I, Marshall H S Dutton, hereby submit this original work as part of the requirements for the degree of Master of Architecture in Architecture (Master of).

It is entitled:
Sanctity of Water

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Sanctity of Water

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Abstract

Water is one the world’s most abundant substances, yet within modern societies it is also overlooked as an industrialized commodity. In desert metropolitan areas where water sources and flow has to be heavily manipulated for human consumption the sanctity of water has been lost. Engineered landscapes tame the irregularities of nature but often, waterways are created solely as infrastructure similar to alleyways. For decades, the residents of Maricopa County, Arizona have enjoyed a vast infrastructure that captures and channels throughout the arid climate. It brings water to countless spicketts within the fifth largest city in the United States. In an area that receives an average of 8.3 inches per year an average Phoenician uses 136 gallons a day. This need has created a separation between society and the environment. As the water is diverted into utilitarian canals, stripped of all vegetation to improve efficiency, the natural riverbed lies as an abandoned wasteland.

The 1985 Rio Salado Master Plan outlines a parkland and commercial development that is centered on the 38 miles of riverbed running through the metro area. Tempe, a landlocked city within Phoenix metro, incorporated a smaller version within it city limits. These plans include, a 5 mile artificial lake, rebuilding Tempe Beach Park, and development of the new waterfront into an oasis-like office park. This creation of “Tempe Town Lake,” has limitations: control of 977,000,000 gallons of open unfiltered water, and steep flood walls prevent wading or shallow swimming.

In my argument that follows, furthering the landscape design of the parkscapes and water-related architecture, will allow society to celebrate and reinforce the connection between man and water. Design and planning can rebuild the sanctity of water within desert communities. As a start, the large number of private pools in the Phoenix valley, second only to Los Angeles, place a burden on the water supply. As water resources become stretched, the costs of ownership are steadily increasing. Water shortages and the intense summer heat drives people to public and private bodies of water. In consideration of resources and individual costs, drawing the allure from private pools into a public natatorium will help to alleviate water concerns and can strengthen the regional sense of community.
A special thank you to -

-my parents

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for without this combination of people this accomplishment would never be possible.
ImageSourcing .......................................................... 6

DesertWater
- Phoenix History ...................................................... 12
- Phoenix Water .......................................................... 16
- Tempe Town Lake .................................................... 22
- Desert Landscape ..................................................... 28
- Landscape Integration ................................................. 30
- Water + Culture .......................................................... 36
- Public Water
  - Fountains ................................................................. 40
  - Canals + Rivers ......................................................... 43
  - Bridges ................................................................. 47
  - Waterfront ............................................................ 49
- Pools ................................................................. 53
  - Natatoria ............................................................... 58
  - Recreational Pools ..................................................... 59
  - Atavistic Pools ......................................................... 61

Design1
- Precedents ............................................................... 63
- Zones ................................................................. 69
- Transformation ....................................................... 79

Design2
- Program ............................................................... 91
- Program Precedents ................................................ 99
- Unique Features .................................................... 102
- Form Intent .......................................................... 108
- Form Precedents .................................................... 113
- Form Inspiration ..................................................... 133
- Transformation1 ...................................................... 143
- Transformation2 ...................................................... 147
  - Collage ............................................................... 148
  - Faceting ............................................................. 148
  - Structure + Envelope Assembly ................................. 150
  - Program Infill ...................................................... 152
  - Interior Surfaces ................................................... 157
  - Exterior Surfaces .................................................. 158
  - Apertures ........................................................... 159

Conclusion .............................................................. 162

ReferenceList ........................................................... 163
Figure 1. Channelling Desert Water to Urban Areas, Various Image Collage, JPEG, (collage by author).
Figure 2. Chuck & Mickey, New Construction along Central Arizona Canal, http://www.panoramio.com/photo/8559280, JPEG.
Figure 3. Transforming Desert into Farmland Through Irrigation, Various Image Collage, JPEG, (collage by author).
Figure 6. Reutilizing ancient Canal System, Various Image Collage, JPEG, (collage by author)
Figure 7. Dichotomy of Drought Conditions and Water Usage, Various Image Collage, JPEG, (collage by author)
Figure 8. Gober, Patricia, Phoenix Land Use, 119, JPEG.
Figure 9. State Engineer- Arizona, Map Showing Irrigation Canals Flowing from Salt River, JPEG.
Figure 10. National Archives, Photograph Showing Where the Consolidated Canal Co, had Utilized a Prehistoric Canal, 1907, JPEG.
Figure 11. Salt River Project, Deeping the Arizona Canal on the North Side of the Granite Reef Camp, 1907, JPEG.
Figure 12. Gober, Patricia, Salt and Verde Watersheds, 12, JPEG.
Figure 13. Salt River Project, Various Image Collage, JPEG, (by author)
Figure 14. Early Canal Landscape, Various Image Collage, JPEG, (collage by author) (Originals Alf Simon, pg 62, 63, 65, 69.)
Figure 15. Manufactured Landscape, Various Image Collage, JPEG, (by author)
Alf Simon, 89, 91, 97
Figure 16. Simon, Alf, Typical Canal Landscape After the Removal of Trees, 94, JPEG.
Figure 17. Simon, Alf, A Phoenix Metropolitan Area Canal as a Sere gated Landscape, 89, JPEG.
Figure 18. Tempe Seaport Proposal, Various Image Collage, JPEG, (by author)
Figure 19. Unknown, Google Map (with Highlighted Riverbed), JPEG, http://maps.google.com/maps?um=1&hl=en&biw=1239&bih=803&q=phoenix&ie=UTF-8&sa=N&tab=il
Figure 20. Unknown, North Indian Bend Wash Superfund Site, JPEG, http://commons.wikimedia.org/wiki/File:NIBW_Superfund_2005_map.svg
Figure 21. Mark Wahl, Embarcadero Freeway (now gone), http://www.flickr.com/photos/90557979@N00/247522780/
Figure 24. Tempe Town Lake Dam, Various Image Collage, JPEG, (by author)
Figure 25. Tempe’s Connection with Water, Various Image Collage, JPEG, (by author)
Figure 26. Unknown, Dry Rio Salado, JPEG, http://www.gemland.com/tempe.htm
Figure 27. Unknown, Full Tempe Town Lake, JPEG, http://www.arizonatribe.com/images/urban/tempe%20town%20lake%20view.JPG
Figure 28. Rio Salado Park and Development Overlay on Map, JPEG, (by author).
Figure 29. Town Lake Water Temperature, JPEG, http://www.tempe.gov/lake/
Figure 30. Town Lake pH Levels, JPEG, http://www.tempe.gov/lake
Figure 31. Drained Town Lake Bank, JPEG, http://azstarnet.com/news/state-and-regional/article_54b6e836-95a5-11df-ac6e-001cc4c03286.html
Figure 32. Drained Town Lake Bank, JPEG, http://arizonageology.blogspot.com/2010/07/dam-burst-empty-s-tempe-town-lake.html
Figure 33. Spirit of Arizona’s Desert, Various Image Collage, JPEG, (by author)
Figure 34. Erosion, Various Image Collage, JPEG, (by author)
Figure 35. Integration of Post Industrial Landscapes and Nature, Various Image Collage, JPEG, (by author)
Figure 36. Reclaiming Stressed Landscapes, Various Image Collage, JPEG, (by author)
Figure 37. Field Operations, Fresh Kills Evolution, JPEG, http://landscapeandurbanism.blogspot.com/2010/10/more-on-ecological-urbanism.html
Figure 38. Unknown, Yellowstone National Park, Charming Scenery, JPEG, http://www.deshow.net/travel/2008/yellowstone_national_park.html
Figure 170. Conceptual Collage Model: Overlay of Motion Diagrams, JPEG, (by author)
Figure 168. Schematic Form Diagram, JPEG, (by author)
Figure 171. Schematic Model: Collage of Freestyle + Butterfly Motion, JPEG, (by author)
Figure 172. Schematic Model: Collage of Freestyle + Butterfly Motion, JPEG, (by author)
Figure 173. Single Faceted Form, JPEG, (by author)
Figure 174. Section Perspective, JPEG, (by author)
Figure 175. Section Perspective, JPEG, (by author)
Figure 176. Infilling Form with Program
Figure 177. Form Encapsulating Pool Creating Aquatic Environment, JPEG, (by author)
Figure 178. Subtracting Area from Form, JPEG, (by author)
Figure 179. Section Perspective: Looking North Near Main Entrance Ramp, JPEG, (by author)
Figure 180. Short Section: Not to Scale, JPEG, (by author)
Figure 181. Long Section: Not to Scale, JPEG, (by author)
Figure 182. Plan: Not to Scale, JPEG, (by author)
Figure 183. Plan colored for Level Changes: Not to Scale, JPEG, (by author)
Figure 184. Section Perspective: Looking South Through Competition Pool, JPEG, (by author)
Figure 185. Structural Diagram, JPEG, (by author)
Figure 186. Reflected Ceiling Plan, JPEG, (by author)
Figure 187. Section Perspective: Looking South Through Competition Pool, JPEG, (by author)
Figure 188. Section Perspective: Ventilation Diagram, (by author)
Figure 189. Aperture Study, (by author)
Figure 190. Skylight Study, (by author)
Figure 191. Section Perspective: Skylight Study, (by author)
Figure 192. Section Perspective: Looking North- Through Leisure Pool and Skylight, (by author)
Thesis Statement

This investigation is finding the *Sanctity of Water* within a sobering desert community that is long accustomed to manipulated water to fuel its manufactured oasis, which the commodification depreciates of water’s intrinsic value and regresses the climatic relationship between the hostile desert and human survival.
Desert Water

-Phoenix History

Desert cites represent the urban realities within the harsh region. As the centers of life, they are surrounded by barren landscape that often demonstrates the “oasis civilization of the American West,” and “Arizona is one of the most urban states in the nation.” 80% of Arizona’s population is within the metropolitan cities of Phoenix and Tucson, regardless of a vast and scenic desert landscape enveloping much of the state, these cities are an urban oasis within the extreme Sonoran Desert.¹

The American West experienced major population booms, especially following World War II, due to the advancements in automobiles, air conditioning, health concerns, quality of life, water distribution, transportation networks, and military expansion and migration toward the deserts. By the 1980’s, Phoenix had grown to be the 9th largest city in the United States and accounts for 60% of Arizona’s total population. By 2008 Phoenix grew to be the 5th largest city with a population of 1.6 million people and also the 12th largest metropolitan area with 4.3 million people. On average, a person uses 136 gallons of water per day, within a region that averages 8.3 inches of yearly precipitation.

1. Luckingham, Bradford, Phoenix: The History of a Southwest Metropolis, pg1
Figure 1. Channelling Desert Water to Urban Areas,
Figure 2. Chuck & Mickey, New Construction along Central Arizona Canal
The Valley of the Sun, where the Phoenix metro is located, was created by a series of geologic interventions over millennia to produce the current vision of the valley. Around 1.4 billion years ago, the geologic activity buckled up formations creating mountains (Squaw Peak, Black Mountain, McDowell Mountains, Sierra Estrella and most of the Camelback Mountain), until the Pacific Ocean later flooded the lowlands, which eroded the valley floor into its flatness. As 20 million years passed, volcanic activity pushes even more mountains (West, Usery, South and the Superstition Mountains, and the partial exposure of Camelback Mountain) into the desert skyline. Roughly 15-20 million years ago, changes within earth’s mantle started to fracture and the crust settled downward, which elongated the peripheral mountains, separating the valley from the higher elevations of the Mogollon Rim and the Colorado Plateau. Water traveled from the Mogollon Rim toward lower elevations forming rivers, which caused erosion, and created a large alluvial plain that filled the valley with thousands of feet of sand, salt, and silt.2

The city of Phoenix, in 1868, was founded on the Salt River (Rio Salado), near the confluence of the Gila, Verde, and Santa Cruz Rivers. Settlers came into the Salt River Valley in the early 1860’s and the establishment of Fort McDowell, in 1865, protected the settlers and miners. The American settlers gradually expanded an ancient Hohokam canal structure. This provided the desert with water, and turning expansive desert into an agricultural paradise. The ample sunshine, long growing season, and a flowing water source allowed crops and civilization to bloom across the valley. Jack Swilling reconstructed a former canal, that created a 2-1/2 mile ditch, which initially cultivated 600 acres, but quickly expanded to 4,000 acres by 1871.3 With the introduction of the railroad in 1887, “the Salt River Valley [became] the garden of the Pacific Slope and Phoenix the most important inland town.” Phoenix found itself on a nexus of two transcontinental railroads, and well connected with national markets as this helped allow the migration of people and wealth to the valley.

2. Allen, Richard, Geostories,
Figure 3. Transforming Desert into Farmland Through Irrigation
With the national connection and exposure from the two railroads, Phoenix became the commercial and distribution center of the state. As Arizona and technology grew, this allowed outlying communities of farming, ranching and mining to profit and prosper. The health seeker was another motivator of the population migration toward the American West. With its perpetual sunshine and low humidity, Phoenix became noted for its health benefits. As numerous visitors’ health had significantly improved and had lead them back into productive lives, the region benefited and developed from these individuals contributions toward society. Incoming people realized that Phoenix “cannot dream your town into a city; you must build and [promote] it into one,” then the quality of city was dependent of the quality of people. The diverse population drew from the ideas and goals of various regions and institutions, it tried to replicate the best from their previous homes.\(^1\)

Phoenix had the rare designation of a completely new Anglo settlement, which technology had created the civilization. Unlike most other western cities, the American settlers developed the original city and the social structure. The valley of the sun was uninhabited from 1400 CE when the ancient Hohokam civilization disappeared until September 1865, when the United States Army established Camp McDowell. By early 1866, Jack Swilling was promoting the re-construction and re-use of ancient canals and by November 1867, he had collected enough financial backing and organized the Swilling Irrigation and Canal Company.

\(^1\) Luckingham, pg2-10

Figure 4. Phoenix, 1885
Unlike most other southwestern cities, there was no immediate Native American or Hispanic population, the Anglo settlers had a clean opportunity to develop a new city with little known history. Major cities such as Tucson, Albuquerque, Santa Fe, San Diego, and Los Angeles all had a long and contentious history of habitation, conquest, and domination. Phoenix developed the social structure that favored incoming fellow Anglos, and establishing ethnic and technological dominance over the exploited yet non-Native Hispanic population. These Americans originated the power, wealth, prestige within the valley; “Phoenix from its founding was run by Anglos for Anglos.”

1. Luckingham, pg 8-18

Figure 5. Casa Grande Ruins
Figure 7. Dichotomy of Drought Conditions and Water Usage
“Water has been critical to making the making of human history. It has shaped institutions, destroyed cites, sets limits of expansion, brought feast and famine, carried goods to market, washed away sickness, divided nations, inspired the worship and beseeching of gods, given philosophers a metaphor for existence and disposed of garbage. To write history without putting any water in is to leave out a large part of the story.” D. Worster

4. Tvedt, Terje. The History of Water: The World of Water, pg249. Figure 8. Phoenix Land Use
From 1885-1890 Phoenix tripled in size, yet the all the water needed to feed the city population and extensive agriculture was solely dependent of the Salt River, and its unpredictable flows of flood and drought proved the desert oasis unsustainable unless the river could be restrained. The growth of a canal system evolved from cooperative ventures into corporate and independent canal companies competing for water rights along the river. The separate companies interested in the profitability of water and land speculation competed for the extrinsic value of water thus compromised the validity of the entire system. With little political oversight, Arizona not yet a state, the water rights were based on simple first-come first-served approach, which lead the companies and speculators to gain power and profit by controlling more quantity of water, and acquiring more water by leapfrogging each other getting closer to the headwaters of the river.

Figure 9. Map Showing Irrigation Canals Flowing from Salt River
Figure 10. Photograph Showing Where the Consolidated Canal Co, had utilized a prehistoric canal
Figure 11. Deeping the Arizona Canal on the north side of the Granite Reef Camp
A gravity canal system can only feed land downhill of the canal. The higher canal is the more land it can irrigate, so the higher canals have to have a higher source of river water, adding to the competition for headwater sourcing of the canals. By 1900, 10 canals irrigated 113,000 acres and eventually the water rights exceeded the actual flow of the Salt River.

Due to the severity of floods and droughts of the 1890’s, the community started to feel the burden of the conflict between nature and private companies. The system of canals were entirely based on river flow. This dependence meant that no company could supply an annually dependable source of water. Organized citizens created the Salt River Valley Water User’s Association in 1903, and debated the use of federal government and the 1902 National Reclamation Act. Many of the citizens who moved to the territorial Arizona and were “distrustful of the federal government and its intervention, and committed to the survival of the fittest.” Within the National Reclamation Act, the Salt River Valley was recognized as the first potential water conservation project. Eventually the 3,500 landowners agreed to match federal funding for the construction of the Roosevelt and Granite Reef Dams then unifying the canals into a dependable water storage and distribution system.³

³ Simon, 26-43
Figure 12. Salt and Verde Watersheds
In 1911, Roosevelt Dam, the then world’s largest masonry dam, was completed and created a reservoir 25 miles long and 2 miles wide. Both the dam and lake was named for Theodore Roosevelt, who initiated the 1902 National Reclamation Act, and gave a “glorious future” to the Salt River Valley. By 1908, the Granite Reef Diversion Dam was completed and fed all the Salt River water into a unified canal system; all individual canals were federally purchased from competing private companies. With the completion of dams, then not only stored and distributed reliable water, but hydroelectric power brought electricity to the population of Salt River Valley, which helped to recuperate investment costs. The power supply greatly reinforced the prestige of the territorial city, and helped the promoters to entice incomers to move to the valley and prosper. Also with the intrusion of the two dams, the Salt River was transformed into a dry riverbed, demoted from a lively river, to a mile-wide drainage channel.¹

1. Luckingham, pg12-17, 68-80

Figure 13. Various Image Collage
The canals evolved as a utilitarian landscape and engineering tried to perfect the efficiency of water distribution. The original canals were little more than dirt ditches that were dug by hand, with little engineering. The canals were stripped of the vegetation surrounding the canal, transpiring water into the environment. With eradication of the trees and shrubbery, the canals eroded from the constant flow from the powerful water. Annually the canals had to drained and cleared of eroded dirt and garbage. The canals eventually were widened and lined with concrete, in order to prevent erosion and water loss. The natural flow of life-giving water was transformed as infrastructure and manipulated through a landscape that was scraped into mechanical channels slicing through an arid environment. 181 miles of canals slice through the urban fabric, and since regulations have driven the public away from the water most communities have turned its back toward the canals, much like alleyways. Society views and values water as an abundant commodity. Water is connected as the life-blood of the desert, but flowing within household fixtures without its knowledge or public connectivity of how that water reached the faucet, pool, fountain, or toilet.

Figure 14. Early Canal Landscape
As the water was diverted into the canals, the Salt River sat dry and only fills during monsoon season when flash floods ravage the city and its aquatic infrastructure. The ignored riverbed becomes an unofficial dumping ground, straddled by the urban fabric of the Phoenix metropolitan area. Some of the bridges connecting the bisected urbanity were constructed when the Salt River flowed unimpeded; during the 1970’s and 1980’s many were eroded and structurally damaged in the sudden floodwaters. Some roads, such as northbound Mill Avenue were constructed in the floodplain that were closed in the event of floods and caused further congestion, thus endangering drivers who crossed the river. In recent decades the Salt River has undergone an attempted rehabilitation. Much of the garbage and industrial waste was cleaned; parts of desert habitats have been set aside for protected restoration, and proposals submerge the riverbed came to life.

5. Gober, Patricia, Metropolitan Phoenix: Place Making and Community Building in the Desert, pg.40-45.

Figure 15. Manufactured Landscape
Figure 16. Typical Canal Landscape After the Removal of Trees
Figure 17. A Phoenix Metropolitan Area Canal as a Segregated Landscape
In 1966, James Elmore, the dean of the Arizona State University’s College of Architecture, took on the challenge of revitalizing the lost river. He charged students to redesign the riverbed as an inland seaport. The resulting concept included public parks, a linear greenbelt, recreational areas, and development along 17 miles along the river.6 As the project matured from an academic project toward physicality, it gained political support, but eventually lost public support, except within the city of Tempe.5 In 1979, Mayor Harry Mitchell created the Rio Salado Citizen Advisory Commission, which gathered public input and representation through the process. In 1985, the final Rio Salado Master Plan was released outlining elements, benefits, budgets, and the implications along the 38 mile corridor through the metropolitan area. By 1990, construction has begun on flood control channelization with plans continue to develop for wildlife management, water treatment, recreation, and commercial development. Progress continued through the decade, 1997 construction bids were sent out and by 1999 the lake was declared full.6
Tempe Town Lake was a part of a greenbelt initiative, a proposal to restore environmental significance, within the community. In 1983, the Indian Wash, a tributary of the lake that is the location of the eastern inflatable dam, was declared a superfund site due to industrial pollution blamed mostly on the Motorola Corporation. A superfund site is a polluted ground, which by federal law required responsible parties to clean up the contaminated soils, as it is a danger to public health. As environmental awareness was being raised, the Rio Salado Project within the city of Tempe gained public support. Support for smaller yet similar projects such as the Indian Wash recreation area, a small greenbelt of parks and golf courses within the flood plain of the wash.  

At a cost of 45 million dollars for lake construction, in addition to the 40 million dollars required for river flood control and channelization, the City of Tempe tried to recreate the desert oasis by constructing the 240-acre Tempe Town Lake. The project was seen as an investment for incentive for developers to construct and sell both office and residential along the waters edge. The full developmental potential could have an economic impact of 1.3 billion dollars and generate 3.2 million dollars in annual tax revenues. This will generate 145,454 dollars per acre, as compared to 2,847 dollars per acre for a golf course; a popular sport within Arizona that was environmental criticism outside the research of this thesis.

