract lines, city form and subsequently infrastructural forms would follow across the American landscape, regardless of topography and local environmental conditions.

The Jeffersonian grid represented a reasoned philosophy of control over the landscape that supported a zeal for the yeoman farmer. Jefferson's philosophy of nature centered around a "pastoral conception of American space" that was rooted in a utilitarian ideology of landscape (Marx 2008 8). His mathematical measure on the landscape was the tool through which the "moral and social goods of a new nation could be achieved" (Corner 1996, p 8). Born from the symmetric rationale of Greek and Roman city planning, Jefferson saw progress and purity in the ordered settlement of the wild expanses west of the Mississippi River. The ordinance divided new land into a grid of 6 mile by 6 mile rectangles, with the smallest areal division of 40 acres, which was believed to be the largest acreage able to be managed by a single family. Larger areas of 80, 160, and 240 acres were available as well to more ambitious farmers.

The township and range system embodied in the Land Ordinance of 1785 was one of the first federal efforts to support new settlements in the recently acquired Louisiana Purchase of 1804 the system's principle aim was to support organized and efficient economic growth. In 1815, President James Madison commissioned Prospect Robbins and Joseph Brown to survey the Louisiana Purchase according to Jefferson's township and range grids. The structure from which the measurements began that would subdivide the American west of the Mississippi River was located in a swamp at the corner of what are now Monroe, Lee, and Phillips counties in the state of Arkansas. The first major collision between Jefferson's grid and the unsettled west took place along abstract lines of measurement that extended all the way to the Montana. Jefferson in some respects became the father of the measurement of space and the rail and canal infrastructures that would be built upon it. Jefferson's ideals echoed through the next two centuries in the planning of our towns and cities, which disregarded natural forms and processes and the sublimity of nature for an organized settlement pattern which translated into the creation of infrastructure. As James Corner writes, "Our modern culture, particularly our relationship

with the environment, is constructed upon dichotomies and oppositions that cannot seem to find a common measure" (1996 14). In other words, our deep love of our sublime natural wonders that we would monumentalize and preserve in our national parks were contrasted against a utilitarian infrastructural pattern that tended to neglect and exploit nature's processes, limiting its ability to be multifunctional.

Infrastructure and technology would provide the means for executing the settlement and taming of nature that had previously been open only to fur traders and explorers. Perhaps the most effective infrastructure to accomplish the goals of Manifest Destiny and settlement was the railroad, which was the principle reason the west was won. As Dennis Cosgrove notes, "confidence that nature had been nailed down by geometry was shared by both the railroad companies and the isolated homesteaders on their quarter or half-quarter sections that stretched west"(1984 145). The railroad had liberated the American people from the shackles of nature's vastness, and would fuel a passionate and patriotic belief in the swift settlement of the west. Infrastructure had become a sign of progress, and unified a collective vision that these systems were valuable public assets. Technology was being spurred by new scientific discoveries that would lead to more creative and innovative means for subduing the landscape and supporting cities burgeoning with new populations.

The Golden Age of Public Works - The Technological Sublime

The infrastructures that were built during the golden age utilized aesthetics to express great civic meaning and embody the collective progress of cities and the nation. As settlement continued, regional scale forms of infrastructure like railroads and canals were expanding rapidly. The technology needed to develop those infrastructures was emerging with the industrial revolution in the early 19th century. Technology, mostly built upon the basic discoveries of European engineers, was slowly disseminating across the American continent through engineers (Layton Jr. 1973). New discoveries in steam propulsion and understanding of natural sciences were making the untamed American landscape more accessible. As David Nye notes, "the experience of the natural sublime was not intended to justify preserving the wilderness or halting development" and "both natural wonders and mechanical triumphs like the Erie Canal were said to elevate the moral character of the people"(1994 38-39).

By the height of the industrial revolution in the mid 19th century, American cultural ideologies like expansionism and Manifest Destiny combined with new technology and capable engineers would require the defining of a new sublime – *a technological sublime* – that was expressed through infrastructure (Nye 1994). As described by Nye, the technological sublime "is based on mechanical improvements made possible by the superior imagination of an engineer or technician, who creates an object that overwhelms the imagination of ordinary men" (1994 60). Railroads, Canals, and bridges built in the late 19th century, upon the foundations of the settlement era infrastructures, were filling the same emotional void with their massive and extensive networks that the natural sublime did, inspiring awe and astonishment.

As Annalisa Meyboom dramatizes, "these 19th century projects are where clever and determined men forged heroically through the wild terrain of untamed America to create the essential connections of a new land" (2009 73). James Corner notes the infrastructures of the American landscape "can often produce some of the most fantastic landscapes, creating a sublimity that is at once terrifying and immeasurable" and goes on to say that the "awe-fullness" derives from the sheer autonomy of the technological measure, the ruthless indifference of which can be matched only by nature itself" (1996 69). By 1869, the railroad had crossed the continental divide and bridged the Mississippi, connecting the two ends of the nation. The

notions of natural and technological sublime would paradoxically work side by side in the creation of the American nation, and help to define the relationship between America and its landscape through the construction of new infrastructures.

Many of these early technological feats of infrastructure were seen as *remarkable* by the public, contributing to the technologically sublime notions of manmade objects. For example the Brooklyn Bridge, built in 1883, was an immensely popular tourist attraction even while it was being built. Infrastructure's growing scale and materiality offered it as an object or system of sublime proportions and representation of progress. Bridges and dams that seem to defy the laws of physics reminded Americans of the essential function of infrastructure and the magnificent engineering that it sometimes requires. America's infrastructure that emerged by the 20th century "were the envy of the world. . . and still stand as handsome reminders of America's pride in its infrastructure" (Bruegmann 1993 9).These projects served their essential function but also served to inspire and direct for the sake of social and economic progress, a blending of the functional and the architectural which provided meaning and value.

By World War I the major cities in the United States were underlain with fully networked infrastructures (Tarr and Dupuy 1988). Water, sewer, and electric grids formed the foundation for the growth of cities beyond the industrial age. Infrastructure had evolved with the needs of the growing city but had taken shape as a collection of separately functioning systems. The creation of the mass production line and product standardization, both results of the Fordist ideal developed in the early 20th century, had bled into the creation of most types of infrastructure. Fordist systems of mass production fueled the organization of cities from the early 1900's to the 1950's. The Fordist city stressed automation and standardization supported by hierarchical infrastructures (Berger 2006). Fordism centralized production and would result in the creation of massive centralized networks of infrastructural systems. Transportation and service oriented infrastructure now penetrated the outlying lands beyond urban areas, extending the scale of infrastructure beyond the city.