5. Gober, pg 42-48
Figure 19. Google Map (with Highlighted Riverbed)
Figure 20. North Indian Bend Wash Superfund Site
Two inflatable dams control the Tempe Town Lake; the eastern (upstream) dam is 5 foot high, while the western (downstream) dam is just over 16 feet. All the dams can be lowered to let floodwaters pass, and are computer controlled. A clay liner was laid on the eastern part of the lake helping to control seepage losses, in addition to 10 pumps that controlled lost groundwater and returned it to the surface. The canal was originally filled with water purchased from the Colorado River via the Central Arizona Project canal. The lake has been politically served with water rights, for the yearly filling of the lake to recover evaporation losses. However, since 2005 the lake has not needed additional water due to its location within the floodplain at the head of a 12,000 mile watershed. Seasonal flashfloods rip through the Salt River, flowing through the lakes inflatable dams. As the floodwaters slowdown, the dams are reinflated trapping water thus filling the lake back to capacity.6

6. Tempe, City of., tempe.gov/lake/
Figure 22. Full Projected Development
Figure 23. South Bank Development
Figure 24. Tempe Town Lake Dam
Tempe has always connected itself with bridges and the river due to the fact that it was situated on the south side of Salt River. Tempe has always resolved the traffic and commercial problems inherent of being on the opposite side of the river from Phoenix. The artificial lake had five bridges-three automobile bridges including the historic 1931 southbound Mill Avenue, a new 1993 northbound bridge to replace a surface road that was closed during flooding, as it would be submerged under the lake. Within the Tempe Beach Park was a remnant of the 1913 Ash Avenue Bridge, this bridge was the first permanent public bridge, and designed for pre-automotive loads but was obsolete before opening. One of its eleven arches was severely damaged in 1916, and was effectively replaced by the previously mentioned 1931 Mill Avenue Bridge. The Ash Avenue Bridge remained as a pedestrian link between Tempe and larger Phoenix, until 1991 when it was demolished due to structural damage from another flood. On the westside of the lake sits another historic 1912 railroad bridge and a 2006 light-rail bridge, which has an award-winning design, using multi-light display for a nightly showcase of the new structure. The annual July 4th firework display takes place on the bridges, thus the site became center-stage to the traditional public event.
The Rio Salado Park was an extension of Tempe’s 1931 Tempe Beach Park, the municipality’s first park. The park surrounds the lake and creates a prime location for developmental opportunities. Near the western dam, the newly built Center of the Arts civically anchors a large park surrounding the lake. A proposed pedestrian bridge was designed over the dam to connect the north and south banks, essentially centering the Center of the Arts within the park. The northern bank of the lake hosts a marina and boat ramps for non-power boats to cruise the lake. Due to the unfinished development, the large park has vast open desert spaces and ambiguous entrances. The heart of the park remains the Tempe Beach Park with its historical connection to Tempe and its proximity to the Mill Avenue and its successful business district. The Mill Avenue District is the business and government center, also neighbors the main campus of Arizona State University. In addition, the recently built light-rail station allows easy connection with Tempe Town Lake and the larger Phoenix metropolitan area.

Figure 26. Unknown, Dry Rio Salado
Figure 27. Unknown, Full Tempe Town Lakend Development Overlay on Map
Although, the lake was planned as recreational water and intended for swimming, was closed from full body contact due to untreated water. The lake's temperatures do follow a predictable pattern, and the pH balance varies widely. The City of Tempe does allow the use of lake for limited competitive swimming events and large triathlons. For the six scheduled events the city annually pays an average 23,250 dollars to treat the water to the acceptable full body contact standards.\(^7\)

The lake is also situated within a channelized part of the riverbed, which has nearly vertical sidewalls, reaching a maximum depth of 19 feet. The lake edge consists of a floodwall and the park melds a levee within the landscape, to protect against the 100 year flood. Both are effective measures of flood control yet separate thus prevent an authentic connection between the water, people, and the landscape.

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Figure 29. Town Lake Water Temperature
Figure 30. Town Lake pH Levels
Figure 31. Drained Town Lake Bank
Figure 32. Drained Town Lake Bank
“Humans are absent here because they die.” -Craig Childs

“The desert looks hideous. Burned out cores of volcanoes, hundred-mile basins with floors mirrored in mirage, and terse studded mountains.”

Sharp, rigid, and abrupt mountains stand through time, stalled in growth and waiting for millennia to erode into large smooth mounds. As the mountains slowly falter the debris of sand and boulders fall to the base, and layers of debris create the alluvial fan, then followed further downstream with a floodplain, and finally a river collects water running off the mountain face. Within the floodplain, sand and gravel is collected with great depth, separating the granite bedrock from the surface by as much as 1000 feet. Aquifers are usually located within this zone. As rain or snowmelt runs down the front side of the mountain, it has many opportunities to seep into the ground water, including the sandy riverbed. Most desert cities are placed within this zone due to centuries of water collection, which has resulted in reasonably large aquifers in the alluvial plain that covers much of the gravelly and rocky desert surface. Only the peaks of the mountains are exposed to the air and can be seen within our environment.

Figure 33. Spirit of Arizona’s Desert
The mountains and canyons have exposed many different geological layers, rock types, slopes, and rates of exposure. Water is primarily responsible for the transportation of debris, soil, gravel, and other materials in making the desert ground. These alluvial deposits start out as similar sediments with fairly uniform qualities, yet over time soil layering happens. These layering are also called soil horizons. These are easily seen in places with vast cuts in the earth, such as the Canyon, where the bands of soil vary by color, hardness, texture and soil composition.

Erosion can happen on the exterior surface and within the interior of the formation. Exterior erosion is from the formation exposure to the elements, mainly water. This erosion usually results in broad sweeps similar to the Grand Canyon, or Arches National Park. Interior erosion happens as water seeps into rock imperfections and cracks, which sometimes goes through freeze-thaw process or will sometime nurture life. Either scenario the crack becomes bigger and eventually the rock starts to erode from the interior, resulting in rockslides and boulder fields. As the debris falls away from the formation it collects near the base as an alluvial fan. The alluvial sediment is generally rough sediment then finer and sandier closer to natural drainages basins due to higher exposure to water erosion.

10. Arizona-Sonoran Desert Museum, A Natural History of the Sonoran Desert, pg 71-100
Figure 34. Erosion, Various Image Collage
Desert Water

-Landscape Integration

Natural Integration

The evolutions of Landscape Architecture has shifted from the remediation of land into the realm of making public nature, the transfer of nature from distant protected parks, and infused within a hybridized community. As America emerged into the postindustrial society, communities had numerous derelict ruins and polluted sites leftover from decades of destructive or abusive activities used extraction and production of the growing industry. Reclamation of post-industrial ruins has lead public interest into landscape projects; the 1975 Gas Works Park was a hallmark of the first round of parks constructed on an industrially contaminated ground, the High Line project is a current project phasing the transformation of an elevated railway into an urban greenway flying through New York’s West Side. More recently, landscapes are used as a marriage in the revitalization of economic, social, and environmental forces within communities. The intention of these projects is to rehabilitate public areas near economic centers and to help people and the environment.

Figure 35. Integration of Post Industrial Landscapes and Nature
The National Parks Act of 1916 set aside and protected pristine landscapes, in a large land bank, from rapid land consumption of the American industrial age. These national parks protected the natural ecosystems for the enjoyment of future generations of U.S. citizens. A change of recent attitudes has communities actively engaging in nature, bettering everyday life of its citizens “that fuels, filters, feeds, and otherwise fosters healthier communities.” Natural ecologies has shared a close relationship with human settlement until the birth of the machine age, when nature became distant from the civic realm and was considered ecological media for supplying raw materials. The protection of pristine sublime nature within the national park system allowed for minimal guilt of the consumption of natural resources used elsewhere.

By the mid-Twentieth Century, the obvious effects of the abusive treatment of the environment starting to spread fears of naturocide, which threatened the public health of communities. With the Environmental Protection Agency helping to breakdown the separate attitudes of production and protection, this allows the remediation projects a healthy building typology within the U.S. and has concurrently spread into postindustrial Europe. A remediation project has various approaches within its project type. It can juxtapose the past history of the industrial site with an architectural/horticultural intervention by redefining the polluted ground into a newly programmed site, and rehabilitate the original structures to fit the new public program. The landscape could also actively distill pollutants and change the site conditions into a cleansed public area. This performance-based method addresses site concerns through process of dynamic response and recovery, which is “embraced and framed by design, not defended against.” Emerging from the performance process, another approach has taken the transformative site with adding program and identity, allowing the remarriage of nature and society. The ecology becomes productive, not just in remediation, but also ingrain entrepreneurial environments with nature.

Figure 36. Reclamating Stressed Landscapes
As public nature morphs and is integrated into cities, it progresses through environmental productivity, yet requires a social seductively. The public space is not frozen or controlled, but “governed by the potent interaction of natural and human forces.” The approach of civic landscape shifts from a simplistic objective environment to a subjective field, thus encapsulating the production of local benefits with active management affecting the experiential interactions. Separating the landscape into zones, drawing attention to specific intentions that integrates productive responses to amplify environmental impact, can create ecological tension. This enables spatial design, habitats, and programs to engage humans with a dynamic romantic relationship with the landscape, yet this has less to do with environmental healing but it is redefining public spaces.

A business district is not individual parcels, but a continuous productive landscape forming an urban fabric, sharing a gravity of influences, attitudes, resources, and environmental factors. The commercial landscape interconnects and weaves within the regional landscape, creating an essential nexus of seduction and work. The urban fabric fuses buildings and landscapes together, as a cohesive and responsive environment that blends the natural with the artificial.

Figure 36. Reclamating Stressed Landscapes
While these landscapes are being designed and constructed, obstacles continue to be overcome. Separate from productive landscapes are small-scale landscapes, or boutique ecology. Designers create autonomous landscapes with separate urban and natural systems, thus avoid variable dynamics of natural forces. The general public appreciates passive scenery, rather than productive landscapes. Within the public's minds, these urban landscapes must compete with protected national and state parks for beautify and memory creation. The protected wilderness generates business through travel and tourism, addressing accessibility of the distant parks, federal publicity as well as the transportation industry that promotes the visitation of the preserved countryside. In order for ecological media to be accepted and commonplace as public space, the public must comprehend the intrinsic and extrinsic value of “information and environmental technologies have the potential to virally increase awareness of ecological states, to link people, place, productivity and performance.”

Figure 38. Fresh Kills Projected Evolution
The concept of nature can be divided into five or six categories: pure wilderness, agriculture, nature within culture, industrial nature, post-industrial reclamation, and possibly the natural urban infiltration. Land use strategies modify over time, which will depend on civic priorities. To transgress into urban greenscapes, the general public must provide social motivation and a “desire to participate, desire to cultivate, [and] desire to advocate.” Natural catastrophes and the resulting mass media explosion are key to rising environmental awareness. Environmental changes drastically affect all populations, regardless of economy or global status. Our exploitation of finite natural resources might have increased the intensity of weather patterns and exposure to climatic disasters, further endangering our lifestyles. “A primary economic and environmental equation is now a tragedy of the common(er).” The reminder of natural calamities, can “provide a foundations for today’s complex and preemptive socioecologies.” Natural interventions reintegrates with productive and commercial landscapes, and can adjust culture toward place and regional responses to environmental conditions.  

Natural ecologies have shared a close relationship with human development, until the machine age commoditized land and resources, and separated man from nature. The performance of the consumer society is indisputably attached with the state of environment, and culturally maintains a strong desirable approach toward nature. As infiltration of productive ecological landscapes intertwine with consumer and industrial environments, the relationship is redefined as the functionality of landscape will not appeal to romantic passive scenery, however impact of the future environments.

11. Amidon, Jane, Big Nature, pg 164-180
Figure 39. Yellowstone National Park, Charming Scenery
Figure 40. Bangladeshi Agriculture
Figure 41. Central Park from 30 Rock
Figure 42. Gowanus Canal
Figure 43. Gas Works Park
Figure 44. High Line Before Restoration
“Ripples in ponds expand from the plunk of a stone endlessly outward, while the gravitational tugs of the moon hypnotically seduce ocean tides in and out. Rivers snake through deep canyons painstakingly carved out by their waters eons before. Rapids surge ahead, as unflinching as chronological time, while the canyon walls that echo the white water’s crash are layered with a geological code of what was.” – Charles Moore

Water, a transparent fixture within our lives, and is crucial to life on earth. This essential liquid covers 70% of the Earth’s surface, yet 99% of it is unusable by humans. 97% of all water is saline or salt water from the oceans and seas. The glaciers and polar ice caps lock up 68% of the remaining fresh water. Our own bodies consist of 55 to 60% water and have an unquenchable thirst and sensational attraction to the substance of molecular fusion of oxygen and hydrogen atoms.

12. Moore, Charles, Water and Architecture, pg 16
4. Tvedt, Terje. pg249
Figure 45. 99% Surface Water Unusable for Consumption
Human connection with water has been shaped by our ancestors linking rich symbolism to millennia of histories from various cultures. For all cultures water is interwoven through art, religion and literature as the symbol of life and as a basic element of the universe. The essential element of life, the water is “familiar and simple, yet enchanting complex, water is endlessly appealing.” People are transfixed toward the roar of ocean waves crashing into a beach, the delicacy of a sinuous sheet overflowing its fountain, or a mountain stream rushing rapids under a bridge. “Even though chemistry and physics dictate the action of water everywhere in the world, the vast range of qualities that water is shaped into by the environment sets the stage for profound poetic interpretation and inspiration for architects.”

The different water conditions have distinct connotations. Calm, fresh and clear water associates with beauty, health, and youth, while tepid water can illustrate destruction, terror and death. Long attributed to youth and fertility, water is associated with freedom, purity, chastity, and seduction. Water as described in D.W. Lawrence’s *Women in Love* alludes to sexual desire. “After a lapse of stillness, after the rivers of strange dark fluid richness had passed over her, carrying away her mind and flooding down her spine and down her knees, past her feet, a strange flood, sweeping away everything and leaving her an essential new being, she left quite free, she was free in complete ease, her complete self.” ¹²

Figure 46. Diverse Water Connotations
As Roman legend has it, a dancing virgin sprite had directed soldiers to the Aqua Virgo, an eventual water source of 2,504 taps for Rome, including basins, public buildings and fountains. Flocks of humans have congregated around water sources, such as Bath England, Saratoga Springs, and the Jemez Springs, to bathe in therapeutic pools. For centuries, explorers sent out expeditions to find the fountain of youth were inspired by Frederik Paludan-Muller’s novel *The Fountain of Youth*. Water across cultures symbolizes rejuvenation as it cleanses the body, yet also as a renewing resource as the water cycles through the environment, evaporation of the ocean water leads to clouds, and eventually rainfall which returns to the earth, only to flow back into civilization. Conversely, Leonardo da Vinci witnessed and studied the fright “among irremediable and destructive terrors, the inundations caused by rivers in flood should certainly be set before every other dreadful and terrifying movement, nor is it, as some thought, surpassed by the destruction by fire.”

12. Moore, Charles, 21-23
Figure 47. Birth of Venus
Figure 48. Stills from Tarzan
As the largest bodies of water, the oceans, stirred the most intrigue, fascination, emotions, and dreams. Homer illustrates the vastness and power of the seas, in his epic poem Odyssey. On the return trip from the Trojan War, Odysseus lead an ocean-bound adventure that lasted ten years on the return journey to Ithaca. During the wandering tale the captain was set between fighting gods, fierce storms, tied to a mast while being serenaded by the deadly sirens and then captured on multiple islands. Homer’s sea’s in the story set the stage for immeasurable number of imaginations, as it is read countless times over the millennia since the epic poem was written. Islands, which are surrounded by water have an intense isolation and separation, in which one can easily contemplate the finite and the infinite. Oceanside cities enjoy the edge between continent and sea, commercial success of maritime transit and trade. Citizens within these cities feel an intimacy with the vast volume of the ocean, and the broad horizon. The realities and poetic metaphors address the immediacy of immeasurable and nearly infinite space of the sea.

12. Moore, Charles, pg. 201-204
Figure 50. Tempe Flood North-bound Mill Ave
Figure 51. 1969 Rock Spring Flash Flood
Figure 52. Ulysses Defying the Cyclops
Figure 53. Ulysses and the Sirens
Fountains

“Any study of architecture has at its disposal a rich history of meaning and tradition as well as a foundation in mesmerizing physical and natural wonders.” - Charles Moore

“The sea is... the perpetual source which has the power to diffuse various parts of itself, symbolized by the Tritons and the sea of Nymphs, who go forth to give necessary sustenance to living matter for the productivity and conservation of the new forms of life, and this we can see. But after this function has been served, these parts return in a perpetual cycle to take on new spirit and a new strength from the whole, that is to say from the sea itself.” - Nicola Salvi

Throughout time, the lifeblood of civilization has been water and man’s control from its source to its use. Rome is infamous for its infrastructure innovations including its use of aqueducts and reservoir to manipulate water into a landlocked city. For millennia, numerous fountains have been the source of water for urban dwellers, and a center of life within the city.

Fountains declare the mastery of man over nature, and help integrate architecture with nature, and enliven public space, while captivating onlookers with animate effects. The design of a fountain is not to upstage the surrounding environment, but enrich environments through motion and sensual activity.
The grand entry of the Aqua Virgo within the roman walls is released to emerge into a celebrated 1792 fountain overshadowing a piazza near the church of San Vincenzo. The audible splashes from the Trevi Fountain reverberate through the urban canyon of the Via di San Vincenzo. Architect Nicola Salvi imagined a glorious declaration of the water entrance into the city, with the grand statue of Oceanus, protector of the seas, who overlooks and guards the fountain while water pours from marble stallions to symbolize the arrival of fresh water into the fountain.

Pietro Bernini’s Baracaccia Fountain at the base of the Spanish Steps gurgles as a sinking ship forever frozen within the shallow pool set into the popular piazza. Because of the low water pressure of the area, the fountain has less presence and prominence than other fountains in the area, yet is necessary to enliven this parched area of the city after the collapse of the empire.

Gianlorenzo Bernini designed the Fountain of Four Rivers in the Piazza Navona, with four river gods presiding over a travertine mountain The Fountain of the Four Rivers, as a “flamboyant centerpiece of Roman art and society,” was used to fill a flooded piazza on numerous occasions to provide a water stage for Baroque theater. The theater of the ‘Lago Navona’ showcased the power of the aristocratic Pamphill family, with boats and carriages roaming around floating prominent members of society.

In modern times, Phillip Johnson’s Fort Worth Water Garden is a menacing experience of the abyss. The artificial canyon has everlasting channels of water rush down the battered pit that charges into a churning pool collecting water before vanishing into a whirlpool. The angular concrete canyon is similar to a “cooling oasis in a concrete jungle” in downtown Fort Worth, a city where summer temperatures routinely break 100 degrees. The cooling effects of the active pool or partly real and psychological. The water is also agitated resulting in airborne droplets that cool the skin and creates evaporative cooling by raising the humidity in that area. In addition to the temporal manipulations, which just by sensing water, such as audibly hearing the cascades, can make a mental deception of a cooling feeling.\(^\text{12}\)

12. Moore, Charles, pg 39-49
The Armand Vaillancourt fountain titled “Libre Quebec,” in San Francisco, has numerous flying squared concrete armatures cantilevering in random directions plunging vast amounts of water from various heights. Staircases lead to elevated catwalks that allow guests to immerse themselves with the thousands of gallons of water as it roars across the fountain, also drowns traffic noise from a long-erased elevated freeway. “Libre Quebec” continues to connect the development to the bay, which for decades was alienated by the freeway. Formally juxtaposing the linearity of the utilitarian double deck concrete structure to the aggressively angular and soaring rusticated concrete structure that gushing water out of its squared orifices. Once stated as the “Stonehenge unhinged with plumbing problems” at the Embarcadero Center, it served to violently thrust downtown San Francisco past the concrete freeway and into the bay reconnecting the city back to a waterfront. The Embarcadero Freeway was later damaged in the Loma Prieta earthquake and subsequently removed, thus reuniting the city and its waterfront of the city’s namesake, San Francisco Bay. Currently “Libre Quebec” continues to be an object in an open field, naked without a concrete backdrop, yet it still energetically propels people and water though the fountain.

Throughout civilizations the water and fountains “can be called the only everlasting source of continuous being.” Time cannot alter the inherent properties of the liquid, yet a few drops can represent the greater whole. The fluid acts more than to merely fill and morph to its container, it spills, erupts, sprays, cascades to enliven the sculpture, but with great care the water is further dignified, respected, and cherished. Fountains possess a hypnotic attraction with simplistic physics such as spewing parabolas, swirling and churning eddies of turbulent flows, acting against stone competing currents race toward the earth, only to repeat the cycle, as it does within the global environment.¹²

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¹² Time, http://www.time.com/time/magazine/article/0,9171,876984,00.html
Figure 21. Embarcadero Freeway and “Libre Quebec”
Canals + Rivers

“It was with indescribable emotions that I first felt myself afloat upon its waters. How often in my school-boy dreams, and in my waking visions afterwards, had my imagination pictured to itself the lordly stream, rolling with tumultuous current through the boundless waters to which it has given its name, and gathering itself in its course to the ocean, the tributary waters of almost every latitude in the temperate zone! I looked upon it with that reverence with which everyone must regard a great feature of external nature.”- Mark Twain

If fountains are the spring or heart-source, then the canals and rivers continue the circulatory system metaphor and become the arteries and veins; transporting life through channels of connection and communication. The rivers and canals are parallel ideas of movement and threads across landscape, however both maintain a network useful to link trade, sustain life, and symbol of constant renewal.

The Tigris, Euphrates, Nile and the Mississippi Rivers are grouped together as major rivers, not because of their girth or power, but because of the numerous civilizations that grew due to their flow. Over time more rivers have led to increased trade, and networking throughout the world.

Carving through the Syrian Desert, the Tigris and Euphrates Rivers formed the Fertile Crescent. This probable homeland of the human race includes numerous remains of prehistoric cultures, and at least known 9 different civilizations. Babylonians, along with attempting to build the Tower of Babel, successfully built the hanging gardens, fueled from canals diverted from the major river. As the river scored the desert it gathered and deposited minerals and nutrients, redistributing the natural wealth into the convergence of these two rivers. Present day capital of Iraq, Baghdad sited between the two rivers provides a living oasis apart from the extreme heat, sun, and rugged desert surrounding the city.

12. Moore, Charles, pg 79
Figure 57. Salk Institute
Figure 58. Rialto Bridge over Grand Canal
Figure 59. San Antonio Riverwalk
Figure 60. Amsterdam Canal
The River Nile, the silvery watery ribbon slicing through the lifeless Sahara sand, it gives a thread of life and culture surviving through the millennia. Humans have long lived through the flood cycles that deposited fertile soil into the valley and fueled Egyptian culture. The river intertwined villages, cities, temples, and pyramids that united them as one nation. “Hence also those who fill priestliness of the Egyptian tradition show that all things arise from the principle of water. Therefore, after carrying water in a vessel to the precincts and temple with pure reverence, they fall upon the ground, raise their hands to the heaven and return thanks to the divine goodwill for its invention.” The river delta connected the civilization with the Mediterranean Sea and the surrounding maritime cultures. The water brought trade and commerce into the desert, spread its influence and stimulated wealth within the delta. The River Nile created, defined, and strengthened the prosperous Egyptian civilization.