Infrastructure was essential in carrying out the settlement of America, and would also be integral in its continued progress even through tough economic times. In response to declining employment of the Great Depression in the early 1930's, Franklin Delano Roosevelt saw

opportunity in building up America's infrastructure, so he conceived the New Deal. The New Deal was the "greatest public building program in the history of mankind" according to *Life* magazine (Strang 1996). Many of the public facilities and spaces we still use today were a product of New Deal agencies. The Civilian Conservation Corps (CCC), the Public Works Administration (PWA), and the later Works Progress Administration (WPA) maintained the collective goal of ending the depression. Transportation, cultural and service oriented projects such as The Skyline Drive and Blue Ridge Parkway, the Key West Overseas Highway, Mount Hood's Timberline Lodge, the Orange Bowl, the Chicago Waterfront, Washington National Airport, and the Lincoln Tunnel were impressive, even monumental, infrastructure undertakings.

The works of the New Deal were a testament to the economic and social importance of infrastructure investment and construction in pre and post-war America and carried America through the depression. Many of these projects still function as they did 70 years ago and continue to define the spaces we use today. The infrastructure created during the golden age and the New Deal solidified the utilitarian and cultural role of infrastructure within society. As Gary Strang notes of the expressive of the utilitarian landscape, "that one of the most profoundly moving landscapes were nothing more than the irrigation, domestic water supply, sanitary sewer and flood control systems that allowed the works of nature and humanity be revealed in an eloquent way" (1996 15). The sublime and beautiful aesthetic present within these infrastructures provided an awe-inspiring experience and sense of pride in the viewer.

The "golden age" of infrastructure culminated with the New Deal. New technologies would provide a passion and inevitable pride in the capabilities of man to impose his will upon the land. This ideology, developed during the golden age and based on technological sublime and utilitarian function of landscape, precludes infrastructure development in the United States in the second half of the 20th century. But, as infrastructure developed throughout the second half of the 20th century, social, cultural, and economic forces lessened its sublime magnitude and the civic importance of infrastructure as public works.

The Infrastructures of Modern Era

In the 1940's and early 60's, cultural and economic shifts in the United States greatly affected the design of the infrastructural landscape. The movement of populations from city centers and the shift to a post-fordist process of production and consumption greatly affected infrastructure. Both of these cultural and economic trends had wide spread affects on the visual form and scale of infrastructure and our cities. As Alan Berger notes, "the post fordist patterns of development are supported by extensive highway and infrastructure networks that allow production facilities to locate outside the traditional city while ensuring access to hubs" (Berger 2006 54). The creation of Eisenhower's Interstate Highway System beginning in the 1950's exemplified the post-fordist notions of efficiency and standardization. The Interstate Highway Act's 41,000 mile network was the largest infrastructure project ever projected in the United States (Tarr 1984). The standardized construction of sewers, waterworks, and roads proceeded at a rapid pace reflecting the impacts of suburbanization, the automobile, and the baby boom after World War II.

The modern era of infrastructure also witnessed the growing invisibility of infrastructural complexes, with the exception of systems such as highways, as "infrastructure was metaphorically and physically shifted beneath the surface" (Graham 2000b 183). The modernist movement which was taking shape during this time, as Stephen Graham further notes, strove for "clarity and standardization" which masked many infrastructural systems (2000b 183). As the larger infrastructure networks were gradually elaborated, many of the supports that were necessary to support the development of the old 'Fordist' city and urban system, were gradually rolled out across national space economies from the cores of the old metropolitan cities forever changing the form of our urban and regional landscapes (Graham & Marvin 2001). The urban processes that are constantly in flux constitute many superimposed and contested infrastructure systems. As Graham describes further, there are numerous infrastructural "landscapes" that weave through the contemporary city, the "electropolis", "hydropolis", and the "autocity" which create incredibly complex sets of interactions and conditions. It is important to note that these infrastructural "scapes" are not completely separated and autonomous; they rely on each other

and co-evolve in their interrelationships with other infrastructures, urban development and urban spaces (Graham 2000b 114).

Eisenhower's expanding interstate system is an excellent example of the effects of these new economic and cultural trends. The highway, water, and sewer systems built during this time were possible due to huge streams of government provided funding after WWII. These projects, though considered the culmination of the "golden age" of public works, contained elements of the technological sublime in their scale and civic importance. And, as historian Robert Bruegmann points out, "the success of these systems was contained within seeds of failure" (1993 10). Due to the scale of these systems, rigorous technical and standardized design methods had been adopted by the government and essentially created vast mono-cultures of infrastructure. Bruegmann further characterizes the lack of appeal of these systems to the public, "starting in the late 1960's, the engineers and public-works agencies came under increasing fire for the large size and impersonal character of their projects" (1993 10).

Nowhere was this opposition greater than with urban renewal projects of the 1970's. The renewal programs sacrificed low-income neighborhoods and urban fabric for highway corridors, where highway infrastructures unintentionally took on the role of slum clearance through the creation of edges and unused spaces (Melosi 2000). The decentralized, low-density nature of the growing outer city was utilizing infrastructure technologies that were designed and meant for more concentrated urban environments. The new suburban scale of low density development built out from the city caused different demands that raised issues of economies of scale and compatibility of infrastructures (Tarr 1984) As Gary Strang describes, "today we are still masking a system of infrastructure vastly and impractically expanded beyond the boundaries of the city, multiplying the task of maintenance and renovation beyond comprehension" (1996 12). Infrastructure implementation was caught between the pull of the outward growing city and the obligation of replacing inner-city services. Other infrastructural systems, such as flood control and water management systems were also increasing in scale with the transportation and service oriented systems of the time.

The only other infrastructural system to exceed the expense of the highway system was flood control. The Corps' inland waterway systems have become the most costly infrastructure

systems in the United States (O'neill 2006). Flood control development was approaching its apex in the 1970s with the vast majority of the infrastructure was built during the 60's and 70's. The 1986 Water Resources Development act specified that major flood control projects would be financed and maintained at local, state and federal levels. Karen O'neill explains one of the major issues with flood control built during the modern era is that "most of the time, these programs are invisible to the public, financially and even physically, because the projects have made rivers seem predictable" (2006 174).