For cities along rivers, the city planning and street grids are manipulated and generated around the river flow. Cities like Pittsburg and New York are triangular islands shaped by the convergence of aquatic forces, so that the city is configured roughly perpendicular to the nearest river. This organization might add to confusion as the grids can join at odd angles. Contrary to that example there are cities similar to Philadelphia, which is built between two rivers and still organized within a strict grid. Many rivers separate cities or become political boundaries with the water as the identifiable edge condition for the metropolitan area, like Minneapolis/ St Paul, St. Louis, Cincinnati, and Washington DC. Rome was originally within an elbow of the Tiber, only to grow and spread out as infrastructural technology were created, most notably the aqueducts bringing water into the surrounding hills and bridges crossing the Tiber.

Paris could be looked at as a network of roads linking countless monuments plazas, and urban centers, with 25 bridges along the two banks of the meandering Seine. The city and the islands within the flow, share an “intimate relationship with the waterway, so full of connections both intangible and tangible.”

12. Moore, Charles, pg 76-85
Water can be manipulated or channeled, to form a canal. The canals usefulness depends on its role, it can feed societies, form trade routes by linking cities or other bodies of water, protect cities from invasion, or rebuild a landscape usable for human habitation.

After threatened of being moved the San Antonio River continues to wander through downtown San Antonio. After years of flooding, the riverbed sits twenty feet below the urban grid, local businessmen wanted rid itself of the problematic river by filling in the riverbed to aid downtown growth. The river is now seen as a loop where the mainstream is diverted straight across but the river still fills in the loop allowing a leisurely flow rolling through a commercially vibrant Riverwalk District. The Riverwalk is bordered by shops, hotels and restaurants separated from downtown with twenty vertical feet yet connected with bridges and staircases. The abundant trees and vegetation filter intense sunlight, while transpiration releases water from the leaves stomas for natural evaporative cooling.

Venice, famous for its canals blended 117 islands into one city, manufactured usable land out of a marshy island in an oceanic lagoon. The canals grew with little long term planning, this resulted in an organic pattern meshing land and water “woven together with a web of water arteries instead of streets.” The serpentine Grand Canal is the major waterway, it averages 15 feet deep and ranges between 100-300 foot wide, and is believed to be located on an ancient riverbed of the Rio Businiacus. The Grand Canal has helped Venice facilitate and dominate maritime trade within the Adriatic and Mediterranean Seas. The smaller canals were originally designed to carry waste out to the sea, but as the city grew denser more capillary canals were dug into the sand and clay island. The only drinking water is found in wells and rainwater cisterns, although the city is surrounded and infiltrated by water, the canal water remains flooded with waste of the city so the canals are dredged for maintenance.

Amsterdam, once a small town around an Amstel River dam, is currently a famous landmark city for its rigorous semi-circular canals. Amsterdam, a port town on a marshy river delta, uses canals and dikes to control water flowing through the city. The city planning controlled canal and city growth, so as the city grew the outer canals were dug is semi-circular pattern. This pattern allows for larger perimeter and more area for the most outlying parts of the city to grow. The canals allow raw materials, and goods to be quickly transported throughout the manufacturing-based city, and offer a seamless transition to the port for international trade. Located on the IJ Bay, these canals transition from residential landscapes, urban business districts, and the maritime port in the Atlantic Ocean.
Rivers and canals channel water through the landscape. Cities have better utilized these waterways to sustain life, traffic, commerce, and defense of the civilization. The connection of the flowing waters bring fresh water throughout the city, though recently have been utilized to also remove waste from the city. The rivers and canals dissect the landmass and force boundaries but additionally create opportunities for communities to exist and prosper.

12. Moore, Charles, pg 76-85
Bridges create a greater connection with the landscape to overcome barriers, link sites and communities over the obstacles. Generally bridges are best known over waterways, though can create a backdrop of the connections throughout the city. They become a symbol of human ingenuity inherent with the problem solving for the linkage of two landmasses. The bridges often create a secondary arterial life force for the city, helping to alleviate segmentation problems of the primary flow of the river. The bridge creates opportunities for people and societies to have mutual land connections that improve both trade and traffic, which benefit both sides of the bridge. As technology has developed, bridge construction typically followed suit and served as a timeline for societies, technologies, materials, customs, wealth and culture.

The aqueducts of ancient Rome have carried both people and water over deformations in the landscape, leveling out the path from the water source to the destination city. Most aqueducts remain channels through the earth, as the land negatively fluctuates with dips, vast valleys, deep canyons. However, the gravity feed flow must continue unimpeded downhill from the source to its destination, which causes the need for a series of bridges to level the path. With the invention of the arch and the arcade, over 2000 years ago, helped distribute loads, and make vast structures, such as Aqueduct of Segovia, Pont du Gard, Caesarea, and the Appla Antica possible to be constructed.

The supply of water to communities relied on these aqueducts but when they failed, Roman cities suffered. The affected populations deserted the unsustainable cities, or relocated to regions of the city with naturally supplied water. Many of Rome's aqueducts failed because of lack of maintenance, especially after the collapse of the empire when resources where sparse. Many aqueducts were destroyed through warfare, as enemies strategically cut cities water flow, helping to topple the Roman Empire by distressing the fortified society. While the aqueducts lay in ruins, they still visually connect people with the previous society, nature, and water. As massive icons they set visual boundaries, frame views, establish visual space, plus objectively link both edges of the natural realm with the man-made intervention.
Bridges physically link landscapes together but additionally meld social fabric of communities together. One such way is when the bridge itself becomes a habitable extension of the community, creating a continuous urban fabric over the river or other obstacles. The Ponte Vecchio, Rialto Bridge, and the medieval London Bridge serve the urban fabric more than a mere connection, a series of shops line the pedestrian traffic corridor and provides a marketplace above the respected rivers. There are residences above the medieval London Bridge and the Ponte Vecchio built up its connector with three to seven stories of urban buildings on top of the rivers.

Another way bridges can meld urban fabric is by the sheer number of bridges, completely networking the city over the river. Paris and London have numerous bridges connecting urban fabric over the major rivers within their respected cities. Paris has 37 bridges over the Seine, linking both the right and left banks of the river and London has 33 bridges crossing the Thames. The river inherently serves as a social border, yet the numerous connections across the river actually unite public spaces lining both sides, as well as islands, within the river. As the cities grew around the rivers, more public spaces and urbanity developed around the river. Then as bridges crossed the river, even more opportunities were created for commercial growth within the community. Throughout the history of both cities, the bridges and the city intrinsically bond to form a cohesive urban fabric over the river boundaries.

Bridges also represent the technology of the time of construction, whether its the previously mentioned Roman aqueducts or form icons of the industrial revolution with the Eiffel wrought-iron truss bridges, such as the Garabit viaduct. This lead to the steel combination suspension, truss, and cable stay such as the Roebling Bridge, predecessor to the infamous Brooklyn Bridge. Further transitioned materiality to the elegant and streamlined reinforced concrete Salginatobel Bridge, or massive constructed creations of the Bay Bridge and Golden Gate Bridges. The bridges showcase engineering and ingenuity of the respected designers, yet also show the power and beauty of human societies, solving natural landscape obstacles with machined interventions.\textsuperscript{12} Though the bridges create an object within a landscape, usually the focal point, then also allows the nature to form a backdrop, shifting focus back toward the water or other obstacles that made the bridges required.
Waterfronts

The edge condition of how cities and water meet are central to how the community views and values the public water. Societies fall into a gradient of engagement or abandonment of the waters edge. Cities reliant on the water-going trade locate around natural harbors, with dockyards stretching along the coast. This industrialized zone tends to separate the core city from the waterfront, yet it can actively engage the water access with numerous piers meant to dock ships. As technology progresses and trade streamlines the landscape shifts from long piers, to large yards connected to railroads, that rapidly transfer container cargo from land and sea vessels. Some cities engage the water edge as civic space, a community asset and connection with nature and society. In other cases the engagement can be a battle against the elements and natures wrath.

New York uniquely dug land out of Manhattan to create elongated piers, engaging the water with the trade interest of the island. The Westside dockyards, defined Chelsea, Hells Kitchen, and the Meatpacking Districts form industrial and labor-driven districts that are commercially busy and economically essential to New York. The dockyards and subsequent warehouses, though necessary, did not actively engage the urban centers of downtown or midtown, but because of the type of work the surrounding neighborhoods socially or demographically separated the core of the island, from the Hudson. The eventual construction of the bi-level Westside Highway exacerbated the physical separation within the island, only to be relieved when the demolition of the upper deck and the reconfiguration of the highway as an on-grade thoroughfare. As the dockyards transferred across the Hudson to New Jersey, the abandoned piers and waterfront landscape decayed. Eventually many of the piers were demolished, or striped of the disrepaired decks, leaving the remnants as a memory of the former dockyard.13

Figure 61. Hudson River Park
Figure 62. Clinton Cove 1995
Figure 63. Clinton Cove Present
Some docks have been reprogrammed, such as Chelsea Piers, Intrepid Sea Air Space Museum, several parking piers, and numerous piers have been reclaimed and integrated into the Hudson River Park, stretching 5 miles from 59th street to Battery Park City.13 The refocus on the waterfront, allows New Yorkers another opportunity to engage parkland, revitalize post-industrial wasteland, and reconnect the islands population with its waterfront.

An opposite approach of waterfront exists within Sausalito California, a San Francisco Bay community. The community grew, as a community of houseboats, with 15% of the city limits is underwater. The city is located within the Marin County in North Bay, near the north approach and anchorage of the Golden Gate Bridge. The city’s location was historically severed Sausalito from San Francisco, and the rest of the world. Before the Golden Gate Bridge, the only way to approach the city was to circumnavigate 100 miles around the bay or by a direct ferry. Before the bridge, the city was the ferry terminal for a rail connection to the San Francisco Peninsula, and by 1926 it served as the northern terminal to the US 101 Highway and another vehicular ferry would cross the Golden Gate, toward the San Francisco. During World War II, the local economy boomed as a Navy shipbuilding dock was set up on the shoreline, only to be decommissioned after the war.14

The historical connection with the water transportation, and the steep incline of the North Bay peninsular hills lead to the development of houseboat alternative housing. The decline of the houseboat communities was attributed to the House Boat Wars, when wealthy land population struggled against the floatia of houseboat communities, as a result increased regulations were incurred and one community relocated to float outside the city limits. Because of the expansion of the city onto the water, the land community continues to run along and engage the waterfront, The steep hills surrounding the community naturally thrust the Sausalito toward the bay.14
Not all engagement with the waterfront is welcoming; some are hostile, battling the forces of water, and other invading forces. Along the Normandy coast, which was freckled with World War II bunkers, sits a coastal island long battling the tides of the oceans, fusing architecture with the island and surrounded by sea. Mont Saint-Michel, a medieval compound, served as refuge for the former monastery and rose out of the sea with towering sea walls. The village continues the ascent up the mount only to rise to the foundation of the soaring La Merveille chapel perched at the summit of the granite mountain. The island within the English Channel, long situated between warring civilizations, has had centuries of attacks with continual fortification increasing the defense of a tidal island. The tidal island was only approachable during low tide, which allowed well-timed land based transit for trade to continue without aquatic interference. In current times, a land bridge ties the island to the coast a half-mile away. Effectively destroys the visual and psychological separation and the continuity of the battling sea surrounding a hold out of the granite landmass. The integration of the monastery with the landscape developed over centuries of growth, yet currently the entire island civilization seemed chiseled out from the landform.

Topped with gargoyles and spires from the church, with its slender gothic windows, flying buttress tying the roof to the massive retaining walls reaching the ground, houses are nested within the rising land, protected by sea walls fused with lower natural boulders against the cold waves attacking the island. The waterfront of the island is ingrained with the harsh seascape that daily overtakes the surrounding landscape, it is visibly man’s creation battling nature.12

In 1896 Adolph Sutro opened the large indoor swimming pool, on a beach inlet of the Pacific Ocean. Integrating a program with the waterfront, Sutro Baths in San Francisco, had harvested seawater to create a coastal bathhouse that tried to connecting swimmers to the surging cold water of the Pacific Coast. This massive reinforced concrete, wood, iron, and glass building had 7 ocean-fed pools, a concert hall and later an ice skating rink, along with the nearby Cliff House Restaurant served a scenic retreat for San Franciscans. The ocean fed pools filled and replaced water the rising and lowering tides. Sutro Baths failed in part that is was far from the city’s population, and high operating costs, even though pool water was recycling ocean water with the tides. The bath was eventually closed in 1964, during the 1966 demolition the structure caught fire, and burned to the ground.15

12. Moore, Charles, pg 162-164
The ruins of the bathhouse provide an active backdrop for visitors to explore another portal of San Francisco history. Currently the ruins of the baths are protected within the Golden Gate National Recreational Area. Nature was encompassing and retaking the eroding building; trees and other small plants continues to thrive, consequently hastening the pace of the erosion. The ruins consist of algae-infested pools, decapitated and rusting steel columns, rebar-shattered concrete, broken brick walls, decomposing foundations and the crashing waves of the Pacific Ocean. The ruins of Sutro Baths create a unique connection with dammed waters, sited on the Pacific coast with ocean water crashing just beyond the foundation walls. It also creates an intense perspective of mans shortcomings with its failed intervention to control nature.
“The scenery of Walden is on a humble scale, and, though very beautiful does not approach to grandeur, nor can it much concern one who has not frequented it or lived by its shore; yet this pond is so remarkable for its depth and purity as to merit a particular description. It is clear and deep green well, half mile long and a mile and three quarters in circumference, and it contains about sixty-one and a half acres; a perennial spring in the mist of pine and oak woods, without any visible inlet or outlet except by the clouds and evaporation.” - Henry David Thoreau

Unlike other aquatic interventions, basins and pools have the unique distinction of containing water, whether it is a natural collection of water like a pond or lake, or an artificial pool. The containing of ‘still’ water can harness three unique but significant qualities: that regardless of the container shape, it will consistently have a flat horizontal surface striving to reach the horizon, the meditative nature of peaceful water spurns human imagination, and thought provocation, and the reflective nature mirrors the surrounding environment back to the viewer. Pools of ‘still’ water have developed into recreational pools housing activities and outlets of human energy through clean bathing, playful frolicking, or rigorous competition. In the absence of natural collection of lakes and ponds, it is possible to build pools, many times imitating or embellishing nature, with amorphous shapes and undulating edges that connect seamless with the surrounding environment. 

12. Moore, Charles, pg 122
12. Moore, Charles, pg 120-129
Figure 70. Roman Bath and Abbey: Bath England
Figure 71. Tidal Basin and the Jefferson Memorial
Figure 72. Reflecting the Modern Art Museum of Fort Worth
Figure 73. Reflecting Pool and Waterfall at the Kimbell Art Museuem
Throughout the history of pools, it was difficult to separate the history of the pool, or various containers of water, from the concurrent history of swimming. Swimming was a learned activity, requiring knowledge and skill that might not have been considered necessary in other darker chapters of history. The skill of swimming was originally a military skill, for the strategic and tactical advantage of attacking, staving off enemies, or fording rivers while marching to destinations. Calvary horses commonly would be given preference for swim training, over the general public especially women. The Roman military developed the first swimming pool, the Campus Martius, fed by the Tiber River, for training military dominance through aquatic skills. Other historical swimming pools, such as Roman Bathes and Thermae, relate to “swimming with ground contact” and seldomly were over three feet deep. These shallow pools were used for cleansing and social gatherings around the water. The skill of swimming was publicly reserved for gods, heroes, and other mythical characters. However, the art of swimming was a carefully guarded secret for royalty, military leaders, and people with extreme political influence.

Public bathing and swimming were largely forgotten after the collapse of the Roman Empire, and throughout medieval Europe general public swimming was forbidden. Within the Christian religious political powers in medieval Europe, prudent public modesty and public decency forced the cleansing bath to be a private affair. In more innocent cultures, such as the Netherlands, nude bathing and guiltless frolicking existed within lakes, rivers, and canals. As Europe came out of the middle ages, with the rebirth of public knowledge and education, survival swimming came back into favor.16

16. Leeuwen, Thomas van, The Springboard in the Pond, pg 16-20
Figure 73. Bathers in the Boerenwetering
By 1760, Docteur Poitevin had constructed and opened a special floating bath, with medical endorsement from the Doyens et Docteurs Regens. The specially equipped barge was anchored in the Seine, and provided warm baths and showers for public use, eventually business expanded and became more respected. Floating bathhouses expanded to other cities, but remained small bathing barges, intended for cleansing and sedentary exposure to river water. The baths were popular until residential indoor plumbing was connected to the city water supply.

The first recognizable swimming pools, were developed some thirty years later, expanding the bathhouse to allow large river-fed floating pools to teach swimming. Barthelemy Turquin started his first swimming school in 1786, though it was later destroyed by ice; in 1796, he reopened the Ecole Royale de Natation, or the royal swimming school on the Seine. The success of the swimming school is largely credited to France’s military buildup, and the resulting need for swimming soldiers, swim teachers, and swimming pools. During this time, breaststroke was the stoke of choice for its symmetrical, and the swimmers head can be constantly above water, keeping the soldiers eyes focused on the objective.¹⁶

¹⁶. Leeuwen, Thomas van, pg 21-24

Figure 74. Design for Ferro Baths
Turquin’s son-in-law Deligny, furthered the development by the creation of Deligny’s 106x30 meter pool surrounded with decks and structure for changing rooms, private salons, common rooms, café, restaurant, barber shop, various instructional rooms, and royal apartment. The structure was partially floating on pontoons, but also supported on wooden columns. The large central pool was open to the river, which allowed the flow to continually freshen the water.

The floating pool further evolved to a sloped wooden bottom, allowing wading and deep-water swimming to emerge in the river, diving boards were installed to create aerobatic excitement. Additionally a mesh net separated the river from the pool; that allowed water to flow through the pool, yet prevent unwanted substances from entering the pool. As river pollution became more prevalent, the pools became more separate from the river; eventually by 1937 the Deligny pool became a watertight closed system of filtered river water, and the water floated on water separated by a steel basin. During the process of river pollution, floating pools moved anchorages upstream or closer to the center of the river, in an attempt to gather the cleanest water. If the pool could not provide clean water, the business quickly failed.

In the mid-eighteenth century, the Seine was crowded with various floating pools. Swimming had become a popular activity as well as a social gathering, the pools continued to one-up each other in extravagance of amenities to appeal and attract the business of the bourgeois. “The swimming school even smelled like the most chic restaurant of the day.”

16. Leuwen, Thomas van, pg 16-20
Figure 75. Damenschwimmschule: Frauenbad
Floating pools had spread across European rivers, yet the K. u. K. Militarschwimmschule, built in 1831, was one of the first modern excavated ground pools. It is fed by a sulfurous artesian well, and rectangular military pools were similar to the floating pools of the time.

The Dutch pools were developed from the floating river pools, into large pools, surrounded by floating decks, yet most of the programmed facility space was constructed on land. This allowed less impact and blockage of the rivers flowing through Amsterdam and the IJ bay toward the ocean.

As the progression of modern plumbing and the concurrent rivers pollution, floating pools either became defunct, or were adapted into a closed sterile system. Modern plumbing allowed for sanitary and private bathing, as well as the advent of land pools with the continual recirculation of filtered water, floating pools started to fail and became obsolete. The previous named Bains Deligny had been constantly resurrected with contemporary technology, and managed to survive until 1993, when it was destroyed by an unknown explosion. The 2006 La Piscine Josephine Baker opened to replace the historic Bains Deligny, the last floating pool.16

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16. Leeuwen, Thomas van, pg 36-48
Figure 76. Bathing Establishments Along the Seine at the Fin-de-Siecle
Natatoria

Modern athletic competitive swimming had roots within the military swimming schools of the late eighteenth century. Europeans in great numbers learned how to swim, as the schools expanded teachings to the public. The main stroke being taught was still the breaststroke, due to its ease of learning technique, and convenience for teachers, since it was already being taught to military personnel. The military advantages of the breaststroke; was its symmetrical pattern, the shoulders squared forward approach, and ability to keep both a firearm strapped to the back and the head completely above water. The rectangular pool was compared to the parade ground used in a military drill, and the military would rigorously train and swim laps hoping to gain a military advantage. As the swimming became public knowledge, aggressive people became enthralled with this training as competition. It became a part for the athletic program of the first Olympics and was swum in the open water at the Bay of Zea.¹⁶ During the second Olympiad in Paris, the 50 meter x 25 meter pool was established, which continues to be the standard international pool, yet the American standard pool measures 50 meter x 25 yard.

¹⁶. Leeuwen, Thomas van, pg 16-20

Figure 77. Natatoria
Recreational swimming has differed through time, the term swimming refers to the athletic form of bathing. This came about as the 1916 *Daughters of the Gods* movie showed Annette Kellerman in a controversial one-piece swimsuit. Hollywood’s use of swimming athletes within movies, included Kellerman and Johnny Weissmuller as Tarzan, had images of sleek athletes frolicking, which brought the public transition the terminology from bathing, bathing suits, bathing caps, to swimming. Recreational swimming also developed with the floating pool, and satisfied the human urge and attraction without the intense training of competitive swimming. Also a vital aspect of recreational swimming is the relaxation, sunbathing, socializing, smoking, eating, drinking, and other non-water activities.

Diving, developed from gymnastics, as German and Swedish athletes moved high equipment along the beaches, then they created diving towers for uniform training. The 1840 version of the rebuilt Bains Deligny, incorporated a diving tower, then the 1904 St. Louis Olympics incorporated the 10meter platform diving within its competitive program, and the following 1908 London games included a springboard competition. American Diving has won 52% of the Olympic gold medals, and dominating the sport since 1920.

16. Leeuwen, Thomas van, pg 156-170

Figure 78. Recreational Water
Wave-making machinery was developed to stir and revitalize water, within closed pools. In 1910, German engineer Recknagel created hydraulically operated shovels to rhythmically move water across the pool. This system was first implemented in the public Undosa Wellenbad pool in Dresden. The 1910 Hildesheim had been fitted with showerheads in the natatorium to simulating nature by recreating clouds and rain. The Renaissance movement of Bella Nature improved existence by recreating artificial nature, and continues through contemporary world of water and amusement parks. Water parks maintain an appeal to trill seekers and aquatic hedonists with a variety of water slides, tubes, waterfalls, diving pools, zip-lines, climbing walls, meandering rivers, and wave pools. 

16. Leeuwen, Thomas van, pg 16-20  
17. Wylson, Anthony, Design for Leisure Entertainment. pg 83.
Atavistic Pools

Coupled by Hollywood’s theatrical influence of the American people, and the large private pool construction boom in California, the typical American swimming pool has reverted to a curvilinear, serpentine naturalistic form. Early Hollywood sets capture distant lands, yet with man’s seduction with water has made the pool a favorite location, and creating archetypal “hydroerotic” films. Filmmaker Eric de Kuyper stated “a swimming pool presents two highly important principals: Basically, a pool is a beautiful composition of clear, straight lines... And to swim in a pool allows the [semi-]nude body to be shown in a restful pose or in action.” 16

The organic pool has its roots from young starlet Mary Astor’s father, Otto Ludwig Langhank, built a narrow lagoon shaped pool, of various widths and depths. This 1927 pool, designed by Phillip Ilsley as a 100 foot swimming river, was chiseled out of a steeply-raked hill covered with overhanging vegetation, including a sandy beach on one end and a springboard at the opposite. The fantastic pool invited adventurous swimmers into its secluded romantic atmosphere, yet within a private backyard in Southern California. A similar but three times larger swimming river, was built for John Zublin, its meandering form was built as a river for rowing his boat, specifically designed so the oars could barely touch the walls. Both pools maintain straight walls, flat or ramped floors, scum gutters, and surrounded by vegetation hiding or covering overall form; completing the organic illusion of an aquatic wonderland.16

Free-form pools were also developed by Ilsley, as an adaptation to fix leaks from cracking and expansion joints of rectangular pools. In 1939, Ilsley developed the inverted dome construction, improving straight pools with fluid curved shells of flowing plans and sections that could withstand the shifting ground and reduce leaks. By the 1950’s, this pool construction could economically be built for the middle class and its popularity soared; as California led the rest of the entire United States in number of pools. Just as rectangular pools were designed for exercise and training, the free-form pools were shaped by the technology that allowed imagination and fantasy.16

16. Leeuwen, Thomas van, pg 16-20
17. Wylson, Anthony, pg. 83
Figure 79. Atavistic Water
Figure 80. Free-form Pools
Louisville Riverfront-

Previous to 1998, the Louisville waterfront or the front lawn to the Ohio River, was a derelict wasteland of post-industrial ruins, warehouses, and parking lots all were sited within a stripped utilitarian floodplain. During the development of post-industrial America, many established productive cities suffered through the economic transition and loss of industry and production, and Louisville Kentucky falls within this category. Its waterfront, once steaming with river-trade, and railroad bridges crossing the river to broaden commerce that expand the link between growing America and industrious Louisville. With the development of automobiles and the trucking industry, transportation evolved into superhighways, which slice through metropolitan cities and barricade neighborhoods into segments. The creation of I-64 connected downtown to other urban areas, and efficiently moved commuters and traffic through the urban core of the city, yet the elevated concrete highway cut-off the riverfront from the urban fabric of the city. I-64 was constructed parallel to the river to serve or transplant much of the transportation services already within the riverfront swath. As industries faltered and urban populations simultaneously migrated away from the urban core, the urban problems of the overlooked fragment of urban ground continued to devalue through the following decades. As civic priorities have evolved to reinvigorate urban cores, this piece of under-utilized has land started to been seen as an opportunity instead of an eyesore.
George Hargraves, an San Francisco based landscape architect developed the Master Plan and set forth a 120 acre park to be constructed in three phases, and support developers to build one-million square feet of mixed-use waterfront space. Inlets were designed to draw the Ohio River closer to the city, and large lawns and plazas and other largely flexible spaces that attract people and festivals to the front yard of Kentucky. Small intimate spaces interweaved and connected the larger spaces, memorials, running and biking trails, water features, and the soon to be renovated pedestrian bridge crossing the ½ mile to the banks of southern Indiana. The landscape has been sculpted and paths braid to let principal perspectives to be shaped, hidden, and discovered. Built out of derelict land the Louisville Waterfront Park host hundreds of events per year, drawing 1.5 million people annually, and began a revival of an adjacent historic neighborhood. The project success was not limited to commercial applications, the project also succeeded in landscape repairment; in capping polluted land, alleviating flood walls, growing natural riparian plantings and furthering wetland development. Hargraves’s Louisville Waterfront Park has successfully designed a tattered and dilapidated land fragment into spaces which welcome the draw and mixing of people, land and water reconnected into urbanity and dynamic “vessel for public activities.”

Figure 82. Louisville Waterfront Park
Figure 83. Louisville Waterfront Park Map
Forth Worth Water Garden

Phillip Johnson’s Fort Worth Water Garden constructed in 1974, attempted to create a series of aquatic oasis-like spaces, within the concrete hardscape of downtown Fort Worth. There are three pools of varying aquatic attributes leading to different environments. The garden was designed with a variety of trees, fitting the program of the spaces, tall slender trees are near the tall walls of the quiet pool, shade trees cover seating areas surrounding the aerated pool and major pathways through the garden. With summer temperatures routinely going above 100°, the water garden became a reprieve for downtown Fort Worthians and visitors alike.

The most famous pool within the garden, was the active pool of an abstract abyss, reflecting a man-made canyon. The water rushes down the angular canyon gathering 38 feet below within a churning pit. The sound of rushing water falling to the whirlpool crashes the senses, and only intensifies as visitors voyage closer to the bottom of the pit. The path of the visitors toward the bottom rests on disconnected concrete toadstools, noticeably absent are the safety handrailings, threatening stability and increasing concentration and sensory perception of the environment, mainly the water rushing under their feet and wrapping around the visitor.12

The complimentary quiet pool was a sunken landscape, dropped 16 feet from ground level, with a large still-water pool surrounded by 20-foot battered concrete walls with water gently rolling down to a trough lining the sunken space. Visitors approach the quiet pool from the higher ground level, with concrete guardrails separating the environments. Designed within this guardrail, was a water trough, reminiscent of the medieval Moorish castle, Alhambra, yet the water escapes to the interior of the environment falling down the battered concrete walls. The staircases were in full view from above, became hidden by the tall walls once in the lower space, accentuated the separate environment. The different environments used the tall and narrow staircases as thresholds, varying the perception of human scale, and the quiet pool environment is intentionally absent of human scale, isolating the visitors within the environment. The submerged level protects the pool space from exterior noise, while the gentle waterfalls create a subtle white noise masking the remainder sounds.

12. Moore, Charles, pg41-46
The critically least successful pool was the aerated pool. Johnson designed forty nozzles that mimic lily pads, tried to mimic an illusionary ground plane, which would appear to walkable tiles crossing the pool. Because of the natural parabola of falling water, the lily-pad effect never materialized, yet it was successful as a playful pool. The forty nozzles animated the aerated water similar to lawn sprinklers. The buzzing noises of the mechanical nozzles compliment the sound of the misting water returning to pool. The aerated pool’s nozzles spray 871 gallons per minute, and during summer heat much of that water is lost to evaporation, but within the microclimate of the lower basin the moist and cooler air sinks back into public basin cooling the public space surrounding the basin.
Lake Powell in the Glen Canyon National Recreational Area

Glen Canyon was eroded by the Colorado River and cuts through the high altitude Colorado Plateau. Glen Canyon, located upstream from the infamous Grand Canyon, and is located on the border of Northern Arizona and Southern Utah. Because of the proximity to the Colorado River, and its location within a harsh Great Basin Desert, it was the ancient and recent homes of Native Americans, their ruins and sacred sites are presently still in the canyon, yet submerged under the water’s surface. In 1956 the Glen Canyon Dam started construction, near the confluence off the Colorado and San Juan Rivers, with the goal of water storage and hydroelectric generator for Arizona’s growing power needs. Completed in 1966, the dam stagnates 186 miles of the wild Colorado River and 72 miles of the San Juan River with shoreline of over 2,000 miles and a capacity of 24,322,00 acre-feet. One of the unique aspects of this reservoir is the number of tributary arm canyons, which are also flooded creating numerous intimate spaces with the steep sandstone cliffs towering overhead. Lake Powell is the 2nd largest reservoir in the United States, yet due to fluctuating upstream desert water conditions the lake water level and volume fluctuate greatly, in 2006 the lake was deemed half full after a decade of drought. The scenic reservoir has attracted millions of visitors a year. The recreation area allowed hiking, camping, boating, water-skiing, jet-skis, fishing, and many visitors rent houseboats to vacation within an intimate arm canyon and small private beach. Because of the steep canyon walls encompassing most of the canyon, road access was only granted to selected 6 marina locations, which restricts most travel within the park to water-surface crafts.19

Figure 88. Map of Lake Powell
Figure 89. White Bathtub Ring on Sandstone: Lake Powell
Desert canyonlands, had uneven landscapes and rock formations due a combination of water flow, flood debris, and rock density. These formations of erosion separate canyons into chimney-like monuments, arches, and broad and slot canyons. Deep canyons have a natural potential for reservoirs and with construction of large artificial dams, they can be utilized to create for flood and erosion control with large water storage for agriculture, and human urban populations. If the formations are large enough or low water levels can peak formations above the water level, these appear as stone islands within the lake. The islands and other discovered surfaced land; preserve the memory of the canyon, protected under the surface to be discovered as the water recedes.20

Under drought conditions and environmental pressure, water has been released from Glen Canyon Dam that has lowered the water level of Lake Powell. In 2006, the reservoir was half full and the high water level was recorded on the red sandstone cliffs by a ‘bathtub ring’ of white mineral deposits. The low water levels closed smaller channels and arms of the winding canyon to boating, but it opened the previously drowned landscape to hikers and canyoneers. The Gregory arch, the nations second largest natural stone bridge, with numerous ancient Anasazi ruins, countless slot canyons, and the ‘Cathedral in the Desert” waterfall that was fed from a natural spring, had reemerged and subsequently submerged, as lake levels rebounded. The lost landscapes remain hidden and protected under the surface, to be later discovered as water levels continue to fluctuate.21


Figure 90. Drought Caused Bathtub Ring
Figure 91. Cathedral in the Desert at Full-Pool
Figure 92. Cathedral in the Desert with recent drought conditions
Design Zones

Tempe Town Lake served as an oasis within the desert, yet different limitations prevent human interaction with the body of water. In this chapter, we will further the design of Tempe Town Lake. Within the perimeters of the Tempe Beach Park, the enhanced connection between the Tempe’s citizens, and reinforcement of the life-force that enables survival in the severely parched desert.

Tempe Beach Park was redesigned with the introduction of the Tempe Town Lake, and has always been Tempe’s connection with the Salt River. Tempe Beach Park has constantly been rebuilt and adapted over the decades, for many of the adaptations the waterfront identity lacked significant importance, mainly due to the decades of non-flow of the Salt River. One of the park’s lasting aquatic attributes- Arizona’s first 50meter pool was closed and demolished during the parks renovations. It was thought the lake could host public swimming much like the nostalgic memories of public bathing; yet the regulations and technicalities of the lake prevented this submersion, and Tempe Beach Park lost its only immersible connection with water. The park was reconfigured, as sloping landscape toward the river, while throughout the rest of the larger Rio Salado Park the river was being channelized and further protected with 10-foot dykes. Over the length of the park the ground rose 20 feet preventing the dykes to be implemented, and the park was surrounded by bridges approaches and abutments, which further isolated floodwaters and prevented water to creep behind the other dykes surrounding the lake and much closer to the water. This landscape was naturally protected and so allowed to greatly engage the water and resultant floods, yet the park created an inarticulate landscape, and passively allowed the water to act as a border to the park. The design of the new Tempe Beach Park draws water into the heart of park, and engages landforms to centralize human experience toward the lake.

6. Tempe, City of., tempe.gov/lake/
Tempe Beach Park is bordered by Tempe Town Lake to the north, Rio Salado Avenue to the south, the Mill Avenue bridges to the east, and the standard gauge and light rail bridges to the west. The bridges arc over the pathways and seamlessly connect larger Rio Salado Park to the Tempe Beach Park. Within the Tempe Beach Park, a small yet historic baseball stadium is sited near the southwestern corner near Rio Salado Avenue, and a large abutment of the former Ash Avenue Bridge (demolished in 1991) is sited near the west-central area of the park. Due to the history of these two elements, they become fixtures and are elaborated within the program of the park, yet most of the 1999 park will be criticized and reworked to promote the sanctity of water. Original and new elements are organized within zones, and the numerous zones have different focuses and addresses park programs.

Figure 93. Perspective Drawing: Tempe Beach
Figure 94. Word Diagram of Tempe Beach Park
The original ballpark, while not necessarily within the scope of this thesis, addressed the functionality of the typical use of recreational park. The depression-era ballpark was a survivor through numerous renovations, and a stable link between the past incarnations of the park and the newer water-centric proposed park. The ballpark was the anchor through an athletic/ recreational zone of the park. Some articulated parks such as the High Line Project, University of Cincinnati’s Sigma Sigma Commons, are criticized as being too formal, too restricted, and by design did not allow recreational/ athletic use of a parkscape. The ballpark, while not articulated, in this project, was sited within a zone of artificial grass, Fieldturf, which had blades of grass-like cloth woven into a playing surface. A thick layer of rubber beads were added to simulate ground and soften the surface, reducing leg injuries while creating a more consistent field. The artificial grass reduced water need overall maintenance cost, and with its durability could host a variety of events without concern for wear and tear. The current sprinkler system could remain in place, but instead of feeding the thirsty grass, it could be only used when needed to cool the field from the intense summer heat, much like Paul Brown Stadium home of the professional football team Cincinnati Bengals. The athletic zone was be covered with the artificial grass, and a temporary fence was be added to designate the baseball outfield, yet allowed other sports access to the field when not in use. This field anchors the park as a great lawn, and its expansion adds variable orientations and multiple from a single use baseball stadium.
AshBridgeZone

The 1931 Ash Avenue Bridge was the first permanent road bridge to cross the Salt River. The eleven arch bridge was severely damaged twice due to flooding. It was also designed with pre-automotive loading and width, and was obsolete prior to completion, yet served as a public link between riverbanks for 60 years as pedestrian bridge. In 1991, due to the floodwater damage to the foundations of one of the eleven arches, the bridge was demolished. The remnant of the southern abutment continued to be on-site along with the remnant of Ash Avenue sited behind the ballpark.

The new park reconstructed 2.5 arches of the antique bridge, as a formal keystone memory of the former crossing. The newer Ash Avenue Bridge was an actual pier that was cantilevered over the river’s edge, and activated the backdrop for the AquaticZone, to be described later. The bridge also served as the pump housing for both the inlet fountains, and the canal system.

The canal system that feeds the AgricultureZone, was sourced at the end of the pier and gravity flowed toward the southern bank and into the heart of the park. The canal system was showcasing the current 181 miles of canals within Phoenix water delivery system, which brings them back into the public eyes, with the integration with the public park.

Figure 95. Perspective Drawing: Tempe Beach
The main entrance into Tempe Beach Park was sited on the southeast corner of the park and the path meandered northward toward the lake and the former amphitheater. The AccessZone continued the placement of the main entrance, but the reworked park dismantled the former circulation paths. The AccessZone was situated across the diagonal from the southeastern entrance to the northwestern corner. It fanned out away from the entrance to enhance sight lines from the entrance, so from first glance the visitor could see various zones as they journeyed into the park. Pervious pavers allow ground water runoff to be retained in the soil, and ground cover to soften and break-up the perceived hardscape.
The AccessZone further segmented the park, leaving small remnants along the eastern boarder, and the Mill Avenue bridge abutment. The remnants were furnished with native drought-tolerant plants, yet plant placement was articulated for seasonal colorings, and year-round desert beauty. The desert landscape will juxtapose against the other water-consumptive zones, refreshing the palate of the visitors of the Sonoran Desert, and the beauty of the nature that surrounds the city.
Agriculture Zone

The Phoenix-valley and its water system was originally developed for agriculture, yet most of the urban island of the city had moved agriculture outside of the city, the population had lost the connectivity to the water, the water delivery system, the purpose of such a system, and the life that the water can bring. The canal system fed from the AshBridgeZone, feeds a 47 lemon tree orchard, and 7 cottonwood tree line. The orchard served as a natural sun- and wind- break for this zone, and creates another microclimate within the park. The trees also raised the humidity of the surrounding area, through transpiration, further cooling the Agriculture Zone.

The lemon trees were selected because of the alkaline soil conditions of the Phoenix valley allowed only the hardest citrus trees to grow without heavy soil modifications. Citrus trees were one of the first agriculture crops to introduced to the valley after the canal system was initiated. The cottonwood trees were a natural desert plant that grows near open water, and was one of the largest desert plants giving ample shape through its tall and thick canopy. The cottonwood tree is a very thirsty tree, and due to drought conditions should only be used sparingly. The Agriculture Zone focused the zone on water consumption, and the canal system which allowed survival in the Phoenix valley and responsible for the destruction of the Salt River.
Articulated Zone

The channelization of the Salt River prevented much human interaction with the Tempe Town Lake, and the Aquatic Zone rectified this dilemma resulting in articulated landforms focusing on public water. The northern one-third of the park was radically integrated with the former channelized river and has reformed the landscape to focus on Tempe Town Lake. This zone was greatly transformed over numerous steps resulting in angular yet segmented riverbanks, a large water inlet into the heart of the park, articulated flood-controlling landforms, small amphitheaters, river docks, bridges, and a swimming pool. The design process of this zone was conceived as an extension of the unique building form into the landscape, and is further described within the natatorium building chapter.
Aquatic Zone

The large water inlet within the Articulated Zone, was further designed into separate basin, allowing controlled public water and beach of Tempe Town Lake.

This area was set between the former river channel and the new coastline of the Articulated Zone. This area was designed to increase the experience of park patrons. It was to house new and relocated boat docks, which can also serve as a launch point during open water swim competitions. Near the mouth of the inlet, the bottom of the new submerged area is considered Tempe Town Lake with a shallow 3ft floor. This area as well as the larger Tempe Town Lake will be left untreated, except for special occasions, such as open water swims. This area ended at a pedestrian bridge, which was actually a low-flood dam designed to appear as a bridge, to blend the boundary with the adjacent basin. The separate public basin located within the inlet, which visually blends into the lake, was lightly treated and filtered. This basin was conceived to encourage public swimming use of the lake, acted as an outdoor swimming hole treated with a beach, and uses the AshBridge Zone as a backdrop. The shallow pool reminiscent to public bathing that happened in the early days of Tempe Beach Park.

The separate public basin prevented problems similar to Louisville’s revived waterfront, where similar inlets were designed to help integrate the waterfront with the city, and make public space from a vast derelict industrial area. The inlets, due to being on the coast and away from the current of the river, house stagnant water from the polluted Ohio River, thus prevented safe human submersion along the waterfront. “The consequences of ignoring the signs at Waterfront Park could be serious illness. The sun beating on the standing water can create bacteria. Waterfront Park officials say this recycled water is not chlorinated or purified, just made to look at,” yet as of June 2010, there has been no complaints or reports of illness from the non-treated water; it does remain a liability, for intimate human interaction. At, Tempe Town Lake, the separate basins give the city control of water quality and manage the majority of the Tempe Beach inlet.

Along the southern edge and east portion of the inlet contains various angled waterfalls that serve as the basin’s water-circulation return, and concealed the flood control dyke from the rest of the park. These waterfalls created an environment similar to the Active Pool within the Fort Worth Water Gardens, an audibly draws visitors to the Aquatic Zone while the pathway cutting through the
waterfalls immerse visitors into lowered watery environment, similar hiking into the deeper natural canyons located within the Colorado plateau area of northern Arizona. Enhancing the canyon-like experience, was the additional ingredient of water encompassing visitors formed a constant link between the force of water and the erosion of the canyon lands.

Within the inlet, were abstract stylized islands within the public basin that recorded water levels, created playscapes, and provided micro-zones of water flow conditions. At a glance, the islands represent land that existed before the flooded basin, with water has overtaken all but the tops of the formations. On the water surface the islands are independent isolated land formations yet they were connected with a submerged path reminiscent of an underground slot canyon, terminating in a bell chamber, sited underneath a larger and more vertical formation. The ramped pathway winds in both in plan and section, with tall and slender attributes of a slot canyon. The subterranean path weaves and connects islands together and the islands act to hide the canyon under the water level and limited daylight enters the subterranean world through a sliver cuts within the islands. Controlled waterfalls and troughs introduce and move water through the space, reaffirming the connection between the canyon environment and water. The moving water also helped to add humidity and use evaporative cooling. A tall bell-shaped chamber similar to deep caverns, conclude the path as a gathering space, with a exit staircase was beyond the walls, and emerged through the water as tall island formation. With water that surrounded the formation a short bridge connected the looping pathway back to the to AccessZone. Throughout the theatrical path of winding spaces, with variable widths and sectional angles, a consistent five-foot wide by seven-foot tall unimpeded path act as a code compliant hallway to the chamber and exit staircase. These spaces further the exploration experience of the canyonlands, and the discovery of lands that figuratively formed and hidden by water.
Tempe Beach Park was a sloping park within the larger Rio Salado Park that surrounds the Tempe Town Lake. It was bound on the east and west sides by two pairs of nearly parallel bridges. The graded slope of the park acts as a dyke, with its highest points lie on the southern edge of the park along Rio Salado Boulevard. This thesis attempts to increase the public acknowledgement and immersion within water. The existing park, amphitheater, playscape, and trails was removed and redesigned to improve the understanding between the survival of desert life and water.

1. Set scope of work boundaries

   Within the Tempe Beach Park, the redefined area sits within the most eastern Mill Avenue Bridge, and the raised western parking lot near the Ash Avenue Bridge abutment. The western boundary follows the former Ash Avenue, to the southern boundary along Rio Salado Boulevard. The completed park was mostly set within the lower section of sloped park, and all work was not to interfere with the dykes or raised land protecting the adjacent land.

2. Acknowledgement of the bridges crossing the lake

   The bridges visually extended the landscape across the water, and bring the historical crossings into focal points of the park. The partial rebuilding of the Ash Avenue Bridge in the heart of the park also rebuilds the historical diagrammatic line by rebuilding of the two and half arches, which extends an existing abutment to the lake edge. This rebuilding acted as a focal backstop in the center of the park.