From the "golden age" of public works through the modern era, the method of building infrastructure has remained relatively consistent. As Annalisa Meyboom describes of the modern era's motivation for infrastructure, "[infrastructure's] design considers travel demand, property acquisition requirements, cut and fill balance, and economy of time and materials" (2009 73). These motivations fueled the creation of efficient and aesthetically mundane infrastructural systems including flood control, embodying a purely functionalist design. The focus shifted away from the civic and cultural considerations that had driven the design of earlier infrastructure as public works. Thus, infrastructure design became more considerate of economics and efficiency that effectively removed form and meaning as an important aspect of its design. Infrastructure that once made headlines and forged progressive ideals into the public had lost the public attention. As Peter Bruegmann continues about the public interest in infrastructure, "it was difficult to find even a reference in popular magazines to the aesthetic aspects of roadway alignment, grading, or bridges" and goes on to say about other infrastructural systems that "the engineers had done such a good job controlling floods, delivering water, and removing waste that citizens could take these services for granted" and inevitably forget about them (1993 10).

As a result, the modern infrastructural era of the second half of the 20th century saw a general devaluation of infrastructure to the public. The change of terminology from "public works" to infrastructure also greatly affected the public's perception of these extensive systems. After urban renewal and the environmental movement, infrastructure suffered from criticisms that eventually led to a steady defunding of large scale programs during the 80's and 90's. The current infrastructural landscape is, as described by the ASCE, in great need of repair, investment, and planning (ASCE 2009). The infrastructure built during this modern era make up

the vast majority of the systems we see today, but relatively little has changed in their form and function over the past three decades. The complexities surrounding current infrastructure development are immense and reflect the shift to a predominantly technological environment which has produced numerous superimposed and interdependent systems in the urban environment.

Summary of The Historical Aesthetics of Infrastructure

Each of the three eras of infrastructure building produced its own aesthetic that is still visible in the infrastructural landscape we encounter every day. Whether the aesthetic is rooted within the appearance of the infrastructure itself, or within the cognitive contemplation of the infrastructure, the experience can be dramatic as seen with the Brooklyn Bridge or the vast township and range systems still visible today across the western American landscape.

The settlement era saw the importance of infrastructure to sustain economic growth while also defining the framework for fu ture infrastructures that is rooted in an ideology of utilitarianism of the landscape. The settlement era showed how infrastructure formed a tenuous relationship between man and nature that disregarded natural forms and processes for organized settlement. This produces an aesthetic experience that is rooted in the contemplation of our historic relationship with the landscape and the importance of these foundational infrastructures to the growth of the nation. This is closely related to a cognitive aesthetic that requires previous historic knowledge of these systems. Additionally, the settlement era infrastructures also contain formal aesthetic properties within their grand scale and form. These early infrastructural endeavors contain within them an autobiography of our values, aspirations, and fears in a tangible and visible form which produces a profound aesthetic experience to the modern public which still relies on them.

The golden age of displayed the great value and meaning of infrastructure to the public and displayed its ability to inspire the public through technologically sublime works of engineering, and to act as a civic amenity. The aesthetic experience elicited by these works lies not only within their scale and form as testaments to technology's ability to tame and control nature, but also in their appearance as architecturally designed elements that incorporated cultural and social themes. The technological sublime defined by David Nye summarizes the aesthetic power of these early infrastructure projects. As the design of infrastructure became more autonomous during the modern era, valuable aesthetic and cultural considerations were lost to efficiency and standardization. While infrastructure projects were built during the modern era

that contained an aesthetic dimension, most projects lost aesthetic considerations to economic and functional pressures.

CHAPTER 3

INFRASTRUCTURAL AESTHETIC CASE STUDY

Several recent projects highlight how aesthetics can introduce new layers of meaning and function to the infrastructural landscape. One such project, The Dell, is a stream restoration and larger stormwater infrastructure project that day-lighted a 1200 foot section of Meadow Creek on the University of Virginia Campus in Charlottesville, Virginia. The Dell works in conjunction with other ecologically designed stormwater mitigation projects on the campus of UVA. The history of the Dell, as a piece of public infrastructure for the university, goes back nearly 2 centuries. Thomas Jefferson bought the Dell's original 11 acres to tap Meadow Creek as a water supply for the university in the early 19th century. As the university expanded during the 20th century, golf links and homes were constructed on the Dell. During the 1950's and 60's the Dell was completely transformed by dormitories and recreational courts for tennis and basketball and Meadow Creek was piped underground (Welton 2009). As the population of Charlottesville increased, runoff volume from rainfall put more pressure on the underground pipes and wet spots began forming in the Dell. The university contracted with Nelson, Byrd, and Woltz landscape architects to develop an option for restoring Meadow Creek and installing a retention basin to absorb excess flows as part of the larger stormwater mitigation project.

The landscape architects saw a unique opportunity to bring the stream to the surface in a way that would reconstitute the original natural processes that had existed decades before. Instead of traditional stormwater engineering methods that bury water in concrete pipes, the design recreates the natural stream morphology of the region. This curving morphology contrasts the geometric forms of the surrounding landscape that were inspired by Thomas Jefferson's orthogonal layout of the campus. The newly revealed stream has a constant flow from the spring uphill and runs through a curvilinear channel lined with native vegetation that is unmaintained. Part of the solution entailed keeping the underground pipe for high flow situations, creating a hybrid system that functions during all levels of flow events. The key is that the majority of the times, the natural processes are working until it becomes absolutely necessary to augment high flow events with man-made infrastructure. The site was planted with species from Virginia's

three physiographic regions, coastal plain, piedmont, and uplands that occupy the low, middle and upper portions of the stream respectively to visually represent the regions to the public (McIntyre 2008). As it enters the retention pond area, it takes on a more geometric path through a 20 foot Pennsylvania Bluestone rill that creates a dialogue between nature and the manmade rill (Welton 2010). The water then enters the forebay via a spillway, and falls two feet to the ponds surface creating a sensory experience of the sound and sight of falling water.

The pair of linked retaining ponds filters storm water before it leaves the system. Sediment from the creek is now retained in the upper pond, or forebay, which is cleaned out periodically. (Welton 2010). The project's design is unified by the geometry of the surrounding built landscape juxtaposed against the curving path of the stream and the soft vegetated edge of the retention pond. The sharp, ninety degree angle of the sedimentation forebay and retaining pond visually contrast the curves of native Virginia wetland plantings. The design creates an interesting dialogue between human interventions and natural processes, both of which still function in concert on the site. The aesthetic experience of the site is explained by Elizabeth Meyers on a visit to the site after its completion in 2005,

> "When walking in the University of Virginia Dell, one crosses a small bridge where a stream flows into a stone rill. That moment is followed by the sound of water falling from the rill's scupper into a pond with clearly constructed geometry. That fall aerates and cleans the stream water as it moves into a fore-bay – while the waterway does not look natural, the hydrological processes of this disturbed urban stream are regenerated through human agency – the design and construction of natural processes over natural forms" (2008 9).