   The orientation of the bridges becomes important as the site placement of the natatorium was placed at the midline between the former Ash Avenue Bridge and the eastern Mill Avenue bridges, placing the new building in the middle of the new park. The Mill Avenue bridges follow nearly parallel paths and land in close proximity to each other, yet were 8.6° off from each other on the south side that form the eastern boundary of the park. The bridge angle of rotation was continued into the new design as the massing of the natatorium was set at 8.6° from the nearest bridge.
Figure 96. Rendering of Renovated Temp Beach Park
Figure 97. Diagram of Existing Tempe Beach Park
3. Establishing the AccessZone and Waterfront

The main entrance of the Tempe Beach Park was sited on the southeastern corner of the park and the corner of the Mill Avenue and the Rio Salado Boulevard. Mill Avenue was the main commercial corridor of Tempe, historically sited near the Mill Avenue Bridge; which was once the only connector between Tempe to Phoenix over the Salt River. The commercial corridor recently served the younger population of the Arizona State University and corporate offices were interspersed helping provide a positive business environment. With the positive location of the main entrance of the park, it was relocated, yet since the reprogramming of the park the circulation paths and focal points were altered. The AccessZone was established within a vision-wedge mirrored on the diagrammatic line of the natatorium massing. This diagrammatic line was anchored at the main entrance, and moves northwest toward the lake. The wedge shape AccessZone broadened toward the lake and the AshBridgeZone acted as a visual backstop within the field of vision from the main entrance. The ground moves downhill toward the lake reinforcing the vision cone toward the lake and the interior of the park.

The waterfront was designed to breakup the engineered straight floodwalls that were inherent of Tempe Town Lake. The newly designed waterfront was set inland of the floodwalls, limiting the scope of work, and helping to bring the water inland toward the park. The engineered and steep underwater floodwalls could remain intact under the surface of the water attempting and preventing much of the anticipated flood erosion. The variable angles of the waterfront, was intended to breakup the singular tunnel vision of visitors traveling along the southern bank of the lake. The visitor’s vision shifts as they move toward and away from the lake, allowed the creation of new views of the lake and its new coast. Near intersection of the water and the eastside of the AccessZone, a 90° bend of the waterfront was designed as a small amphitheater that focused on the historic Mill Avenue bridge. This commercially viable location near the confluence of the AccessZone and the trail surrounding the lake was set as a new dock servicing paddleboats and other rental boats.
Figure 98. Bridges of Tempe Town Lake
Figure 99. Diagram of Establishing Zones
4. Divide park laterally into three distinct programmatic zones

The park was divided into approximate thirds, with the north dividing line drawn between the spring points of the Mill Avenue and Ash Avenue bridges, and a parallel southern line drawn at the northern point of the baseball field. This segmentation allowed programmatic demarcation and separate microclimates to be established.

The waterfront and the northern third of the park was programmed as the ArticulatedZone. Within the ArticulatedZone, the natatorium was positioned, fitted within the water focus of the waterfront. As the expressive building articulated to meld within the landscape, the surrounding landscape folded to meet the building, thus created a unique landscape that responded to the building form. The program of this segment of the park drew attention to the desert water and articulated to enhance the visitor’s awareness of the public oasis. Within the next steps this programmatic zone was the most transformed and redesigned with a focus of intermixing land, people, and water.

Along the southern boundary of the park, lies the historic Tempe Beach Stadium, first laid out as a recreational baseball field in 1927 and in 1934 with WPA funding, the ballpark added cobblestone and concrete grandstands and a cobblestone fence surrounding the entire park. The grandstands were constructed in the southwest corner of the park, and within the abutment ramp to the Ash Avenue Bridge. A pool renovation in the 1960’s destroyed much of the cobblestone, yet the ballpark and its historically significant grandstands remained. Because of the ballpark was located on the opposite edge of the Tempe Beach Park from the water, the thesis design anchored a recreational lawn, the AthleticZone, around the stadium. The recreational lawn keeps programmatic park continuity, and enabled a majority of the park to be reprogrammed congruent with the thesis.
Figure 99. Diagram of AccessZone Dividing Park Zones
Figure 94. Word Diagram of Tempe Beach Park
The middle third of the park was reprogrammed in memory of the pre-engineered canal-scape and the original purpose of the now urban waterways—agriculture. The AgricultureZone was set inland of the water, and fed by a canal that appeared to draw water from the lake. The canal was actually a constantly recirculating fountain, with a current moving away from the lake and toward the orchard. The canal system terminated within long slender parallel laterals, set between tree lines of the orchard grove. This zone represents water taken from the source to feed desert life. The inner microclimate of the park attempted to reverse the heat island of the surrounding urban area by providing natural shade of a tree canopy, increased humidity through transpiration of the orchard, and water evaporation of the canal.

5. Inject AquaticZone within Tempe Beach Park

The AquaticZone was a shallow basin for shallow public bathing or wading, which cuts into the central area of the park. This water serves as the replacement swimming area, of which the larger Tempe Town Lake was intended, but due to variable water quality the lake allowed only limited fully submerged use, mainly large-scale athletic events such as the yearly Ironman Triathlons. The southern boundary line was rotated along the most western point, keeping the Ash Avenue Bridge as a backdrop for the lowered waterscape. The Mill Avenue Bridge was to be obscured by the natatorium, thus lost visual importance, so the diagram line was rotated south to allow a gentler angle with the AccessZone. The natatorium form that was more defined in The Form chapter determined the eastern boundary of the Aquatic Zone. With the AquaticZone enveloping the natatorium, the building and the surrounding articulated landscape appearing on an island from much of the park. The water within the AquaticZone acted as a formal break between the building form and the park.
Figure 100. Injecting AquaticZone into Tempe Beach Park
Figure 101. Articulated Aquatic Form Manipulating Landscape
6. Natatorium peninsula and multi-use coastal trail

Bridging over the lowered AquaticZone, the AccessZone led visitors into the main entrance of the natatorium and psychologically and physically separated the watery pool from the desert environment. Instead of digging lower into the earth, the majority of natatorium pool walls were constructed above-ground and backfilled with protective dykes. This motion prevented the digging lower into the soil and avoiding veins of caliche, a cementatious mineral abundantly found in Arizona that makes excavation difficult and costly. By raising the pool decks up from the ground level, it also brings the habitable space above the flood plain equaling the higher flood protected AccessZone and other parkscapes. On the exterior of the building, the built-up land was shaped as an extension of the building form, protecting the building and pools from floodwaters and the accompanied mud and debris.

For passive cooling purposes, the building extended into the water. The thermal exchange takes place under the surface of the water, helping the building cool itself, and the pool water. Above this submerged machine, the building form completes itself with a large canopy over the water, and as the form was completed the form vertically truncates itself back into the water. The northern inlet allowed deep cool water to circulate over the submerged machinery, while formally 75 feet wide, it matches the dimensions of the interior 50 meter pool, so visual connections of the lake and the pool could be made. On the water surface, this inlet could be used as an additional dock for lake tours or boat storage. Because of the proximity to the natatorium machinery and its dead end into the building, the northern inlet separates the lake coastal trail. The path was moved adjacent to the building by cantilevering off the building’s foundation wall, and this path could double as a building egress point.

The northern landscape pinnacle into the lake, was unique to the park as the only area crossing over the existing floodwalls and protruding into the lake. Because of the protrusion and the wedge shape of the pinnacle, the land inherently was nearly surrounded by water, which have many perspective visions including the lake or the inlets on either side. The landscapes extension was determined by the landscape form completing itself and engaging the lake, similar to the building form hovering nearby. The pinnacle could be used as a dock or a launching point for long distance swim races, such as the Arizona Ironman Triathlon.
Figure 102. Rendered Site Plan: Tempe Beach Park
Figure 103. Tempe Beach and the Town Lake
The disrupted coastal multi-use trail was redesigned parallel to the jagged coastline and pointed toward the lake, then back toward the AquaticZone. A bridge floats the coastal trail back toward the Ash Avenue Bridge and the larger park beyond. This bridge hid a shallow dam, which separated the AquaticZone basin from the larger lake. The separation enabled the water quality to be controlled within the smaller basin, enabling human submersion within the park. This dam was not intended for flood control, which was to be contained within the 12-foot walls and waterfalls.

7. Complete AccessZone and residual landscape

The AccessZone served as the main circulation for the park, whether connecting the major axis between the main entrance to the coastal multi-use trail, or tie programmatically unique zones into an amalgamated parkscape. At its intersection with the AquaticZone, the AccessZone split into two paths; bending toward the Ash Avenue Bridge and splitting between the masses of natatorium and the Mill Avenue Bridge. An eastern residual parcel of land remained isolated from other programmatic zones due to the AccessZone’s diagonal orientation. The AgrestalZone was expanded from this small parcel segmented from the rest of the park toward the lake and moved eastward under the Mill Avenue Bridges. This zone designed for planting natural desert vegetation juxtaposed to the water abundant zones within other areas of the park. The AgrestalZone was designed bordering the AccessZone, so visitors can view the dichotomy of the park and furthering the visitor’s impression of the importance of water in the desert.
Figure 96. Rendering of Renovated Temp Beach Park
Figure 93. Perspective Drawing: Tempe Beach
The building programmatically houses two large swimming pools and a hot tub, all with various uses, temperatures and aquatic focuses. The natatorium was planned for the multiple users of the Tempe School District, City of Tempe, and Tempe Town Lake Development. The 50 meter x 25 yard Olympic (American) pool could host various high school, middle school teams, and private age-group club swim teams, to meet the demand within the growing sport of competitive swimming. A tier one competitive swimming venue is located within a 2 mile radius on the Arizona State University campus. The ASU pools were built and engineered for speed with a flat deep bottom, yet with cannot programmatically function as a community pool with the lack of shallow ends. A separate deep-water pool allows competitive diving, within the ASU complex. The 50 meter pool within the Tempe Beach Natatorium, has a variable depth bottom because the variable uses are collapsed into a singular community pool. The leisure pool is designed to serve multiple and simultaneous uses. The pool has two areas, straddling a water playground. The two areas can function as shallow instructional pools, within a larger pool that shares the same filtration system. During public swim times the pool areas can split between recreational and instructional programs.
Site

The site is contained by four bridges—two automobile bridges (Mill Ave.) to the East (upstream), and two rail bridges to the West (downstream). The newly constructed light-rail bridge has an award-winning design using multi-light display to have a nightly showcase of the new structure. The annual July 4th firework display takes place on the bridges, the site thus becomes center-stage to a traditional public event, for the large metropolitan community. The site is located on the southern banks of the Tempe Town Lake. The advantages of this move allow the building to be surrounded by the lake and the connection to water that has metaphorical and physical advantages. The natatorium becomes a center of aquatic focus for a desert population, and being sited within the artificial lake helps augment the human connection to water. Physically, the building can use the lake’s microclimate to increase humidity thus reduces temperature, and use the surrounding water to insulate the pools as well the building. The pools could also use the lake to help cool the water, and solar tubes would aid in the heating, thus creating a passive approach to minimize environmental costs. The building could use water walls to help evaporative cooling or could let water cascade down exterior walls to prevent solar and ambient heating.

Tempe Town Lake is a recreational lake within the Rio Salado dry riverbed. Tempe created it in 1999 as an aquatic focus for the desert community. The lake allows sailboats, rowboats and paddleboats to navigate 224 acres of water. Fishing is made possible by stocking the lake with fish, yet no human swimming is allowed, except for large organized event such as triathlons. A large park surrounds the lake, and proposed bridges will span the dams connecting and uniting the north and south parks. Within the Phoenix Metro area, Tempe Town Lake is close to the center of the urban area, yet it is close to the north edge of the Tempe, so the south side of the lake is most developed, and connected with an urban fabric. Four main bridges cross the lake, two automobile, one railroad, and one light-rail, the recently opened light-rail connects suburban northern neighborhoods to downtown Phoenix, Arizona State University, Tempe, and the south-east community of Mesa. The Center for the Arts was just recently built on the southern edge, near the dam. Also sited on the southern park, a seasonal public splashscape, where water is splashed around playground equipment, but not allowed to gather over 2”, reducing evaporative loss. This connection to existing water park reinforces aquatic play.
Environmental Response to this extreme Sonoran Desert, is to use the raised humidity of the Tempe Town Lake microclimate, to help mitigate 110° summer heat and help to regulate pool temperature by extending pipes into the lake and connecting solar tubes to the filtration system of the pools. The building is orientated with its long axis going east-west, allowing a broad but controllable solar exposure to the south/ north façade, the east/ west facades should be more protected due to the horizontal light, and the heat associated with western daylight. The building can also pump lake water into the building helping to cool the building, either through reverse radiators, or by allowing the water to flow over the elevations. Whether over solid surface or a water-wall, the water will help cool the building. The climate is rather comfortable most of the year, with the exception of the extreme heat of the summer, the mild winter helps regulate building heating needs. The desert’s lack of humidity also increases daily temperature swings, which amplifies highs and lows. The swimming pools are mostly a daytime program, yet early morning practice is not uncommon, as well as evening public swims. The mechanical aspect of the machine for swimming can adjust with seasonal differences, and level the interior climate.

The intense sunlight and the high number of exposure days, can be advantages as a steady and predictable lighting of the interior, however shading is required to control intensity and climate control. Diffuse or perforated systems can control day-lighting, yet many possibilities can create numerous original light/spatial conditions. Sunlight seems to be the norm, but rain does come to the desert with fierce storms, the building will have to deal with intense rain from the sky. The building will also have concerns due to flooding, since it is located within the main flood-plane of the valley. Most of the concerns are cancelled out with the artificial lake and the inflatable dams that control and stabilize water levels, however the building is integrated with floodwalls and the pool decks are constructed at the height of the floodwalls.

The immediate context of the site is a singular building located within a park. No buildings are directly relevant to cause shadows. The building also does not fit within an urban fabric for adjacencies or context. The surrounding park has been redesigned to align the main entrance of the park to the main entrance of the natatorium. The southeastern corner of the park is the main entrance to the park, which directs people from Mill Avenue, the busy urban corridor of downtown Tempe. A running path following the coast of the lake has also been reworked to allow visitors closer interaction with the lake and the natatorium. The connection with the nearby light-rail station allows
easy connection with the larger city, and parking lots that already serve the park, can be utilized for automobile transportation to the natatorium. Nearby buildings are also scattered down the river-bank, anchored by the Center of the Arts by the dam, a development of office and condo towers near Mill Ave, and the Hayden Butte ("A" mountain) along with the ASU stadium and arena further upstream.

Tempe has many seasonal public pools, although very few remain are open year-round and competitive swimming uses year-round pools for different swimming focus and high-school athletics. ASU’s campus has two year-round aquatic complexes, but only one city-run pool remains year-round.

Figure 105. Sustainable Intent Diagram
Figure 106. Ventilation Diagram
The program for my thesis is a cross-programmed aquatic center—a machine for swimming. The complex serves as a community complex of multiple pools for the variety of human/water engagement. It will facilitate the needs of a competition, training, and recreational users within one roof. This program will serve as a desert oasis and utilize the community’s wide range of needs, and could help promote swimming as a legitimate desert sport.

Figure 107. Tempe Pools per High School Diagram
Competition Pools

These pools are designed for speed and in compliance for multiple regulations of separate aquatic sports, competitive swimming (short- and long-course), synchronized swimming, water polo, and underwater hockey. A nearly flat-bottom pool runs around 9-10 feet, keeps underwater waves acting consistently, which provide competitors with a predictable and uniform volume of water to swim through. The depth allows dive-starts, while permits other sports legal depth to maneuver without illegally touching the bottom. Movable bulkheads can be placed within the pool to segment the pool into different areas, two bulkheads can be used to convert a 50 meter pool into two legal 25 yard pools. Visibility and seating is generally highly needed during meets, most of the year permanent seating goes unused. In 1982 IUPUI built a world-class natatorium, which can seat roughly 4,000 visitors, with exception to big national meets the building is under-utilized and expensive to maintain. In the current era, temporary pools have been built in various arenas including the Conseco Fieldhouse, in Indianapolis, and the Qwest Center, in Omaha; this allows arenas that are designed for visibility, restrooms, and concessions to comfortably host a one-time mass of people. The above-ground temporary pool is expensive to construct, has obvious space and depth restrictions, which eliminates long-course swimming and diving from the event program. Temporary outdoor pools with seating have been constructed in a parking lot in Long Beach, CA. This was used for newer Olympic Trails, where long course swimming is required and multiple warm-up pools are allowed to spread throughout open lot. The entire complex, including seating was temporary and removed after the event, and the space is returned back to a normal parking lot. For many decades, Olympic venues have small amount of permanent seats, yet have a temporary enclosed structure host most of the seats for the games only to be removed afterward. Munich, Montreal, Atlanta, Sydney, and London game sites all fit into this classification.

17. Wylson, Anthony, pg.61-71
Competitive Diving Pools

The pool is generally much deeper, 17 foot at IUPUI, and does not follow a consistent footprint. It can double-function as a warm-up pool if it follows a general 25 yard width. The diving tower can mount all 5, 7.5, 10 meter platforms, with separate installations of 1 and 3 meter springboards. Visibility and seating priorities is similar to the competitive swimming, which has moments of heavy use, but most of the seats are vacant. Generally competitive diving pools are in the same space as competitive swimming pools.

Training/ Community Pools

The pool does not have to heavily engineered for speed, but should maintain the 50 meter by 25 yard footprint for training consistency and program variability. The use of movable bulkheads can also help the variability of training. The depth can also vary based on other programmatic needs, most have a fairly large shallow end transitioning into a deep end for diving.

Recreation Pools

This is absolutely the most variable type of pool, based on leisure, recreation and other community needs and tends to be shallow for non-swimmers and children. These pools are generally warmer than competition pools, for comfort of patrons- young and old. Playground equipment and other play areas can be incorporated into this type of pool.

17. Wylson, Anthony, pg.71-72
Usage

PUBLIC-RECREATIONAL- general public swimmers, swim lessons, leisure swimmers, children’s play area, wading, diving, therapy, summer children, lazy river, slides, (bouldering, ziplines, SE Missouri State)

PUBLIC-TRAINING- lap swimmers, swim team practices, SCY swim team meets, LCM swim team meets, swim camp, water polo, diving, synchronized swimming, scuba diving, aquacise, training/team rooms

PUBLIC-GENERAL- locker rooms, rest-rooms, party/classroom, decks, sun-bathing

PUBLIC NON-WET- spectators, parents, drop-off/pick-up, vending/café, general park users, community members, community classes/meetings, sun bathing

WORKERS- lifeguards, staff, maintenance, storage, equipment, service, meeting room/classroom

17. Wylson, Anthony, pg.71-72
Figure 108. Rio Salado Master Plan
-Program Precedents

Vicinity Pools

**Arizona State University- Mona Plummer Aquatic Complex**
- 50Mx25Y pool= 11,250sqft
- 2x 25Yx25Y pool= 11,250sqft
- decks= 12,000sqft
- spectators= 10,000sqft
- locker rooms= 2,600sqft
- service space= 2,000sqft
- total= 40,000sqft

**Arizona State University- Student Recreation Complex**
- 70Mx 25Y= 15,750sqft
- decks= 7,050sqft
- total= 22,800sqft –(locker rooms+ service spaces)

University Pools

**IUPUI Natatorium**
- 2x 50Mx25Y pools= 22,500
- diving pool= 3750sqft
- locker rooms= 5,000sqft
- decks= 10,550sqft
- spectators= 21,000sqft
- official/ staff= 800sqft
- mechanical= 2000sqft
- total= 65,600sqft /2floors

**Ohio State University**
- 50Mx25Y pool= 11,250sqft
- dive pool= 4600sqft
- decks=12,000sqft
- 25Y lap pool= 4700sqft
- 25Y recreation pool= 3500sqft
- leisure pool= 2850sqft
- 2x whirlpools= 366sqft
- spectators= 12,000sqft
- total= 51,266 /2floors –(locker rooms +service spaces)
University of Cincinnati
50Mx25Y pool +decks= 12,641sqft
leisure pool +decks= 3,388sqft
3 offices= 700sqft
dry classroom= 1200sqft
pool mechanical=2,000sqft
spectators=1,500sqft

total= 21,429 –locker rooms

Community Pools
University of Dayton
25Yx8lane
+diving well
+1000ft circular teaching pool=6000sqft
hot tub= 1,600sqft
decks= 4,000sqft
community room= 600sqft
guard /staff= 200sqft

total= 12,400sqft –(locker rooms +service spaces)

Farmington Aquatic Center
50Mx25Y pool= 11,250sqft
west deck= 3,750sqft
north deck= 1,750sqft
east deck= 1,500sqft
south deck= 1875sqft
leisure pool +decks= 5,625sqft
slide area= 2,100sqft
mechanical= 3,200sqft
locker rooms= 2,625sqft
lifeguard/ staff/ front desk=1225
lobby/observation=1,500sqft

total= 36,400sqft
High School Pools

Cranbrook Natatorium
25Yx 25Y pool= 5,625sqft
west deck= 1,500sqft
north deck= 750sqft
east deck= 750sqft
south deck= 1,080sqft
pool equipment= 1,300sqft
locker rooms= 2,500sqft
staff= 1,000sqft
ramp= 3,000sqft
spectators= 2,750sqft
lobby= 600sqft

total= 18,105 sqft

Clovis North High School Pool
2x 50Mx25Y pool= 22,500sqft
3x longitudinal decks= 15,000sqft
2x short decks= 3,500sqft

locker rooms= 2,500sqft
-Unique Features

Heat Exchanger

Reducing the operating budget for a complex of numerous swimming pools can save millions of taxpayer dollars. With passive strategies integrated within the building, heating and cooling costs should be negligible.

Within the Arizona desert, many pools are fully heated during the winter months and transition to fully refrigerated during the summer months. Unsurprisingly air conditioning cost also skyrocket during the summer months when temperature routinely reach 110°F. Annual temperature variations are predictable within the neighboring Tempe Town Lake. Using the larger lake as a heat sink to chill the pool temperatures and provide chilled water to provide air conditioning for the natatorium, thus greatly reducing operating costs related to cooling the natatorium. By varying the depth of a heat exchanger within the lake, various temperatures could be obtained. The recorded temperature is measure 1 meter below the surface, and gets considerably colder at greater depths. The highest the lake temperature is around 88°F during the hottest summer months, however cooling loads could still be achieved by lowering an exchanger to colder temperatures.

Within the enclosed natatorium, shaded bodies of water will cool below human comfort level and will need to heated. Solar hot water tubes are placed on the roof canopy to provide passive heating of the pool water. The desert sun and high ambient temperatures will heat oil within the tubes, which will transfer the heat to the pool water through a heat exchanger located in the natatorium’s mechanical room.

6. Tempe, City of., tempe.gov/lake/
Figure 103. Natatorium’s Northern Pinnacle Meeting the Lake
Upward Pool Construction

The natatorium takes advantage of a unique site conditions to build upward from the pool bottom toward the pool deck. Because the natatorium is built within a floodplain of a major river, the building must be constructed above the 10 foot waterline. The current location of the natatorium is on-grade with the normal waterline of Tempe Town Lake, and the bottom level must be raised to the proposed flood level.