The Dell, as J. Michael Whelton quotes the project manager Kennon Williams, is "a dialog between cultural and natural forms – a place where nature and society meet" (2010 55). This dialogue is visible through many design interventions that make two systems juxtapose against each other. The traditional engineering response to the issue of stormwater was buried concrete pipes with no visible dialogue with nature, except downstream when it exacerbated flooding. The designers introduced a narrative that revealed a vital link between natural stream processes and human development. The legibility of the design makes it an ideal educational piece for students of hydrology, biology, horticulture, architecture, and landscape architecture. The Dells successful melding of beauty and function has made it popular among students and has

become an exemplary precedent for other stormwater projects in Charlottesville. (McIntyre 2008). While the Dell functions to clarify and clean stormwater, absorb excess runoff volumes, and enhance wildlife habitat, it also functions as a valuable public amenity. Numerous students use the Dell as a place for rest, relaxation, and recreation and local residents also uses the site for dog walking. (McIntyre 2008). The Dell accomplishes what the aesthetic and beautiful should do, to change people's attitudes about our relationship with nature.

The Dell strikes a chord for an infrastructural aesthetic that makes its hydrologic function visible and offers added function. The water quality of Meadow Creek has improved and the new habitat provided by the flowing stream has attracted turtles, ducks, and fish. The forms of the newly designed Dell reference natural and man-made dialogues that are juxtaposed against each other. The geometric form and bluestone material of the pond organize themselves within Jefferson's nearly 200 year old plan for the university grounds and contrast against the natural form of the vegetated edge. The Dell is a multifunctional, hybrid landscape that has used human agency to re-create natural processes working over natural forms. The students and community around the Dell highly value its character and function as a stormwater and civic amenity.

The Dell utilizes the aesthetic in a powerful way. As seen in Figure 6, a variety of visual, sensual, and contemplative properties exists within the aesthetic layers of the Dell. By revealing stormwater processes through engagement, poly-sensual experience, and juxtaposition of natural and cultural forms, The Dell creates a strong aesthetic experience. The contrasting man-made and natural stream and pond morphology creates a hybrid infrastructural language in the landscape that is highly legible to the public. The Dell exposes links between human agency and natural phenomena by making the hydrology cycle visible. Socially, the Dell has provided a valuable civic amenity for the town that has reduced the need more stormwater infrastructure downstream.

fig 6. Aesthetic layers of The Dell

THE LEVEE STUDY

As noted previously, infrastructure forms the underlying framework that supports human activities and systems over space and time. While many different systems exist that are described as infrastructure, flood control and a component levee in North Little Rock, Arkansas is the offers opportunities for the exploration into the potential of an infrastructural aesthetic in this thesis. The levee appears as a static object along the riverfront that, though basic in its form and construction, offers a unique point of focus to understand how the appearance and form of infrastructure affects the surrounding environment, and act as a medium for exploring the potential of the aesthetic to redefine the role and meaning of levees. Flood control systems and levees have been in existence for centuries and have come to define a tenuous relationship between human development and natural processes.

The Levee as infrastructure

The act of building up earth to protect from flooding is not a new idea, the use of the levee as a protector from floods predates European settlement of North America. In pre-columbian times, during the Woodland Period, many groups of people settled in floodplains of the Mississippi river and its tributaries due to their agricultural productivity and access to river travel (Pauketat 2008). The levees and mounds they built for protection from flooding also functioned in social, religious, and environmental dimensions, not just flood control.

Levees have been extensively utilized as flood barriers in the United States since the time of the American Revolution, and their form and function has remained relatively static since. In more recent times levees were built for protection from floods and the reclamation of land for agriculture, and have played an integral role in the economic growth of America. Two main components define the levee within the larger infrastructural system; floodwalls and earthen berms, and are both referred to as levees in this thesis. Though technically simple and uniform in appearance, the levee performs an essential infrastructural function that protects farms, homes, and communities from floods and supports agricultural activity. Along with flood protection, the levees support barge navigation along many major rivers in the United States which along with

agriculture contributes greatly to the GDP. The potential responses of flood control infrastructure to different contexts and surroundings are numerous in scale and complexity.

Flood control and the levees are essentially a larger version of the common urban stormwater infrastructure systems. To better understand the function of flood control as an infrastructural system, analogies between components of both systems can be drawn. Though many urban systems are buried, their components function in similar ways. The reservoirs for storage on the upper reaches of many flood controlled rivers act in a similar fashion to the retention and detention basins of their smaller urban counterparts. The levees themselves act like the concrete walls of a stormwater pipe, conveying water to another location in the fastest way possible. The reservoirs attenuate flow volumes and store water for consumptive use. Each urbanized area along the length of a flood control system acts as an inlet for the addition of more water to the system, similar to the gutters of a stormwater system. This comparison brings the immensity and complexity of flood control systems into a manageable scale to understand how they function as a form of infrastructure.

While estimates of leveed rivers are problematic, it has been estimated that there are at least 40,000 km of levees, floodwalls, embankments, and dikes in the United States (Johnston Associates 1989). The levees as a whole form a complex system of flood control that utilizes other components such as dams, spillways, and floodways to control flow rates along rivers. If one levee fails during a flood the dynamics of the entire river change. Approximately 160 million people in 881 counties in the United States live near a levee, and that population is expected to grow (FEMA 2009). Levees course through many different contexts including rural farmland, floodplains, small towns and large cities and maintain a continual vertical section of floodwall or earthen berm.

Flood Control Infrastructure Criticisms

While many infrastructural systems are buried underground, none of them are completely hidden and some have an extensive presence in the landscape. Flood control infrastructure and the levee, as this thesis examines, is also an example of a highly visible infrastructural system that courses through miles of urban and rural contexts which makes it a valuable component for

investigation of new aesthetic roles. Its traditional continuous appearance and rigid form reduces its potential to introduce dynamic interactions with its context.