The Phoenix valley has a history of excavation problems. Layers and veins of caliche soil form within Arizona’s dry and alkaline soil. Caliche is a hardened mineral deposit and compared as veins of natural forming concrete. Caliche, or calcium carbonate, is formed as carbonates leach between layers of soil and cements porous minerals into layers of hardened soil. Prevalent within arid areas, including Phoenix, caliche is generally discovered within depths ranging from 3 to 10 feet from the surface. Specialized excavation crews have experienced difficult caliche situations. While planning for swimming pool excavations, caliche removal should be anticipated due to the large volume of soil removal.19

The natatorium pools are constructed to avoid flood and caliche-based problems. The pools are constructed above ground and backfilled to achieve the desired deck level. All but the deepest segments of the pools could be constructed without excavation, limiting the costly specialty contractors to a smaller scope of work. Helping to construct the pool basins, raising the building engages the new floodwalls, which brings the natatorium to the coastline and easier to visually connect the pools to the Tempe Town Lake.

Figure 109. Excavation Versus Upward Construction
Salt Water Pools

This has been a problem with swimming pools since they started sterilizing pool water. Large swimming pools, such as the modern 50 meter x 25 yard the standard of competitive swimming, developed out of floating pools, anchored river barges, that allowed safe swimming pools fed by a river and used the river currents to wash away filth to continuously feed the pool with clean water. During the process of river pollution, floating pools moved anchorages upstream or closer to the center of the river, when attempting to gather the cleanest water. If the pool could not develop clean water, the business was closed. In the mid-eighteenth century, the Seine was crowded with various floating pools. Swimming had become a popular activity as well as social events, the pools continued to one-up each other in amenities to appeal and attract the business of the bourgeois. “The swimming school even smelled like the most chic restaurant of the day.”

As river pollution became more prevalent, the pools became more separate from the river; eventually the conversion of the Baines Deligny, in 1937. From an open current floating pool in the Parisian Seine, to a closed loop of filtered water within a large steel tub, made the first modern large scale swimming pool as we know it. As sanitary chemicals were developed, the implementation of hydrochlorous acid was conceived to sterilize the recirculating water.

A problem with chlorine is the chloramines, the residue of the active chlorine after it inactivates and oxidizes pathogens. Eventually the pool recirculates constantly adding chlorine to the water, yet the chloramines continuously build up with in the water and often responsible for the human irritation, the chlorine smell, and a caustic environment for the pool and equipment. Close chemical control of modern filtration systems can record and alter the chemical balance of the water, reducing the affects of chloramines. UV lights and ozonators can also be added to the circulation system, increasing the disinfectant power of the system, reducing the need for chemical injection, and effectively burning off chloramines thus reducing the negative effects of chlorine. The UV light and Ozonators are considered supplemental disinfectants, because then only destroy pathogens within contact of the components. This reduces its effectiveness to complete pool turnover of the circulation system, which can take hours. Contemporary codes require instantaneous reaction to pathogens and contamination, so chemical disinfection and oxidation are still required to quickly disable bacteria, viruses, infections, and other common contaminates, yet these supplemental disinfectants lessen the need and the effect of the chemical disinfectants.
Chemical Disinfectants

There are two major chemicals used within pools, chlorine and bromide. Bromide is slightly more expensive option and comes only in high viscosity liquid form, much like molasses. Because of the physical nature of bromine, it can withstand heat better than chlorine. Chlorine is naturally a gas, diluted into a liquid or trapped into a granular powder. Bromine is used most frequently in hot tubs and spas, but can be used in pools, such as Indiana University’s Councilman Billingsley Aquatic Center. Bromine does not have a distinct smell or taste and does not easily irritate patrons eyes, unlike chlorine. It is usually added to ammonia-rich water, which in heavy doses or large pools can have undesirable smells and taste. Bromine is extremely reactive to attacking pathogens, but also corrosive toward metals including pool machinery and pool structures. A major problem with sterile pools is allergies to the diluted disinfectant, but patrons allergy to the bromine chemical is more frequent and less known in the general population, leading an to unknowing public swimming to develop rashes, as well as other allergic reactions.18

Chlorine come in many different forms, but regardless of type or feeder, the objective is to get free chlorine into the water, to disinfect and oxidize containments. Chlorine is also the most widely used chemical to treat pools, as it comes in different forms traditionally; Sodium Hypochlorite, active strength 10-12%, Calcium Hypochlorite, active strength 65-78%, Lithium Hypochlorite, active strength 29%, Chlorine Gas, active strength 100%. These chemicals have various positives and negatives, but all release unstabilized free chlorine, which could be easily destroyed by sunlight’s UV rays. About half of the unstabilized chlorine within an outdoor pool, can be destroyed in less than an hour. Cyanuric Acid can be added to the pool to protect free chlorine three to ten times longer, but it also slows the reaction time of chlorine disinfection, requiring additional chlorine to be added at times of an fecal ‘accident’ to compensate for the slower reaction time. Recent developments have added cyanuric acid to the molecular structure of the chlorine, lessening the need to add two chemicals. As the chlorine is depleted, part of the molecule, which is the remaining cyanuric acid ion frees and increases in concentration as more chlorine is depleted.18

Recently the chlorine generation has increased popularity, most new residential pools are built with this system. Because of the nature of the system, it can be easily adapted to larger scale pools. Chlorine generating takes place when pure salt, NaCl, is mixed with the water. The Salt is electronically separated; forming chlorine gas, sodium hydroxide and hydrogen gas. There are two methods of generation: inline and brine. The inline method is known as salt water pools, as the salt is dissolved in the water then separated into the chemicals, as needed. The brine method uses an off-line separate tank for solid salt, then is filled with water as the chemicals are needed, and the super concentrated dissolved salt solution is then separated before released into the pool.18

The inline-system is unique because the pool itself is salt water, so the patrons liken the pool to the ocean favoring the naturalistic water to the chemically treated alternative. Humans float better within salt water, which can create a competitive advantage in the sport of swimming. Floatation devices and tech suits are one of the regulated aspects of the sport, so the added buoyancy can affect swims and the quicken the resultant times, but because it affects all swimmers equally in that pool, that it washes out the unfair advantage. The salt pools reduce the amount of redundant chlorine that is almost self-sustaining, because the excessive chlorine and chloramines rebond as salt in the water waiting to be reseparated into the chlorine disinfectant. The free chlorine produced in this system only changes minor effect on pH and water chemistry, also simplifies traditional approach of adding additional chemicals to offset, protect, and balance water chemistry and quality. Some losses are accumulated due to back washing, rain water dilution, and splash out. Salt does need to be added to the pool and is easily fed into the system, by simply dumping pure salt into the pool basin and stirring it until it dissolves. Current systems are automated and can tell maintenance crews when to add salt and vent the system of a dangerous buildup of hydrogen when detected.18

Some maintenance crews are unwilling to change into more sophisticated systems, because they can overly complicate pool management, even though it seems that in-line generation cuts multiple steps, thus reducing excessive chemicals and providing a more natural water for the public. By adoption of pure salt, the chlorine is easier kept under control reducing the painful chloramines, which are responsible for the dry skin, the burning eyes, the chlorine odor, and suit fading.

Figure 110. Nude Descending a Staircase
Fluid Form | Etienne-Jules Marey

“…showing what one could learn from a curve, which was not merely a simple ‘reproduction.’ It was from and with the curve that forces could be initially be calculated. It was easy to obtain the mass of the body as well as the speed it was going (chronobiology); form this one could induce the force that had set it in motion, the work expended to produce this action. The trajectory always question and interpreted. Not only were the slightest nicks and notches in the line due to certain factors, but they enabled the determination of resistances as well as impulses.”-Francois Dagognet

Within this segment of the thesis, the purpose was to complete the aquatic environment with the addition of the natatorium, the segmentation and privatization of public water. The natatorium design reflected the motion and energy of aquatic activities. The fluid form followed swimming motion diagrams to script the form and spatial environment. The abstract diagrams were evolved and coupled with site, climate, and program to form the natatorium. Fluidity and architecture were not exactly compatible. The expense of the extensive craft required of unorthodox buildings generally inhibit progressive buildings from being realized. Curvilinear buildings and fluid forms were readily designed within the digital realm with extensive use of computer programs, yet without an evolved construction culture complex buildings will continue to be realized. To increase construction simplicity the natatorium’s fluid design was broadly faceted, reducing the complexity but preserving the fluid intent.

19. Lynn, Greg, Animate Form , pg. 26
Figure 111. Connect Curved Lines Through Points
Figure 112. Le Vol des des Oiseaux, Multiple Exposure Photograph
Inspiration of natatorium building's conceptual form came from Greg Lynn’s critique of form and motion and the superimposed photographs of Etienne-Jules Marey, yet separated shortly after volumetric design. This deviation brought the building form into a discussion with desert environmental concerns, southwestern building techniques and contemporary culture. The design process responded to automotive designer Chris Bangle’s criticism of the highly curvilinear form-driven architecture, and produced an intentional yet unique architectural statement of fluid form.

In the late 1800’s, Etienne-Jules Marey studied animate motion and produced images of the curvature of force and time. Marey shifted the study of animal mechanics to away from conventional still-life documentation and simplistic Cartesian space thus discovered rhythms, movements, pulses, and flows related animation. He developed phase portraits, which physically overlaid multiple exposures, triggered by pneumatic and electric sensors placed on the animal. This technique showed the sequence and rhythms inherent with studying “movements not moments.” Marey would join movement points with tracery lines of continuity over time. Marey’s tracery timeline was based on the inflection of motion paths frozen through time. The animated lines produced evidence of motion and can be expanded into modern architectural environment, by documenting how people interact in motion through a medium or society. “Animation implies evolution of a form and its shaping forces; it suggests animalism, growth, actuation, vitality, and virtuality.” Futurist art movement experimented with collapsing time on a canvas, and superimposing multiple static frames “generating a temporal palimpsest.”

Typically, architecture was created within a neutral space of an abstract Cartesian grid and void of contextual and spatial design. Architecture could be advanced to be similar to other fields, such as naval architecture, and conceive an environment responding to force and motion. Architecture could be furthered by integrating and anticipating environmental forces, and fully submerging the building with the “dynamical flows” of its surroundings. Within naval design a ship’s hull was designed to anticipate water and the variable forces of motion. In different circumstances the hull does not literally change shape but utilize other parts of the surface, letting all potential forces to be anticipated to complete the design.

The prevailing conversation of motion in architecture was the cinematic model, in which multiplication of single frames were sequenced to form motion. Greg Lynn continued critiquing this method, by the actual force and motion were removed from the form, and later brought in

19. Lynn, Greg, Animate Form, pg. 26-30, 10-12
only as an optical procession. Phase portraits were one of many ways to produce form and their generators. These animate forms differ from other non-conventional architecture, by studying animate bodies moving through space, then translating the motion into spatial environments. Lynn stated that “design, architecture and life will continue to become more and more biological, not nearly biomorphic.”¹⁹ The phase portraits could document various motions, which have been used by architects and artists for inspiration and also could easily form linear diagrams, to later be used to form conceptual design. These diagrams and motion studies were translated to produce unique signature forms related to the motion in which it was conceived, but without producing a direct anthropomorphic mimicry of the body. Animate forms use the diagrams to articulate different parts of the building including the structure, orientation, geometry and massing. The design approach could also move from volumetric studies to design and specification of apertures, cladding systems, and interior finishes. The design process to create unique forms also relies on technology of design and fabrication. The computer rendering of contemporary architecture, the computer generated drawings of compound shapes show that architects believe that they can produce complex buildings. However, within an automotive designer eyes, there is a naiveté in the implementation and construction of the designs, as “if only acquiring [construction] culture was an easy push of the surface button.”²⁰

Linear diagrams were not architecture or the directive of architecture, but could integrate with other stages of development. Inspiration for the concept could be carried through the architectural process to form a final building. “Any general discussion comparing two discrete artistic fields is inherently fraught with challenges, not the least of which is the ever-present temptation to draw facile parallels.” Due to various depths of investigation of motion lines and the translation carried through various steps to form an architectural response. Various architects and artists reflect this knowledge with a variety of personal interpretation, improvisation, and abstraction. In comparison to the automotive industry, automobile design and architecture had many commonalities yet there are as many if not more differences between them. Both professions were overflowing with stout egos wrestling over aesthetics within the creative world, to produce superior products to demanding customers for beautification of the habitat in which we live.²⁰ Automotive design has produced Venturi’s ducks, and studied the baroque to design a sculptural spirit fused within car design; long before the postmodern movement revolved architectural focus toward contemporary and complex architecture.

¹⁹. Lynn, Greg, Animate Form, pg.10-12
²⁰. Lynn, Greg, Form, pg. 43-47
Though automotive designs were derived from serendipitous sketches, and conceptual design inspiration; the design culture forbids random or irrational designs to survive this process and still appear in the showrooms. Regardless of scale in every design decision, was intentional, every lofted surface follows rules. Automotive designs followed a rich history of mobile machines, an appliance for movement that took vehicular inspirations from similar objects, whether the complex shaping and coloring of Pullman train cars, streamlined teardrops from yachts, or tailfins from jets. Design evolved after generations of clay sculpting meshed with orthographic drawings, producing a surface culture imbedded within modern car design studios.\textsuperscript{20}

Fifty years after the start the architectural modern movement, the automobile industry went through a similar revolution. During the 1970’s, the industry scrapped excesses and reformed the industrial process. Evolving from a handcrafted wheeled sculpture to fully automated assembly lines producing six-sided box on wheels, more similar to common refrigerators than streamlined boats. A limited number of manufacturers evolved, refined designs through the transition period and continued the perfection culture past the automotive modernism. Design refined mass production for the small detailing, created reveals and shadows; while constructed within tolerances, it forced reproducibility, and predictable geometric results. The reflectivity of the shiny surfaces of was unforgiving to mistakes, whether caused by imperfections or inconsistency throughout the entire vehicle. A curve or overall shape was essential to its emotional statement, formal spontaneity or personality was carefully planned and every small detail could take months of refinement. The car’s skin must multi-task as screen the car and climatically separate the interior from the road, but cars must also be value-engineered, crashworthy, efficient, scrapable, repairable, and mass-producible.\textsuperscript{20}
Every car must be identical and uniform throughout its seven-year production run, yet survive a twenty-year lifespan. The relationship of the dynamic nature of cars and fixed architecture can be described as a dancer compared to the statue of the dancer. Different standards of execution, control and constructability drive the professions toward two different products. Automobile designers control the craft of the product by employing the craftsmen who built the products. Architects are contracted out to produce drawings, for others to build, while employing hope that other contracted parties follow the drawings to its specifications. Architecture for the most part was not mass-produced and can be attributed as a prototype. Lacking the unyielding development and honing predictable products, attributed to the years of a design from conception to the beginning of its productive run.\textsuperscript{20} The curved surfaces that architects envy and strive to achieve through complex geometric construction cannot be easily compared to the elaborate developmental process that produces automotive design.

\textsuperscript{20} Lynn, Greg, Form, 43-47
-Form Precedents

Fluid Form
Freshwater Pavilion
Blowout
Son-O-House
-Nox
Vitra Fire Station
London Olympic Natatorium
-Zaha Hadid
Island City Central Park
-Toyo Ito

Animate Form
Embryological House
-Greg Lynn
Korean Presbyterian Church
-Greg Lynn & Michael McInturf
BOAT.hse
-Michael McInturf
Rotterdam architect Lars Spuybroek and his office NOX, created highly fluid form buildings, using delusion or sensory perception by overloading the experiential senses creating vertigo, rewiring the brain to focus on desired exploration. The inventive structure followed exploratory processional, distorted effectual, and unique structural diagrams. Spuybroek believed that contemporary architecture has fallen into “a state of cold minimalism, blind traditionalism, and mindless materialism.” Armed with the philosophy that if man designs and constructs objects and buildings, then man should always feel strongly about them.

The structural diagrams were analog machines used by Antonio Gaudi and Frei Otto, to input structural loads that in result create a unique load paths and space shaping. NOX used similar machines to create exploratory spaces and efficient structures. The structure was re-envisioned structural members form catalog structural members to custom cut steel plates. The members were designed to fit on standard steel plates erected on site, to create a unique formal structure.

21. Spuybroek, Lars, NOX: Machining Architecture pg 18-41
Figure 113. Twisting Deformation on Elliptical Tube Sketches
Figure 114. Exposed Structure Construction Photo
Figure 115. Sectional Sketches
The perceptional mapping gave the desired effect of the specific project and program. With the discovery that vertigo was not caused by the absence of sense, but in an overload of perceptions that confuses the brain, complex spatial environment were desired to retune the brain into consciousness. Projects similar to the Freshwater Pavilion have no connection with the exterior world or the complex interior, fixes perceptions of the body of imbalance and unease. This was the desired effect and similar to the effect of floating or submerging the body into water. The various water sources and exhibits within the space reinforce the water analogy. The Son-O-House exhibited an opposite approach to the exterior environment, yet creates similar phenomenal reactions. The complex form of the project and the changing audio patterns could overwhelm visitors, however the materiality and filtering environment furthers the mental anguish. Cladding the fluid structure with expanded metal, allowed visitors to view through the material to the exterior and adjacent interior spaces. The porous material acted to filter and sift environments and gave a constant known environment and transitioning into a variable and distant pastoral backdrop layer furthering complicate distinctions between spatial interiority.

21. Spuybroek, Lars, 18-41
22. Ranaulo, Gianni, Light Architecture: New Edge City. pg.62-63
Figure 116. Perceptional Mapping
Figure 117. Interior Picture of Well
Figure 118. Audio Perceptional Mapping
Freshwater Pavilion

Afloat on Neeltje Jans, a constructed island, sits an example of liquid architecture, a building conceived as a building for the exhibition and experience of water. The dynamic building was designed for an intense interaction between users and the computer controlled exhibits and environments within the building. The building was designed in two greatly different sections, one a fluid and flexible deformation, while the other an angular tapered form. The NOX freshwater segment- a wavy, fluid and elongated form, was constructed as a large turbulent three-dimensional media artwork for visitors to intimately appreciate water. Designed as fourteen ellipses, shifted in plan and section into an undulated the shell enclosure, but also the floor inside the shape. As visitors moved through the theatrical space, ramps and floors blended into the twisting walls and ceiling with no distinction between the surfaces. As the visitors grasped the visual overload of the twisting non-linear building, the brain must also feel the surplus of information, and were barraged with theatrical exhibits- as misters and geysers erupt, water splashes and flows around the visitors, and waves of electronic sounds and light pulsate through the pavilion, all to reinforce the vertigo effect of the environment. The exhibits were computer controlled and change based on users actions; the sensors were triggered as visitors unknowingly moved about the space, and change based on number of people and their interactions with the building.

21. Spuybroek, Lars, pg 18-41
23. Schwartz, Ineke, Testing Ground for Interactivity, synworld.t0.or.at/level2/soft_structures/allgemein/testing_ground.htm

Figure 119. Mist within Freshwater Pavilion Interior
Figure 120. Misted Well within Freshwater Pavilion
Figure 121. Aquatic Interior of Freshwater Pavilion
Near the water pavilion sat a similar shaped yet smaller public toilet building. The form’s premise relies on channeling natural airflow at high speed, to equalize body pressures and distract visitors using the public toilet. Vents on each end, the male side had a grill, while the female had an exhaustion pipe, direct and accelerate ocean breezes through the open enclosure. The distracting airflow and the intimacy of the form-centric environment, created the vertigo to confuse the mind and lets visitors release in peace. Constructing the amorphic building consists of 10 flat steel plates cut to shape and erected as structural ribs. Light gauge steel beams twist between the ribs and conform to resemble a torqued shape, then the simplistic structure was clad with welded steel plates giving the building ample lateral support to the enclosure, and finally the plates were protected, finished, and smoothed with sprayed concrete.
Son-O-House

Within an industrial park in Son en Breugel, sat a voluptuous public pavilion of expanded metal with sounds composed by movements of unknowing visitors. Sensors and speakers placed to create continuously changing acoustical space, and the computer generating the sounds was composed and programmed by Edwin van der Heide. Visitors generate sounds and can use the pavilion as a musical instrument, complicated by other visitors interacting within the same space. The sensory overload comes from the acoustical variation of sounds but also complex architecture and its semi-transparent cladding. The sculptural structure derived from gathering animate movements of people in a house, corridor, and a sink. The movements choreographed together with strips of paper, and as bands overlap and have connective potential they are stapled together bending and curving the diagram. Diagrams of structure evolve into computer models that sweep surfaces over the pavilion. Aggressively curved walls and interweaving vaulted spaces with its lack of vertical and horizontal reference planes was the first dimension of spatial confusion. The layering effect of the porous materiality of the expanded metal increased the sensory perplexity. The constantly shifting and changing audible sounds further enhanced the environmental vertigo, which intentionally overloaded the brain sensory capacity to reboot the brain, and bring the pavilion completely into focus.