Construction of flood control systems had resulted in the removal of millions of acres of floodplain from rivers across the country. These lands once served an integral part of the flooding cycle of the river by absorbing the vast majority of the floodwaters. They also were inhabited by a wide diversity of wildlife and plant life whose numbers have dwindled since the creation of the flood control system. The levees have also resulted in dramatic changes to the frequency and magnitude of floods along the Mississippi River. In the modern era, there has been a great deal of rethinking on the issue of levees and drainage districts. The fertility of the soil surrounding many controlled rivers and tributaries has, for millennia, depended upon cyclical flooding of rivers. Levees have effectively prevented that flooding for the sake of structural stability. Modern floodplain draining and clearing, along with intensive farming practices, are slowly exploiting these rivers to the point of degradation.

In addition to restricting flooding into floodplains and environmental degradation, levees have been shown to increase the height and velocity of floods (Pitlick 1997). In areas along the Mississippi River near St. Louis, increases in flood heights of up to 12 to 15 feet during the past century have been documented, and flood magnitudes have also been documented as increasing (Pinter 2005) Part of the failure to recognize flood magnification owing to levees is because incremental levee expansion projects are evaluated individually, even when many projects are proposed for a given river reach (Pinter 2005). This owes itself to the limited understanding that the levees are part of a much larger system that responds to disturbances throughout its entire reach.

Although levees have performed their function to a degree, according to a National Research Council report, levee failures have been responsible for roughly one-third of all flood disasters in the United States (NRC 1982). This was most recently witnessed in the failure of the Hurricane Protection levees of New Orleans in 2005 as a result of Hurricane Katrina's battering storm surge.

Aside from environmental criticisms, the social psychology of levee construction has resulted in a complacency and belief that the levees can never fail. As Nicholas Pinter notes, "the broadest criticisms of flood control by levees is that development in levee-enclosed areas promotes the false expectation that flood risk is reduced to zero" (Pinter 2005 1). As a result of frequent flooding even with levees in place, a National Academy of Science panel concluded, "it is short-sighted and foolish to regard even the most reliable levee system as fail-safe" (NRC 2005). The trust in the levee to protect has resulted in the destruction of billions of dollars worth of property that was built in the floodplains of the river.

As the height of the floods increased, so did the levees. The current levee system evolved over the course of many improvements and enlargements over the past two centuries. Most of these improvements were aimed at increasing height and extent of the system to provide more control of flooding. The levee in some sections along the Mississippi River levee system reaches almost 60 feet in height which has received numerous criticisms from adjacent landowners. If the levee must be continually raised to defend from flooding, when will the battle with nature cease and the growth of the levees stop?

The choice to use soil for the construction of the levee had practical and economic benefits. The soil could be excavated from the land adjacent to where the levee was going to be constructed. The linear form of the levees resulted from the ease of construction involved with a straight line as opposed to a more curvilinear form. The excavation of the material for the levees resulted in the creation of rectangular borrow pits on the river side of the levee that have become the focus of recent efforts to re-establish floodplain ecosystems. The Corps of engineers has been looking into borrow pits as a means to improve environmental quality along leveed rivers through the creation of aquatic borrow pits and reforested borrow pits. Aquatic borrow areas are irregularly shaped with smooth side slopes, varying depth sand islands with trees left undisturbed in the middle. This type design promotes fisheries and waterfowl benefits. Reforested borrow areas are graded to drain and are planted in trees restoring bottomland hardwoods and terrestrial wildlife habitat.

The Arkansas Levee

> You hardly ever see the river, but the levee is always close by, a great green serpent running through woods, swamps, and farms, with towns nestling close to its slopes. The levee is unobtrusive, since its slope is green and gradual, but in fact it is immense - higher and longer than the Great Wall of China, very likely the biggest thing that man has ever made...It was the principal human response to the titanic power of the great river.
>
> - Alan Lomax, *The Land Where the Blues Began* 1993

Alan Lomax was describing the levee system along the Mississippi and Arkansas Rivers that weaves through birthplace of the blues in Northwest Mississippi and Eastern Arkansas. The levee has been a part of the lives of many people who have worked and lived in the floodplain of the Mississippi and its tributaries. It has represented a feeling of safety and control that has allowed thousands to live in the shadow of the Mississippi river and tributaries which has become a part of the region's identity. Before the levees the river was a source for food, trade and travel that was the lifeblood for many hunters that exploited the bounty of the wooded wetlands and floodplains. Over time, the levees have changed our relationship with the rivers that has become tenuous and disconnected.

The focus of this thesis, a levee in North Little Rock, Arkansas is a simple, one mile long, highly visible infrastructural component that is part of the much larger system along the Arkansas and Mississippi Rivers. The McClellan-Kerr Arkansas River Navigation System (MKARNS), managed by the Corps of Engineers, serves as the flood control and navigation system along the Arkansas River. The North Little Rock levee is a part of this system, the majority of which was built in the mid 20th century. The MKARNS system is a part of the Mississippi River and Tributaries project whose levees wind through 3787 miles of the lower Mississippi Basin. In its over 50 years of existence, the NLR levee has

Fig 7. Levee along NLR riverfront

performed its intended function of holding back floods only a handful of times (Hodge 1995). The levee and floodwall have primarily served to separate the city from the river.

In the past few years, community efforts have come together to produce murals along the face of the concrete floodwall. The wall and grass covered berm dominate the views into and out of the riverfront and inspired the community to make the infrastructure function culturally and tell a story through murals. This community action is a testament to the visual impact of the floodwall and berm on the riverfront but also a testament to the value and meaning that the levee has to the community of North Little Rock.

North Little Rock sits at the geologic edge of the Ozark Mountains and the Arkansas River Delta. At this point is where the system of Arkansas River levees begins and runs south nearly 200 miles to the river's confluence with the Mississippi River. The levee is not the only flood prevention system present in the region. Less than 12 miles away is an archeological state park known as Toltec Mounds which was constructed nearly 3000 years ago by the Plum Bayou culture. The mounds still stand within 1 mile of the Arkansas River along an oxbow lake called Mound Lake and are dated between 600 and 1050 C.E. (Pauketat 2008). Ranging in height from 6 feet to over 20 feet, the mounds are surrounded by a small protective berm or levee that was estimated to be 8 to 10 feet high when constructed. This is one of the first hints of a method to protect from floods that involved the berming up of soil. The mounds and levees are believed to have signified fundamental Native American beliefs concerning sacred and secular, past and present, and earth and sky (Pauketat 2008). The raising of the ground through the construction of berms and mounds had a practical advantage of protecting inhabitants during floods while also providing an extensive view across the flat landscape (Corner 1996). Toltec Mounds forms a historic baseline for the understanding how the contemporary levee in North Little Rock can hold great historic and civic meaning and be a platform for social and cultural ideals.

Reclaiming the swamp and overflow lands in the Arkansas and Mississippi River's Deltas required drainage of the lands and subsequent construction of levees to prevent the inevitable floods that periodically occurred. Without drainage, the land was useless for farming. Early residents realized that once the land was cleared of the timber and drained, the rich alluvial soil would be productive for a variety of crops, especially cotton (Hodge 1995). Initially, early

settlers had attempted to build makeshift barriers to halt the powerful flood waters, but these attempts were ultimately useless. In 1879, Congress created the Mississippi River Commission to establish a unified flood control plan. In cooperation with the U.S. Army Corps of Engineers, the commission's goal was to build higher levees based on previous flood heights and improve their quality (O'neill 2006). Between 1905 and 1915, the Arkansas General Assembly passed laws to create a program of flood control in Arkansas's Mississippi River Valley (Hodge 1995). This marked the beginning of the creation of levees along the Arkansas River

It took many years for the levee systems and drainage canals to be successful in keeping the water out. In addition, many of the early levees were poorly constructed and were susceptible to collapse when pounded by violent floods. However, through perseverance and sheer luck, in many cases, the drainage districts became successful and enabled Arkansas to become one of the most productive farming states in the nation. Even today, a vast majority of the nation's agricultural rice and cotton crops are grown in the Arkansas Delta.

During the Great Flood of 1927, many levees collapsed, and the entire levee system had to go through an overhaul. Herbert Hoover, then the secretary of commerce, acknowledged that part of the devastation from the flood was due to the "tinkering" of humans: despite unusually heavy rains, it was the levee system itself that resulted in the flood waters being poured into the Mississippi River Valley all at one time, as the tributaries had no room to expand due to the levees (Hodge 1995). This resulted in the creation of the Flood Control Acts of 1928 and 1936 (O'neill 2006 150). Over the course of the next few decades the levees that now contain the Arkansas River were constructed and forever changed the Arkansas Delta landscape.

Fig 8. Murals along NLR levee wall

Aesthetic Inventory of the North Little Rock Levee

The levee in North Little Rock, Arkansas demonstrates in many ways how the spatial and visual impacts of infrastructure can affect the urban environment. As described earlier, infrastructure has received criticisms describing it as "single purpose" (Brown 2010, Hicks 2008 99) "decaying and technocratic" (Belanger 2009 80) and "mundane and utilitarian" (Meyboom 2009 73). The current approach to the design of the levee and floodwall in North Little Rock has not only affected its appearance, but also marginalized spaces that result from its extensive scale along the riverfront. Its continuous appearance and rigid form reduces its potential to introduce dynamic interactions with its surrounding context. As seen in figures 9 and 10, the levee has a significant impact on the North Little Rock riverfront.

The section of levee and floodwall in North Little Rock Arkansas will be inventoried for its current aesthetic affects on the city's riverfront. The levee, though highly visible, has become assimilated into the common vocabulary of landscape, and has visible effects of deterioration that can be seen in figure 10. Through its 50 years of existence along the riverfront, the levee has not responded to changes in its context as the city grew around it. In many cases the levee and floodwall have formed a visual and spatial barrier that has reduced the aesthetic opportunities provided by the river and disconnected the river from the city. The images in figure ten show how the levees appearance has marginalized views from and toward the river, blocking visual connections and reducing the visual quality of the levee as infrastructure.