21. Spuybroek, Lars, 174-197
Figure 126. Framing Diagram
Figure 127. Vertigo-Induced Interior Environment
Iraqi-born and Architectural Association alum Zaha Hadid was known for fluid form, seamless space, and volumetric complexity. Hadid had shared unique spatial imagination, from early paintings and early conceptual work heavily influenced by Russian Constructivism, and Suprematist art movements through contemporary architectural work, heavily responding to the artistic, excessive, and figurative expression resulting in a marketable image of architecture. While waiting for commissions, she continued to paint and enter architectural competitions. Her painting style evolved through this time, and her artistic vision of the world became more refined. The forced perspective, curving horizon line, force fields, and objects within fields, result in imaginative and iconic forms within an urban landscape. Within this vision, similar to a kaleidoscope, thrived on image to spread conceptual and emotion matter yet does not focus on one message or idea but exposes and embraces instability, surprise, and confusion. Her creations represented “a reality that is without origin and not concrete… an image that precedes reality, a simulation in which the vestige of the world do not exist: they are virtual.” The imagery of her art, showed a pure, absolute, and experimental Utopia, which does not exist but within her conception of her imagination.26

Her work can be separated into three phases of evolution, indirectly based on design technology available at the time. Her paintings were the searching for a form and sculptural space, a “visual manifesto-the billboard of the practice.” Her search was similar to Schindler’s ‘spaceform’ is an unseparable combination of form and space, and similar to the Suprematist’s artwork, the architecture project and recede into the depth of space. The unique use of various modeling types, whether relief or acrylic, was used as an investigative tool discovering spatial opportunities. Hadid herself had said, “we began to see the similarities between liquid space and rock. Such ‘discoveries’ could be productive. By sheer use of the model, almost by total accident, you begin to look at things in different ways.” When stacking acrylic floor plates, it opened up new visions of space and lead to exploration of vertical connectivity, and spatial fluidity.26

Not constrained by conventional design tools of T-squares and triangles, she asked “what drawing, watercolor, models, reliefs, storyboards, the photocopier, and most recently the computer allowed and encouraged an idea to become.” Since the advent of computer aided design, Hadid embraced the logarithmic power, and released highly complex geometry into the architectural realm, and used the computer explore the new digital media. The computer did not blindly drive design, yet used as a tool, and as new programs opened new opportunities to further her vision. She continued to push computer design programs as instruments in a laboratory investigating media.26

1. Developed in the late-1980’s, ModelShop computer program, gave Hadid the computer technology to transform her vision and paintings though a design process, and create construction documents. The ModelShop software was limited in computing power, which tended to straighten curves, stiffen geometry, yet the dynamic character of the projects could realized, and made improvement within the design process, an radical evolution from French curve drawing tools and segwaying into more powerful computer programs. These projects were typically complicated composition yet conventional structures. The perceived complexity happened through juxtaposed and articulated elements, an additional approach to design similar to her paintings.26

2. VectorWorks developed in the mid-1990’s, allowed the development of splines and complex curves. The spline was conceived as elastic lines that can be stretched and pulled by moveable control points. Variations of splines, Bezier curves have been used in automotive design, yet never transitioned into architecture, mainly the difference of initial cost of design is overseen by the productivity of mass production. VectorWorks and similar programs made the spline concept develop to be easier to use and integrated within the design process. The use of custom and complicated engineering started to free her buildings, with extensive use of the high strength steel and concrete beams, and space frames, the structure alleviates the building form a column grid, and allowed a symbolic freedom from gravity.26

26. Mertins, Detlef, Patrik Schumacher, Zaha Hadid, pg 23-32
3. As computer programs continued to develop, they could manipulate or distort meshes, surfaces, and grids. The form took another evolution as surfaces became more articulated, molded, and smoothed. The undulations and distorted surfaces continued to shape space by shaping the form itself, yet the computers aid in creating construction documents and fabrication of the materials themselves.  

Many of the recent designs utilize CNC-routered polyethylene panels faced with molded glass panels shop fabricated to the desired specifications, then attached to the constructed frame, allowing difficult surfaces to be constructible. The Hungerburg Funicular has 2,500 uniquely fabricated parts, yet the project was constructed on time, and allowed last minute changes.

The computer had been used as a tool to compute the form, as the building is manipulated and distorted it complicates the frame and the resulting structure, which has to be engineered to allow natural vertical and lateral forces through the building. The computer had also refined out the contradictory or complex building systems, which previously had adapted, clashed, and discontinued due to complications of the confluence of various systems. The computer had been utilized to achieve fluid nonlinear buildings, to achieve her expressive thoughts; it acted not as a generator but enabled design throughout the design process. She embraced technology as a tool similar to the paintbrush and canvas to re-envision the built and spatial environment.

26. Mertins, Detlef, Patrik Schumacher, Zaha Hadid, pg 23-32
27. Meredith, Michael, From Control to Design: Parametric/Algorithmic Architecture, 180-186

Figure 128. The World (89 Degrees)
Figure 129. Conceptual Painting of LF One Pavilion
Vitra Fire Station

Conceived as a small volunteer fire station, this highly angular and sculptural building was envisioned at the nexus of energy drawn into the Vitra furniture factory. Completed in 1994, the Vitra Fire Station was Zaha Hadid’s first completed project, and brought critical architectural acclaim to her office that was largely known for conceptual work, and dynamic paintings. Vitra proved that the deconstructivist architect could translate concepts into dynamic construction. The conceptual painting depicted a peripheral angular building wedged and transformed with suction force into the heart of the factory.28 Her conceptual world was skewed and integrates the forced perspective into the curving horizon line, forcing lines to deflect and bend into curves. Expanding her fluid paintings from the canvas to reality, Vitra does more than an architectural massing that representing a painting,29 but its sculptural fluidity was enhanced with extended volumes, sliding spatial relationships, controlled lighting, and variable transparency. Within the small building, space flowed between, volumetric overlapping, independent curved forms, a sliced floor plate, folded or floating planes, and large glass apertures. Ada Louise Huxtable said “Hadid’s fragmented geometry and fluid mobility do more than create an abstract, dynamic beauty; this is a body of work that explores and expresses the world we live in.”30


Figure 130. Conceptual Painting of Vitra Fire Station
Figure 131. Unknown, Exterior Entrance of the Vitra Fire Station
Figure 132. Exterior of the Vitra Fire Station
London Aquatic Centre

Designed and nearly completed as the gateway building for the 2012 Olympic Games, its double-curved fluid form captured the watery signature of the Olympic natatorium. It has been compared to a wave, manta ray, or following an anthropomorphic diagram of butterfly swimmers, however the shell is shaped by seating and structural requirements. The complex space-frame allowed the sides without columns, which would obstruct the massive side seating pavilions planned for 14,427 fans. Because of the rear sightlines the large seating pavilions, the roof profile raises in the center, helping to establish a fluid curved shape. The 2,000ton structure rests on three supports, and is column free for 160meters long and 90meters wide. The wavy roof form expresses the shape and the loading diagram of the complex roof structure. The three dimensional shape was constructed by varying the two dimensional profile of “relatively simple” flat trusses. The primary structure consists of six major fan trusses spanned the entire length of the building, while four partial fan trusses transferred forces from the cantilevered side wings. On the edge of the long section two arched trusses inclined outward and assisted tying the diaphragm together. Completing and infilling the structure cross members tied the fan trusses together unifying the independent trusses. Additional smaller aluminum purlins were curved in one dimension were required to smooth the lofted surfaces. Structural decking was mounted to the purlins, then clad with Kalzip aluminum standing seam roof, and the underbelly was clad in Brazilian Red Lauro wood. Most of the attention was placed on the roof, but the building also has much spatial fluidity and transparency. Under the wings, the post-Olympic facility was to have large glass windows that separate the roof structure from the ground, and allowed space to flow under the roof and through the elliptical main space. The steel and glass building is a keynote building and was the games second most expensive building especially after its construction cost tripled its projected budget, but “Come 2012, we’ll have a series of venues that are a testament to UK construction and engineering,” said by the project manager of Balfour Beatty, Stuart Frazer.
32. Lane, Thomas, The Big Lift: The 2012 Olympics Aquatic Centre Gets a Roof, www.building.co.uk/buildings/the-big-lift-the-2012-olympics-aquatics-centre-gets-a-roof/3137013.article

Figure 133. Natatorium Structural Diagram
Figure 134. Renderings of 2010 Natatorium
The expressive forms of the Japanese architect Toyo Ito, constantly experiment with structure to provide habitable clothing. The aggressive structures use geometry and patterns and leads to new spatial conditions and unique conceptual buildings. Numerous Japanese form architects have worked and interned under Ito, making the firm an experimental laboratory. Fluid forms follow sensuous curves and evolve architecture from static form and geometry into an “intense geometrical development of matter.” Turning away from compositional design, Ito distorts and deform grids to fit programmatic needs. The emerging grid was the resultant of the experiments with meshing structural grids. Through mathematical patterns and distorted geometry, buildings morph into a continuous curvilinear three-dimensional surfaces enclosing and expanding space. Pattern design takes a natural approach where trees grow in relation to existing conditions such as light, wind, and balance. A simple opening spurns forces to move and with relational continuity patterns are formed, creating a correlation between structure and openings.
Island City Central Park

The Island City, an artificial island surrounded by the sea and planned 400 hectares city with a 15 hectares park. The fluid objective of the park utilizes the change of topography to provide various programmatic activities. Toyo Ito’s “hill-like architecture” takes the fluid nature of the park and extends and blends interior and exterior space. The rolling 190-meters reinforced concrete shell was implanted with a green roof to appear as the landscape easily melds with the structure.35

Hidden under the greenery, the extremely complicated and labor-intensive 40cm thick reinforced shell. The reinforcing steel bars measuring 16mm in diameter, with a 150mm spacing interval and in some places a 75mm spacing interval. Most of the rebar follow a common direction, however in complex geometrical situations some rods are placed in radial or in circumference against the curved surface. Tie-beams congregate eight by 21mm diameter steel rods to collect thrust and tensile forces from the dome-like roof and walls.27

2000 cubic feet of concrete cast by 400 workers, yet the most troubling part of construction was the heavily complex formwork. Traditional and steel mesh formwork were erected and removed to “achieve the smooth free-curved reinforced concrete shells.” The plywood was mostly cut to 1x2meter, in some spots 1x1meter, and smoothly joined precisely into the curved surface. None of the surfaces were traditional flat slabs, and were difficult to construct due to “bacon frying in a pan” shape and dimensions of the project.27

35. Takenaka Corporation, Island City Central Park Gringrin, www.takenaka.co.jp/takenaka_e/majorworks_e/topics/2006/sp/01.html
27. Meredith, Michael, From Control to Design: Parametric/Algorithmic Architecture, 78-90
Figure 139. Interior of Island City Central Park
Figure 140. Aerial View of Island City Central Park
Visionary architect and educator Greg Lynn, attempted to re-envision the world with three-dimensional sculptural building environments. Lynn’s hybrid approach to design melds computer virtual animation with genetic mutation. Architects have a history of challenging of architectural norms and tradition, Lynn compares the 1950’s science fiction movie “The Blob” the turn of the 20th century architects of the Art Nouveau and Expressionist, “because they were the first to break with the classical order, the first to jump right into new methods of fabrication, and they worked with abstractions of nature.” The highly organic amoeba-like form driven from conceptual evolutionary biology and developed by complex mathematical formulas, are reliant on computer technology not only for drafting and rendering but aide in conception, calculating, and develop construction methods.

20. Lynn, Greg, Form, pg.14-20
19. Lynn, Greg, Animate Form, pg. 26-30
Figure 141. Large Scale Model for Embryological House
Embryological House

Displayed at the 2000 Venice Biennale, Lynn and his office used the computer program Maya to create images of blob-like buildings and with fabricated wood and plastic models, which Herbert Muschamp called “a genuine mutation, a natural response to the displacement of bricks and mortar by virtual space.” The highly conceptual houses were a result of research grants from International Design Forum, and the Wexner Center for the Arts. The multitude of houses was spurned out of discussions with an automobile manufacture comparing the assembly of craft in architecture and how automobile design was hampered by the lack of high skill workers, even with the high level of computer manufacturing. Contemporary homes were considered kit of parts, and customization of the homes consists of changing the products or quantity of parts within the kit. American homes were assembled on site, yet 40% of the independent pieces were constructed in factories. The Embryological House realized the economic reality of the construction process, yet utilized different industries and new technologies to manufacture new environments. The concept takes a monocoque shell from the automobile and airplane industry to integrate independent components into a system, thus reducing or eliminating the need for separate parts. Similar to biological beings, the unified constructive systems also reflected into a spatial cohesive morpho-space. The design process utilizes computer programs to generate the forms, the architect designs the seed and the computer mutates the form based on inputs from client, program, site, and context. According to evolutionary biology, mutations such as the thumbs required a high level of information, and symmetry was the result of lack of information. The more input develops more complicated forms and interactions between forms, the architect must also predetermine the minimums and maximums to control endless possible mutations.

37. Lynn, Greg, www.embryological.com
Aluminum and glass double-skin acts as a filtering enclosure to streamline the spatial design of the conceptual Embryological House, which has no punched openings but seamlessly clothe the undulations and indentions of the fluid form. The translucently of the building relates to the position of numerous aluminum rotating louvers similar to Venetian blinds. Filtered daylight smoothly enters the interior of the space as variable gradients, which change depending on climatic or programmatic input. The screened space created a aqueous space of constant and even light levels, within the volume of wrapped environment. The interior of the house was reminiscent if a car interior with its surfaces clad in plastic, upholstery and veneer. On the upper floor the built-in furniture was wrapped into the floor, as the floor deflects and bulges to embed, create, or accept tables, chairs, tubs, and other appliances into the fluidity of the space. The fluidity of space transgresses to the exterior as landscaped berms created a series of wave mounds, in which the house nests into. The ground plane slopes to meet the entries but in some perspectives the house appears to float above the ground. The Embryological House used principals of animate mutation and computer simulation to envision a new domicile that “You should really feel as you’re living in an animal.”

36. Dery, Mark, www.artbyte.com/mag/nov_dec_00/lynn_content.shtml
20. Lynn, Greg, Form, pg.
Figure 142. Renderings for the Embryological House
Figure 143. Diagram for Potential Forms: Embryological House
Korean Presbyterian Church
Douglas Garofalo, Greg Lynn, & Michael McInturf

The 1999 transformation of the Knickerbocker Laundry into the Korean Presbyterian Church included renovation of existing building for accessory functions and the sanctuary addition was constructed on top of the former factory. The new sanctuary was literally placed on the roof of the factory, with its independent structure dropped through the existing construction. The iconic ribbed coverings for the emergency staircase, or signboard, kept the industrial aesthetic, while representing the exterior extension of the metablobs and the spatial structure of the sanctuary. The design process separated from typical geometry and historical church design, but was a product of digital invention, calculations, and production. The structure used constant 22foot open web joists, constructed at variable distances giving an undulated shape with a tight economic budget.

20. Lynn, Greg, Form, pg.84-94, 314-315

Figure 144. Exterior Shells of Korean Presbyterian Church,
Figure 145. Interior of Sanctuary of the Korean Presbyterian Church
Figure 146. Exterior Fire Stair: Inside of the Shells
Figure 147. Conceptual Diagram of the Korean Presbyterian Church
The sanctuary was diagramed with parallel blobs expanding to the conical shape of an amphitheater. From the seating area, the faceted ceiling and walls conceal ventilation registers, light fixtures, doors, windows and other necessary fixtures to create a smooth surface for the cultural confluence of the sanctuary.\textsuperscript{20} The segmentations also diagram the real structure and the oscillating roof above the sawtooth drywall ceiling. The sawtooth ceiling was not a regular angle throughout; but defined as a lofted surface between segmented curved forms directly within the structure. The curved forms were offset to leave gaps and filled by the angled surfaces of the iconic sanctuary.\textsuperscript{38} When the expanding forms breach the exterior walls, seven structured shells jut outward covering an exit staircase and capturing a striated view of Manhattan. The steel framed shells have metal cladding on the exterior and hide the steel manufactured within numerous workpoints and light-gauge joists torque to meet the warped planes, which were dictated by the architects digital model.\textsuperscript{39} The expanding forms within the sanctuary space, dynamically form a fluid sanctuary space which segmented into bands to visually blend spaces and conceal distracting elements within the articulated space. The Korean Presbyterian Church, a unique project as it was an early and one of a few built projects of Greg Lynn, who is famous for blobitecture, fluid design, and intervening digital media within architecture and its fabrication.

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{sanctuary_interior_panorama.png}
\caption{Sanctuary: Interior Panorama}
\end{figure}

\textsuperscript{20} Lynn, Greg, Form, pg.84-94, 314-315.
\textsuperscript{38} Stegers, Rudolf, Sacred Buildings: A Design Manual.
The proposed University of Cincinnati Boathouse was designed as a part of a Spring 2001 student seminar at the University of Cincinnati. The project was designed for the currently-defunct UC Women’s Varsity Rowing Team on the banks of the Licking River, a small tributary of the Ohio River. The project studied the mechanics of the rowing motion to create a diagram then translated with program to envision the fluid form. The motion diagram was segmented to form overlapping enclosures, related to the fluid diagram. The segments formally added levels of engaging spaces, intense visual interest, structural layering, and continuous spatial relationships. The diagram was transferred to the site embedding spatial connections with the building and the surrounding site.\(^{40}\)

The project was intended to develop and work with the university architects’ office, yet various forces within the university including the loss of the Women’s Rowing as a varsity sport that led to the demise of the project.

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40. McInturf, Michael, www.mcinturf.com
Figure 149. Rowing Motion Conceptual Model
Figure 150. Translated Motion Diagram into Overlapping Enclosures
Figure 152. Interior Schematic Design
-Form Inspiration

As the focal building within the aquatic oriented park, the natatorium’s animate form followed animate diagrams of bodies in the swimming motion. Following the Futurist art movement of collapsing time frames into a single canvas, the natatorium massing reflected the apparent swimming stroke. Competitive swimming required the coupling physical strength and technical finesse. Four unique motions have a history and have been developed to efficiently propel one through the dense medium of water. Years of practice and instruction were required for efficient body position and control to achieve higher echelons of competitive swimming. Gathering diagrams by analyzing the separate strokes gives the architecture a unique opportunity to create a new environment. The spatial conditions go beyond programmatic need of a pool, but intimately connect the body to its surroundings.

41. Guzman, Ruben, The Swimming Drill Book, pg 1
Figure 153. Compiled Motion Diagram: Breaststroke
Figure 154. Compiled Motion Diagram: Butterfly
Figure 155. Compiled Motion Diagram: Freestyle
Figure 156. Compiled Motion Diagram: Dolphin Kick
Rotational Strokes

Freestyle

The fastest of the competitive strokes, it uses leverage and body roll to maximize propulsion. The swimmer swims on ones belly using the flutter kick and the overhead front crawl stroke. The front crawl is the typically interchanged with freestyle but freestyle technically could be legally swum in any possible way. Freestyle is constantly being tested, tweaked, and improved to provide the fastest results. Instructed to Roman soldiers to help conquer or evade enemies, it was seen as a strategic advantage to swim across a body of water.16 After the fall of the Roman Empire, organized teaching of swimming became a memory, until the renaissance an the enlightenment only high influential people could possess the knowledge of swimming. Australian Richmond Cavill, and indigenous “crawling” swimmer Alick Wickham, is credited for the early development of modern freestyle.42, 43

16. Leeuwen, Thomas van, pg 17-19
42. Williams, J.G., Cavil, Richmond Theophilius, adbonline.anu.edu.au/biogs/A070720b.htm

Figure 157. Compiled Motion Diagram, Freestyle
The muscular core of the body produces much power that is transferred to the extremities. It should be realized that the core strength of the body unites the kick and the arm pull into one fluid motion. The hips and abdominal muscles produces the body roll along the long axis on ones body to maximize and elongate the arm pull to catch more water. Like a metronome the body roll controls the rhythm and pace of the stroke. Rotational hip speed directly control the turnover of the kick, so if the body works in unison- the faster the kick sets a faster roll that sets a higher turnover of arm speed. Breathing is worked into the body roll and rhythm of the stroke. As imagined inhaling oxygen is important but difficult when ones face is submerged in the water. Because the head position relates to spinal position, if the head is too high the spine and feet will sink lower, the head needs to stay inline and down facing when not breathing. When an inhaling breath is needed the head will roll insync with the body roll and rotate to the shoulder above the water line. As the arm rolls past the head and back into the water, the head follows and rotates back into the inline postion.41

41. Guzeman, Ruben, pg 115
Figure 158. Physical Motion Diagram: Freestyle
The arm pull generates much of the propulsion, as it utilizes leverage of the arm length to maximize muscle strength. The hand is the first to enter the water, at the pinnacle of an outstretched arm. The hand catches the still water and starts to pull the body past the hand. The hand continues to point to the bottom of the pool, and perpendicular to the desired direction of thrust. As the body rolls past the hand, the arm begins to surface and the swimmer accelerates the arm speed to push through the last phase of the water stroke.\textsuperscript{43} As the hand leaves the water, the negative resistance of the air allows the momentum from the accelerated arm to effortlessly swing past the shoulder and back to the front of the stroke. The overhead recovery provides momentary but essential rest for the arm and shoulder muscles, thus allowing greater endurance especially for long distance swims. The overhead recovery is the most visible part of the stroke, but is also important in setting the turnover/ tempo of the stroke.\textsuperscript{41} It is possible to have a turnover faster than the body roll, but not recommended for it takes away the body syncing and transferring power to the arms.\textsuperscript{43}

The flutter kick utilizes the largest muscles in the body churns the water. The scissor motion kick maximizes the power of the quadriceps with straight legs acting as lever arms to create the most leverage. Churning phenomenon is given by the smaller amplitude six-beat kick per one body rotation, which is optimal for sprint swimming.\textsuperscript{43} Because of the size of the quadriceps, they generate power but at the expense of more oxygen, and with the difficulty of breathing oxygen, one would develop different kicking speeds. The variability of kick speed influences body roll speed, and if slowed one could provide a slower but more arm-pull-centric stoke leading to a more efficient and elongated stroke.\textsuperscript{41}

\textsuperscript{41} Guzeman, Ruben, pg 115
\textsuperscript{43} Maglischo, Ernest W., Swimming Fastest, 161-166
Backstroke

Developed into the second Olympiad, the 1900 Paris Games included the first backstroke event. Early developers reversed the body position of the freestyle, yet kept the circling arm motion pushing water. The 1936 Olympic Backstroke champion Adolph Kiefer, further developed the backstroke by altering the arm motion by bending the elbow and use body leverage to pull water, instead of pushing water during the catch phase.\textsuperscript{44} Backstroke has continued to develop from the inverse freestyle into its own competitive, recovery, or recreational stroke.