Spatial Impact of the North Little Rock Levee

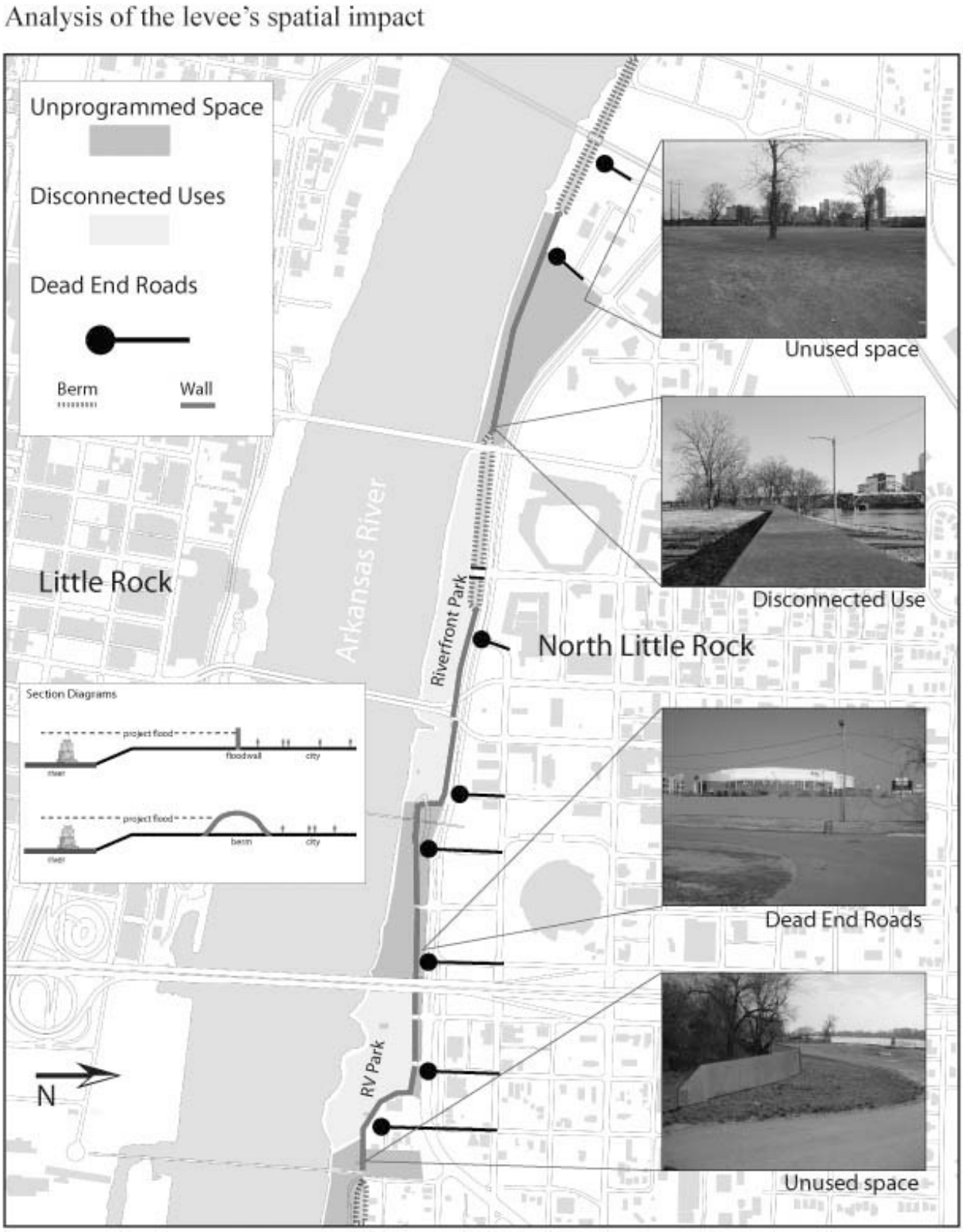

fig 9. Spatial Impact

Visual Impact of the North Little Rock Levee

fig 10. Visible Impact

SYNTHESIS

The modern infrastructural landscape has become a highly complex and dynamic process that is underlain by political, economic, environmental and social demands (Rosenberg 1996, Allen 2000, Graham 2000). Yet, the majority of these systems are mono-functional and interdependent, which has marginalized integration within their context and their aesthetic qualities (Rosenberg 1996, Graham 2000, Edwards 2003, Waldheim 2006) Recently, a re-focused attention has been placed on the design of infrastructure given its necessity, extensive presence in the landscape, and its ability to be generative and directive within social, environmental, and cultural dimensions (Rosenberg 1996, Strang 1996, Allen 2000, Waldheim 2006, Belanger 2009, Meyboom 2009). These authors call for infrastructure to become multi-functional, integrated, and hybrid. Within this new focus and through the historic examination of infrastructure, it was realized that aesthetics is an equally important aspect of infrastructure that has performed in the past (Nye 1994, Poole 2000, McIntyre 2008, Meyboom 2009, Rosenberg 1996). Through the creation of aesthetic experience, additional layers of infrastructural function can inspire, inform, and direct those who experience them (Thayer 1976, Phillips 1998, Meyer 2008, Garten 2010).

The current performance and role of the infrastructural landscape analyzed how the many of today's infrastructures disregard context in their design (Solomon 2004, Berger 2006, Rosenberg 2006, Meyboom 2009). Infrastructure exists in varying degrees of visibility, where highly visible, infrastructure often appears mundane or decaying. The ancillary spaces created by infrastructure have produced an urban landscape riddled with unused and disconnected spaces. Modern infrastructure's mono-functional approach has disregarded integration within adjacent spaces, effectively creating barriers to connectivity (Lynch 1976). The engagement of context will also produce infrastructures that have a regional identity and represent a sense of the place that they reside in and provide an aesthetic layer (Rosenberg 2006, Meyer 2009).

Historically aesthetics has created meaning and value, adding a functional layer upon infrastructure. The aesthetic of infrastructure can render a more valuable and contemplative experience than what is provided (Nye 1994, Meyer 2008). The effect of the modern era on our contemporary infrastructure has created a monotonous, standardized, and in many cases invisible

infrastructural landscapes. Aesthetics and the performance of appearance explored the potential of infrastructure to function in a meaningful visual way that can engage and inspire (Meyer 2008). Aesthetic strategies such as juxtaposition, engagement, poly-sensual experience, legibility, and sublimity can be utilized by the levee to enhance its function. These aesthetic is not about the ornamental, but how to make infrastructure a legible aesthetic experience to enhance its role within cultural, social, and environmental dimensions. The power of the aesthetic was seen in the technological sublime works of the Golden Age and other infrastructures that can elicit strong emotions (Nye 1994). The Dell produced aesthetic experiences that created new layers of function that changed the way a space was perceived and understood (Poole 2000, Meyer 2008).

The historic evolution of infrastructure and the future paradigms of infrastructure highlight the importance of infrastructure to our everyday lives. The historic roles of infrastructure seen through its evolution over three eras of infrastructure building provided examples of how infrastructure can function in cultural and social dimensions through its visibility and form. There is a great amount of cultural meaning and historic narrative contained within infrastructure (Strang 1993, Rosenberg 1996, Meyboom 2009). Great infrastructural works of the New Deal and the golden age utilized aesthetic notions of the sublime and beautiful that inspired those who experienced them and represented the progress of America (Strang 1996, Bruegmann 1993). The Dell expressed the historic narrative of Thomas Jefferson in its geometric forms and brought a hidden forgotten stormwater infrastructure forward for the public to contemplate. Through aesthetic strategies such as juxtaposition, sensuality, and the sublime, a new experiential layer of function was produced.

Aesthetic Opportunities of the Levee

The study of the levee in North Little Rock and the larger flood control systems of the United States produced an in depth understanding of how the levee's form and function has affected the greater landscape. The levee has a long and storied history in the floodplains of many rivers in the United States and has been an integral part of the lives of many people. The elegantly simple form of the levee disguises its essential function and importance within

economic, social, and environmental dimensions. The thousands of miles of levees in the United States weave through a wide spectrum of contexts from wilderness to rural and urban conditions.

Though the community has utilized the levee as a forum for expression through murals, furthering its cultural meaning and value, the levee has not performed as a functional part of the urban fabric of North Little Rock since its construction. The mono-functional design has resulted in the creation of many unused and disconnected spaces along the riverfront. The levee in North Little Rock has performed its intended function of flood prevention only a handful of times, the rest of the time it has effectively separated the city from the river (Hodge 1995). Its aesthetic appeal is limited to signs of decay and a continuous monotonous appearance that elicits no contemplation or prolonged attention from the public.

The levee has not integrated in a beneficial way with other infrastructural systems which has resulted in the creation of dead-end streets and sidewalks (fig 7). The levee system has drastically altered and degraded natural systems over the last century and increased the intensity and frequency of floods (Pinter 2005). The function of the levee and the potential of making its meaning legible implores that the levee must not be removed from the riverfront, because it has been an important part of the city for decades, rather the levee must become more than it is. Aesthetic experience offers a strategy that can be utilized by the levee to enhance its role along the North Little Rock riverfront.

IMPLICATIONS

Aesthetics and its attendant notions of the sublime and beautiful can play an important role in the development of future flood control infrastructure. The sublime described the transformative potential of the landscape, and man-made objects such as large scale infrastructures, to human emotion, while the beautiful spoke to poly-sensual experience that can lead to comforting emotional reactions. Meyer, Nye, and Spirn all recognized the functional role of appearance, and its ability to perform. Kevin Lynch saw the urban environment and infrastructural systems as "an enormous communications device" that could be affective and influential to our experiences (1971 384). Embedded within modern infrastructure are several narrative layers that speak to its historic role within the landscape, and the cultural ideologies that were present when it was constructed. In the case of flood control infrastructure, it represented a control of nature that reclaimed millions of square miles of land from flooding to support the growth of the nation. Whether it is the sublime notions of early infrastructure during the "golden age", or the hidden systems of the modernity's quest for clarity and standardization, there is a great amount of meaning contained within flood control infrastructure that has slowly been built over the course of these three eras. Aesthetics can play an important role in revealing the narratives behind infrastructure, and can help to define a new role for the levee and flood control infrastructure in our urban environment.

By using immersive aesthetic experience, the traditional notion the levee as an edge that mediates between man and nature can be revealed and made available for contemplation. Artist and sculptor Cliff Garten notes the importance of infrastructure's appearance in *Sustainable Infrastructure: The Guide to Green Engineering and Design,* that "by celebrating infrastructure itself, we also recognize our dependency on the natural systems that we mediate with our infrastructure"(2010). Aesthetics and appearance are powerful notions that can transform our ideas and expectations about the role and implications of controlling flooding with levees, and give these structures meaning through visual and spatial design.

Celebrated infrastructural projects mentioned during the golden age of infrastructure like the Brooklyn Bridge or the Hoover Dam inspired and represented the growth of America. Those

projects were a blending of the technical and aesthetic, and utilized architectural engineering and design to enhance their visual appearance. Flood control infrastructure was an equally extensive and important part of the growth of the nation. The notion of aesthetics as an important part of historic infrastructural design can bring back the value and pride felt by those who built and experienced those great infrastructure projects. Many of these projects utilized cultural design motifs that exposed the grandeur of the projects to public. Roosevelt's New Deal programs and the great projects of the Works Progress Administration were a crusade for well being and progress in America. The merging of the technological and aesthetic, which so many New Deal projects accomplished, "presents an instrumentality and organization that is fully integrated into a meaningful cultural and aesthetic framework" according to architect Stan Allen (1999 48). Levees and floodwalls present a less technical, but organized and instrumental component of a vast infrastructural system whose aesthetic properties are largely unrealized.

The appearance and form of the levee must respond to the adjacent uses and promote new uses. The creation of aesthetic experiences can further engage the public in the functions and civic importance of the levee. The levee will cease to just being an infrastructure component and will become a part of the urban fabric that fosters community activities and promotes permeable connectivity between the river and city. The linear form of the levee can become more articulated, colorful, diverse, and visibly interesting which can introduce new juxtapositions of river and city. As an edge, the levee can be reintroduced as a conduit rather than a barrier that would foster movement through, within and around its structure creating new perspectives on the levees function and form.

By creating a hybrid language that juxtaposes cultural and natural forms, the levee can begin to express its function as an edge between human development and natural processes. Hybridized natural and human forms can create an exaggerated version of human constructed nature, called *hypernature* (Meyer 2008) that can draw attention of public to the congruities and incongruities between human and natural processes. The levee can reveal its function as a protector while responding to the dynamics of natural processes. This will blur the lines between natural and cultural, urban and wild, appearance and performance, beauty and disturbance and redefine the cities response to the river.

The standardized and efficient response of the levee to the river is above all pragmatic and must be replaced by forms and functions of local and regional places. The sublime scale of the levee and river itself can enhance understanding of place along the Arkansas River. It will not simulate place, it will be site-specific design that emerges out of its context within an urban floodplain along the river.

Exposing the linkages between human development and natural processes is an essential part of increasing awareness of environmental degradation and celebrating our infrastructural systems as civic and cultural achievements. Elizabeth Meyer notes that when infrastructural systems and natural systems are integrated that, "This intermingling of ecological and social temporal cycles – seasonal floods and human activities such as holiday festivals or sports – links the activities of everyday life and the unique events of a particular city to the experience of the dynamic aspects of the environment" (2008 16). Infrastructure supports many of our social and cultural cycles and has the opportunity to express those cycles through aesthetic design. Establishing these linkages in the design of infrastructure also reinvigorates the meaning of infrastructure to the public by "highlighting the interrelationships between natural systems and everyday urban life and restoring civic meaning to what is now relegated to a separate realm" (Rosenberg 1996 89).

The civic responsibility of infrastructure has, in many cases been lost, and public knowledge of the meaning of infrastructure has been lost as well. Bringing these systems to the surface to make them visible and accessible is integral to them becoming meaningful in a two-fold manner. First, the link between human and natural systems could bring awareness to environmental degradation by making natural processes visible. Second, making infrastructure visible and aesthetically pleasing can foster greater respect and value for infrastructure itself, a notion that resonated well with the "heroic age of infrastructure" (Meyboom 2009 73). Though, Rosenberg notes that, "the intent is not to fetishize these systems... the technology's visibility should not be the ultimate goal, but rather a consequence of the design process" (1996 102). The process, if utilizing an integrated approach, will result in more visible and meaningful infrastructures that perform multiple functions.

Integrated infrastructure, achieved in an aesthetic form, can provide "legible models to illustrate how nature currently works and does not work – intertwined, such as it is, with architecture" (Strang 1996). Nature is being severely altered in many cases, and establishing visible links between infrastructure and its consequences is an important part of the process toward recovering the damaged systems. Michael Hough, a landscape architect, claims that in most urban situations that, "We are unaware of the ecological degradation that occurs to aquatic life and to the beaches which have to be closed after a heavy rainstorm" (2004 23). Hough sees the loss of linkage between human development and nature as a product of poor planning policy and politics and the autonomy of engineering from art in the design of infrastructure. Hein van Bohemen continues in saying that aesthetics and art "can play a role in integrating civil engineering and ecological engineering into a broader framework within society" (2002 195). Making flood control infrastructure available for aesthetic experience will also result in infrastructures that express a sense of place and regional identity. Rosenberg notes further that, "Local topography, water, plants, sun, or wind become integral to the workings of the system" which will render an infrastructure that references local context and can create sense of place (1996 102).

CONCLUSION

The discussion of aesthetics and infrastructure design is a co nversation that will be important to urban designers in the coming years as infrastructural systems grow and become a greater part of our everyday experiences. Given infrastructure ubiquity in the urban environment and extents into the rual environment, the aesthetic design of these systems can bring added value and appearance to an urban realm that has traditionally been left out of the design discussion. As seen historically in infrastructures like the Brooklyn bridge and with contemporary projects like the Dell, aesthetic experience can create value, beauty, education, and civic importance to infrastructure.

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