Due to the inversion of body position, the swimmer must be able to be comfortable and relaxed on their back. The relaxation will aid spinal position and help to control the dynamic body roll. The backstroke arm pull is developed for the hand of straight-arm to enter the water behind the head. The hand instantly catches the water, and starts to pull the body toward it. The elbow of the arm bents to roughly a 90° angle, and the body roll glides the body to maximize the strokes power and engaging the pectorals and other front muscles. As the body moves past the hand, the hand accelerates and the elbow straightens to push water until its exit. This straight arm rotates up toward the next entry point. Backstroke reverses normal shoulder rotation and can cause shoulder problems because of the dynamics within the rotation.\textsuperscript{41}

\textsuperscript{41} Guzman, Ruben, pg 85
\textsuperscript{44} International Swimming Hall of Fame, ISHOF Gold Metal Award: 2007 Adolph Kiefer, http://www.ishof.org/awards/gm2007kiefer.html

Figure 159. Compiled Motion Diagram: Backstroke
Backstroke has the inverted flutter kick from the freestyle, but due to the reversal of body position it has more intense kick. The flipped orientation reverses the powerful downstroke segment of the kick to go upward, toward the surface of the water. If body position is not correct, the spine will start angling downward and the feet will sink and will cause more energy to be spent to raise the feet to the surface.\textsuperscript{41}

Figure 160. Physical Motion Model: Backstroke
Symmetrical Strokes

Breaststroke

Instead of a longitudinal axis of the rotational strokes, breaststroke has a line of symmetry running through the body. Through the stroke the shoulders stay square toward the direction of movement, which keeps the head facing forward. First developed for a swimming military, during the enlightened period of Renaissance Era. Early breaststroke is ideal for fording water obstacles, especially for the military. Constant head position has the ability to stay above the water and lets the eyes stay in contact with potential targets. A swimmer could keep a dry firearm on the back, because breaststroke can be swum to have the back above the water level. Teaching breaststroke can be easier than other strokes as the head can stay above the water, which removes panic of drowning and can instill early confidence. As competitive strokes developed, breaststroke also developed especially in the 1930’s, which development spurns off to develop the butterfly. In the 1952, the official separation of butterfly and breaststroke allows a regulated breaststroke to return. The purifying regulations also led to the requirement of the head breaching the water surface on every cycle of the stroke, increasing the body’s exposure to water’s resistance. Current competitive breaststroke has variability between individuals, body type, and coaching, yet remains the slowest competitive stroke.
Even though breaststroke has much individualization, it has a definite legal sequence- pull, breath, kick, glide. Starting the motion in the outstretched streamline position, the hands separate outward catching water. As the hands rotate to point toward the bottom of pool, they act as anchors pulling the body toward them. The elbows bend to 90° directly under the body, just as the hips undulate and the back arches up. While the hands compress the water start to rotate toward each other, the head surfaces to breath. As the hands face the surface of the water, the hips undulation continues as the head starts the dive back to the water. Within this stage the legs separate, bend at the knees and start an outward rotation. The hands slip forward toward the streamlined outstretched position; some people elevate the hands above the surface to reduce drag. As the body undulates back to a streamlined position, the legs continue to whip around, producing thrust as the body enters the glide phase.41

Figure 162. Physical Motion Diagram: Breaststroke
Butterfly can be the hardest to learn and master but from an outside observer it could be considered the most graceful and beautiful swimming stroke. The youngest of the strokes has derived from the breaststroke in the early 1930’s. In 1928, David Ambruster started researching and filming swimming strokes. In this research, he discovered the dramatic inefficiency of breaststroke’s underwater recovery, or the hands pushing back to the beginning of the stroke creating active drag against the water. He developed and in 1934 introduced the double overhead recovery synonymous with butterfly, significantly increasing the speed of the stroke. Developing the legs to kick in unison, the dolphin kick, Jack Sieg considerably dropped more time but was considered illegal for breaststroke until the official split of the two strokes in 1952.  

Unlike the appearance, butterfly starts with the undulating hip motion resulting in a serpentine body motion to be transferred through the entire body. The motion transfers up the spine providing core muscles transmit power to the extremities. As the shoulders drive down into the water, the hands start to catch water. Immediately after the catch, the elbows bend to engaging and uniting the biceps, triceps, deltoids, trapezius, pectorials, and latissimus dorsi into one powerful stroke. The hands anchor at shoulder width apart then move slightly outward before curving back under the body. As the arms pull accelerate through the stroke, the hips kick reversing the dive into a surfacing motion that allow the arms to catch more water furthering the anchor as the body glides past. When the arms pass directly under the body, the hands continue to accelerate pushing water toward the legs. As the body moves curves upward, the head and shoulders surface exposing opportunities for breathing and arm recovery. Moving the fastest at the exit, the hands use the momentum of the finish to quickly rotate forward and through the less resistant air. Body geometry dictates that arm swing hovers less than 2 inches over the water surface. Straight-arm recovery ensures momentum to be carried through to the catch of the next stroke.
The dolphin kick used in the butterfly uses a double kick, which goes beyond the singular ‘major’ kick that controls the body undulations. A minor kick is typically added between the body undulations to produce more thrust, that places the body within a better positioning. It is arguable that the upkick of the dolphin kick produces thrust, but positions the upper body in a better position for immediate power and essential at arranging the feet at the peak for the powerful downkick. By doubling the tempo of the kicks, it adds efficiency by getting more propulsion per stroke. Adding the minor kick against the body undulations, it flattens the stroke to change the angle of attack of the entry. As the arms recover and the body is on the upswing, the minor kick drives the body forward appearing as the swimming downhill.41

Butterfly can be an efficient stroke and the uniting the double arm pull with the body undulations produces the greatest measured swimming speed. Combining the non-thrust phase from the double-arm-recovery to the powerful double-arm-pull slows the average stroke-cycle time below a speedy freestyle, which generates thrust in all phases of it stroke.

45. Sowers, Virginia, Splash Back, pg 50
41. Guzeman, Ruben, pg 161
Figure 163. Compiled Motion Diagram: Butterfly
Figure 164. Physical Motion Diagram: Butterfly
In studying the dolphin kick, the fluid motion of the body undulating through the water was translated into a fluid roof-scape. The diagram was taken from the composition of phase portraits of the dolphin kick. The diagram led to the creation of study models dictating the body position in relation to the time. The digital simulation choreographs a swimmer going through the kick. Composing separate portraits were taken as the hands move three inches; the split second recording documents body position.

In tracing the separate portraits, spines were created and were drawn parallel to each other. A transparent plexiglass model was laser cut using the splines, then assembled to produce a three dimensional model. As the 26 body splines sequence through the model, the small hip wave is transmitted to the more flexible knees and feet causing an increase of amplitude of the plexiglass wave. The frozen motion sequence of the model dissects time into a sectional diagram, allowing time to become the canvas of the model. The model succeeds in capturing the desired dynamic fluidity with the combination of transparency of the material and the growing sequence of wavy splines.

This successful model was applied to produce architecture. The anthropomorphic wave acts as an articulated plane, which could serve horizontally as an articulated ground-plane or roof-scape, or could be applied vertically as a wandering wall. This model was applied as an articulated roof, to shape the interior spaces and give opportunities for a roof garden to blend the exterior into the park. The model had difficulty expanding from an articulated plane to a sculpted spatial environment. As a wavy plane, it has difficulty folding into walls and enveloping space. Due to this difficulty, the concept has to rely of other influences to complete the envelope, thus looses depth and clarity as the project moves forward.
As the project did not shape space, it also did not dictate program or relationships between spaces. As the articulated plane floated above the pool deck, the aquatic environment could be negatively criticized and compared to a vast warehouse, where the lack of influence between the pool layout and the roof was increasing apparent. The pools had to be designed within a separate program, and as the separate space shaping influences infiltrated the purity of the concept, the project development become muddled.

As the concept developed into a building, simplified structural systems make the dynamic curves into a muted folded plane. The striations of the plexiglass model were made possible by 90° turning separate flat segments that were cut into curvilinear splines. The model was further abstracted to simplify the structure as a plane supported onto beams and girders. The girders are placed at angles to allow the diaphragm of beams and concrete decking to undulate similar to the concept. As the surface of the conceptual model jumps between striations, due to the acceleration of the diagram in relation to the time recorded, opportunities were envisioned for apertures for daylighting and natural ventilation. These opportunities close as the diagram develops, and the surface simplifies into a folded plane.

Figure 165. Compiled Motion Diagram: Dolphin Kick
Figure 166. Conceptual Model: Dolphin Kick
To assist the inadequacies of the motion diagram, the idea of the undulated plane was coupled with the earlier research of early floating pools. The programmatic idea of an artificial atoll, an island surrounding a body of water, was developed to further separate the surrounding desert environment from the inner aquatic environment. The visitors would strengthen their bond with the lake and envelope themselves within the body of water, which is illegal to physically submerge oneself in. Pools were placed inline with each other to reduce exposure to floodwaters, and efficiently control the perimeter to aid construction of the atoll within Tempe Town Lake. The diagrammatically articulated roof-scape extended the park into the lake, furthering the non-pool environment for general public. The undulation of the dry-park offers visitors a fluid landscape without physical water, which xeriscaping is important for public projects and the habitants of the arid Sonoran desert. Transformation2 is required to try to solve conceptual and spatial gaps discovered in the design development.

Figure 167. Schematic Design Model
Figure 168. Schematic Form Diagram
Figure 169. Schematic Sectional Drawings
Within further review of the strokes, it was decided that all the strokes were too dynamic in many body parts anchoring, churning, flipping, or whipping water behind the swimmer. Collage models were developed to overlay separate strokes on top of each other. Within the study, the recovery aspects of the freestyle, backstroke, butterfly, were the most obvious and most familiar parts of swimming. Due to the water masking much of the swimmers motion, observers of competitive swimming instantly recognize the recovery, with the arms flying into the air. Hidden under the churned surface is the real dynamics of the stroke, and so also the most obscure of the publics envision of swimming. So as pop art or architecture, the recovery of the swimming strokes was chosen based on the public’s ability to recognize the form of the natatorium. On the exterior, the ground plane would act as the water surface, passively hiding the remainder of the swimming motion.
With the collage models, the most successful was gauged not on interesting compositions, or showcasing the pure dynamics of swimming, but to have the greatest spatial potential to develop and house a large program of pools, decks, mechanical rooms, locker rooms, and additional support spaces. The rotational motion of the outstretched arms of the butterfly recovery has the greatest potential in the amount of enclosed area. When collaged with the spinal rotation of the freestyle, the fan-like form of the butterfly forms asymmetry, develops spatial relationships, and creates various heights to empower various programs. Shifting the symmetrical fan-like form, along the spine, furthers the collage of the two strokes and separates the form into two separate wings, with various programmatic functions in both.

Faceting

For the sake of construction and structural development the fluidity of the form was simplified into large faceted planes. Keeping the separate phases of stroke motion and the relative heights constant, the separate planes are adhered together to form the roof-scape. While visually maintaining the large-scale fluid form, the fluctuations of the planes also serve the program housed within. The conceptual and structural spine of the building runs down the center of the building, while the exterior walls bend out of vertical to go perpendicular with the articulated plane. The enveloping of the space with canted walls and roof surfaces, the interior of the space forms into a dynamic environment. Encapsulating the space allows further development of the concept into spatial development; unlike the difficulty of the original transformation this concept remains intact without additional references to assist in development.

Figure 168. Schematic Form Diagram
Figure 171. Schematic Model: Collage of Freestyle + Butterfly Motion
Figure 172. Schematic Model: Collage of Freestyle + Butterfly Motion
Figure 173. Single Faceted Form
Structure and Envelope Assembly

The structural spine running down the building consists of 20-24 inch x 48 inch columns constructed 14 feet away from each other. On the other side of the long span roof structure, the gravity loads and lateral loads are transferred to the steel structure hidden within the slightly canted enveloping walls. Smoothing the interior of the building thus hiding the tectonics of the structure, lighting, systems, a ceiling of the natatorium that has been placed within the space. Due to the hidden aspect of the long-span structure various systems can be investigated, and evaluated. A long-span girder and truss steel structural system was developed to span the cross-pool distances and create a diaphragm to absorb all gravity or lateral loading. The steel structure is figured to be lighter weight and easier assembled than a concrete structure. The steel structure also could be factory manufactured with standard recycled steel, and shipped to the site. Workers work with universal fastening techniques to join the unique pieces. Once the structural members are assembled, either decking or light gauge steel framing completes the envelope. With the material consistency throughout the diaphragm and envelope, steel was favored, but other options were investigated.
Concrete structure was originally eliminated due to rising cement, labor and formwork costs. In looking at the complexities of the shell construction of the fluid shaped Island City Central Park, the 40 cm thick cast-in-place slab contains 2000 cubic feet of concrete and has heavy labor to construct the complex temporary formwork with intensive internal rebar buried within the slab. Many buildings within the Phoenix area are efficiently assembled using various pre-cast concrete techniques, however this building does not fit the criteria for efficient assembly. Pre-cast efficiency is the resultant of a redundant process manufacturing identical pieces, to be assembled on-site as a kit of parts. If the natatorium design were segmented, many pieces would be one-off with no redundancy. Instead of crews efficiently assembling joints, construction crews would carefully craft a multitude of unique joints between unique pieces. Joining pre-cast concrete pieces with expansion joints, can by problematic and bulky, especially within the diverse climate conditions within the Sonoran Desert.

A hybrid construction of methods could lead to tilt-up concrete panels bolted to the steel skeleton. The main wall envelope could be completed with local labor specialized with the techniques of tilt-up construction. The walls are poured on the ground, after the flat slab cures it is lifted and vertically tilted by the one site crane. Embedded into the poured concrete are fasteners, which bolt to the inner steel skeleton and the mountings for the corrugated metal solar shield.
Program Infill

The conceptual shell of the completed form is roughly 40 percent larger than the projected program. Included within the program is large deck space and large ramps that take patrons safely between levels, although large portions of the form were truncated out of the form and keep the conceptual intent. Within the north end of the form, the lack of program hollows and reduces the form to a faceted roof canopy. On the southern end of the form is truncated at a facet joint, as the completed form would run aground. The bridge at the entrance traces the footprint of the continued form. The eastern shell is shifted into the center spine reducing the width of the shell by 15 feet and 4000 square feet off the total area. Within the southern confluence of forms, an 1100 square foot triangular sliver is cut out. The triangle is formed between the spine reference line and parallel lines from the faceted eastern envelope.

Figure 176. Infilling Form with Program
Figure 177. Form Encapsulating Pool Creating Aquatic Environment
Figure 178. Subtracting Area from Form
Placed within each radial shell is a programmatically different pool. The pools are spatially separated by a 8-feet of vertical height, varying the pools proximity to the ceiling and creating unique environments related to the programmatic function. The competition pool is placed at the lower level, allowing greatest height for diving boards and amphitheater seating. The higher ceiling helps to alleviate squat proportions of the long and wide space. The smaller upper pool has a more intimate environment, helped by being closer to the ceiling. By keeping the ceiling plane constant between the two wings, spatial relationships flow unimpeded between the diverse environments. The main entrance is established at a middle level, enabling both environments to be easily accessible for all patrons.

Fluid circulation between the sectional differences is established with two sets of ramps and grandstands to connect the 8-foot variation of pool decks. The main ramp located near the mid-level locker rooms and splits to the other levels. One ramp sinks into the lower environment, while the other ramp bridges over to connect the upper pool. The other main ramp slips along side the leisure pool with thick aquarium glass, separating the wet and dry environment. The ramp submerges visitors and enables underwater observation as one progresses between aquatic environments. Spurring off the lower end of this ramp, a staircase lowers to the diving and competition pool’s underwater observation room and mechanical rooms.

Figure 179. Section Perspective: Looking North Near Main Entrance Ramp
Figure 180. Short Section: Not to Scale
Figure 181. Long Section: Not to Scale
Figure 182. Plan: Not to Scale
Figure 183. Plan colored for Level Changes: Not to Scale
A ceiling hides structure, ventilation equipment, light fixture, insulation, and undisclosed attic space. A ceiling plane lowers the perceived spatial volume, but also has opportunities for articulation that can assist in development to directly affect the spatial environment. By articulating the ceiling; large spaces can be shaped, altered, or distorted. Vertigo, the sense of unease and a possibly falling has been discovered from overloading the senses that confuse the brain. The vertigo sense is interesting because of its similarities to the dichotomy of opposite senses within the aquatic environment; common senses with water include flotation and sinking, viscosity and fluidity, stillness and flowing, hot and cold, additionally opacity and clarity. Surfaces of the natatorium are articulated to encompass patrons with enclosed environment, yet the ceiling is the only surface so complicated to confuse patrons. The already faceted surface is further complicated and triangulated to enhance visual stimulation. The majority of the ceiling is triangulated and pulled out of plane breakup the massive surface. The articulations hide or reveal light fixtures and ventilation registers. As the ceiling plan dictates placement of light fixtures directly resulting in the atmospheric lighting effects and light levels. Over the competition pool the ceiling plan calms to rectangles to not interfere with backstrokers using the ceiling to guide them as they race straight across the pool. The articulations intent is to gently alter and retune the typical perceived senses within the vast natatorium space.

The decking of the pool decks is the least articulate, but intended to blend with the water surface. The neutral-colored ½ inch mosaic tiles, is seen to compliment and not compete with the surrounding articulated surfaces. The water and the decks are envisioned as a reprieve to help tame the surrounding hyper environment.

Figure 184. Section Perspective: Looking South Through Competition Pool
Interior Surfaces

Translucent blue glass panels clad the interior of exterior walls and mimic water qualities to enhance the aquatic environment. The reflective glass follows the canted and bent structure of the enveloping walls. A blue pattern within each panel simulates wall texture to the massively shaped walls. The translucency of the wall material allows backlit light to blurrily glow emanated beyond the glass. Using the glass to filter the tectonics of necessary fixtures, the wall surface is smoothed and streamlined to encapsulate the pool atmosphere.

The 20 central spinal columns and sectional dividing wall are constructed as rammed earth, showing layers of desert soil as a central texture. Rammed earth appearance of stratified layers of naturally colored soil, yet has the structural bearing similar to concrete. The dry mixture of natural colored soil and Portland Cement is compacted so that the water within the stratified soil produces a chemical reaction with the cement. Absent from the walls, is the typical grey coloring of concrete, synonymous with the typical cement-rich concrete slurry. The rammed earth, with its similarities to stratified canyon walls, posses the connection with the Arizona landscape. Within the 8 foot exposed edge of the sectional difference, the layered representation of the desert soil serves as an interior landscape. A landscape hosts the pools and is encapsulated by the natatorium and its aquatic environment.

Figure 185. Structural Diagram
Figure 186. Reflected Ceiling Plan
External Surfaces

The rusticated walls of the natatorium fit into the language and context of vernacular and modern architecture within the Sonoran Desert. The rusted metal often signifies the presence of water, so that the natatorium’s rusticated walls fits within the program and its site conditions near the Tempe Town Lake. The rusted metal are the visible outer element of a complex wall assembly forming an environmental barrier between the aquatic interior spaces and the surrounding desert. The rusted metal are mounted to the insulated structural walls. A majority of the exterior walls of the building are clad with a rainscreen of corrugated metal with a rusted patina. The rainscreen, the common name for a cladding system to be applied beyond the wall envelope with an airspace separating the two systems, is not intended to protect the building from the desert rain, but is really intended to protect from the sun. The corrugated steel rainscreen is applied to the walls with 3½-inch light gauge metal studs. The rainscreen shades and protects the building from direct radiation of the intense desert sun. The 3½-inch air space prevents the heat being absorbed by the metal screen, to be transferred to the insulated wall. Bottom edges of the metal cladding start 9-inches from ground and grills at the roof level help ventilate the air space, and also prevent heat buildup along the exterior wall. The structural walls harness all gravity and lateral loading, provide mounting support for the window systems, house the vapor barrier, the exterior of this wall are plastered with a three-stage concrete stucco, and provide mountings for the interior finishes.

The glazing is fritted with an amorphic pattern to filter light and produce water like shadows. The frit pattern is applied to the glass at the factory, and as daylight enters the openings the shadow pattern moves to various surfaces, including reflecting and refracting within the pool.

Figure 187. Section Perspective: Looking South- Through Competition Pool
Apertures

Apertures such as windows and skylights penetrate the formal shell, and connect the interior of the natatorium to the larger desert environment. This connection strengthens the bond between the interior and its surrounding context, and creates stronger genius loci, or the spirit of place.

A variety of operable openings are used to enhance usage, allow egress, daylight, and ventilation. The openings ability to close and gives the building adaptability to changing conditions, security, and different program uses.

Large sliding doors physically connect the internal environment to the exterior landscape articulated to match the form of the building. The large plate-glass doors are slid to allow human passage between both environments. Its variable porosity enhances the connection between the landscape or to be closed to secure the building.

Above the sliding doors are glazed garage doors with the sole purpose of natural ventilation. The high ventilation windows are required to let air move through the building, without having a breeze move across the water surface chilling wet patrons beyond their comfort zone. To provide cross-building ventilations the high windows are placed multiple sides of the enclosure. Natural ventilation will reduce cooling need and utility cost during most months of the year, even if it is impractical for sole climate control during intense summer months where temperatures are regularly above 110°.

Figure 188. Section Perspective: Ventilation Diagram
Figure 189. Aperture Study
Figure 190. Skylight Study
Figure 191. Section Perspective: Skylight Study
Skylights penetrating the roof and ceiling planes flood the natatorium with Arizona sunlight and optically vent the interior space into the typically blue sky. The skylights decrease the distance between the ventilated wall openings, natural ventilation losses effectiveness as the distance between openings becomes greater. The open skylights prevent and neutralize heat build-up under the roof shell, helping to lower cooling need. The openings are triangulated to fit within the articulated ceiling plan, and are placed within the roof as to not insect the spanning trusses hidden in the attic. The triangulated skylights are also similar to the irregularity of apertures found within natural canyonlands. Narrow slivers of the blue sky and abnormal daylighting are characteristics of exploring undulating slot canyons, as in the northern Arizona landscape.

As with the operable windows, all the roof apertures have sliding covers that close off the openings, during inclement weather such as the seasonal but severe summer heat or the torrential monsoon rain. This allows for the apertures to be purely open, expanding the connection with the Arizona sky. The openings also allow equalization of temperatures when wanted; yet during the summer afternoon heat the building can be sealed and cooled to control the interior climate.

Figure 192. Section Perspective: Looking North- Through Leisure Pool
Conclusion

Within the modern desert landscape, the water’s intrinsic value is often overlooked as an available commodity that is artificially brought to oasis-like metropolitan areas. This thesis proposes and investigates in different aspect of in which humans could better interact with public water.

The investigation addresses flaws within the current Tempe Town Lake and leads into the more articulated Tempe Beach Park, which shifts focus toward public water of the Tempe Town Lake. The pathways are realigned and integrated within a landscape to form perspectival corridors, amphitheaters, and a small pedestrian bridge that draws people to the water. These path alterations allow a greater attention leading to a larger possibility of public engagement of the lake. The landscape also partially rebuilds a lost bridge to act as a pier drawing people closer to the heart of the lake. The pier also hosts a canal-like fountain feeding water to a small orchard of citrus plants, which provides a shaded parkscape and a unique desert orchard, this is similar to the original agricultural purpose of the canal system. The canals represent water’s dire connection to desert life and to create a focal point that brings water to the region. The articulated landscape folds into a large waterfall allowing a shallow inlet of sterilized water to seep into Tempe Beach, addressing the lack of public interaction within the larger Tempe Town Lake. Nested within this articulated landscape, sits a unique natatorium, conceived by concepts of human movement through water. The natatorium houses and protects water from the desert environment, which allows public use of the sacred water. Within the sculptural building, the interior is specifically designed to overindulge the focus of visitor’s senses to the aquatic environment. The Revived Tempe Beach Park reenergizes the sensory perception of the aquatic environments and shifts the focus back toward the Sanctity of Water within a desert community.


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