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THE STUDENT DESIGN WORK OF HUTONG: ENGAGED SCHOLARSHIP WITH STAKEHOLDER PARTICIPATION

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1 ABSTRACT

This paper presents a design competition of hutong renovation in China to explore how engaged scholarships benefits to communities while providing students with research and practical opportunities. The site for the design competition is placed at ChongYong Street, Beijing, in which there exist a lot of hutongs. hutong refers to the relatively small alley between the main streets in towns or villages. As a special architectural and organizational structure in China, it's in the spotlights of the conflicts between Chinese traditionally family life and city modernization. The same problem is also found around ChongYong Street. There lacks public open space for activities and the residents’ lives are not convenient. In addition, because the alley is narrow, parking vehicles on the roadside often cause traffic jam. Being intended to solve these problems, the competition invites students who live in Beijing to participate and their research and design will be applied to the city. This paper describes how the competition serves the community while providing students with research and practice opportunities, and describe in detail about the design based on community engagement. Through design, the relationship between the hutong and the modern street has been improved, public spaces have been created, and residents were encouraged to participate in community renovation. As a result, this design has been recognized by residents and judges, and part of it will be applied to the actual hutong renovation, this can provide some useful reference for similar practices.

1.1 Keywords

engaged scholarship; landscape architecture; community renovation; hutong;

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2 INTRODUCTION

In the traditional mode of education, colleges and universities are relatively independent of society and government, research and education are closed, and students lack practical opportunities. As well as landscape architecture is a subject which closely related to the social benefit, colleges and universities seek opportunities for cooperation with the community to achieve mutual benefit. External organizations are involved in engaged scholarship. While providing practical opportunities for students, universities and other organizations have increased exchanges, collaboration, and mutual benefits. It can be said that engaged scholarship, as a new mode of education, creates a new type of contractual relationship between higher education and society. While solving social problems, it creates a unique academic atmosphere that integrates with the community culture, thus enhancing the level of academic research. This paper introduces a case of engaged scholarship, a design competition for hutong renovation in Beijing, China. In this design competition, the organizers have established close ties with the government, universities, community and other stakeholders.

3 BACKGROUND: THE HUTONG IN BEIJING

Beijing is an ancient capital with a long history and was first planned in the Yuan Dynasty. The emperor of the Yuan Dynasty, Kublai, divided the city into fifty "squares". Each "square" was separated by a main road and a secondary road system. There is a narrow road in the “square” for the carriage, that is, the hutong. There are thousands of hutongs in the ancient city of Beijing. The direction is mostly positive east and west, and the width is generally only nine meters. Most of the buildings on both sides of the hutong are quadrangles. Siheyuan is a type of building surrounded by four squares of symmetry in the east, west, south and north. It is usually occupied by a large family and provides a relatively hidden courtyard space. Large and small courtyards are arranged one after another, and the passage between them is an alley. In China, Siheyuan and hutong represent a traditionally family life and are also an important part of Beijing's ancient capital culture.

After the middle of the 20th century, due to the social changes and the rapid increase of population, the courtyard was gradually reduced from a closed courtyard with a single-family life to a large mixed courtyard with many unrelated families. The low rent attracted a large number of low-income tenants, many tenants build private buildings to increase their own housing area, which not only destroys the original appearance of the hutong, but also occupied the narrow public space of the hutong. Under the motor vehicle-led traffic mode, the rapid increase of private cars has made hutong became a parking lot, further reducing the public space, and the conflicts between Chinese traditionally family life and city modernization has become increasingly prominent.

According to this background, the government has paid more attention to the protection of historical district and hutongs. The hutong's renovation has become one of the most important topics of urban public space in Beijing. Since the history of the Siheyuan is a private residence, there is almost no public open space. But for modern life, the open space for activities and leisure is very necessary. Therefore, the renovation of hutong has important significance for the urban appearance and the improvement of residents' quality of life. In the 1980s, several hutong renovation projects were initially carried out in Beijing. Most of the residents were moved away, and then the hutong was transformed into a commercial district with no living atmosphere. This kind of way has undermined the traditionally family life in the hutong and has been questioned. So, purpose of the hutong renovation project has gradually changed to provide residents with a better living environment, and residents gradually began to participate in the construction of their own communities. Residents make their own voices, fully express their appeals, and jointly discuss solutions to achieve community building for public participation.

In recent years, more hutong renovation projects have promoted in the way of design competition, inviting students from various universities in Beijing to participate. While solving practical problems, it also provides students of landscape architecture with a platform to exchange with other students of other majors such as urban planning and architecture.

This paper describes the case of community renovation around Chongyong street in Beijing. This is a pilot project of the “Urban Public Space Renovation Enhancement” in Beijing. Government, planners, and universities collaborate on it. The government held a design competition to invite students studying landscape architecture and urban planning in Beijing to participate. Planner assists participants in site research. Educators as judges participate in the selection of design. And residents participate in voting
and select designs that meet their needs. This project promotes community renovation through engaged scholarship.

4 THE LOCATION

The site of this design competition is around Chongyong street, which has a long history and located in the central city of Beijing (Figure 1). Chongyong street connects the Temple of Heaven and the Temple of Earth, and pass through many historical and cultural attractions. It has become an important street for cultural, commercial, residential, and sightseeing functions.

![Figure 1. Site location](image)

The competition organizers selected four representative sites along Chongyong Street. The designers who participating in the competition would carry out in-depth planning and design of the four sites. Site 1 is located at Ciqikou Street, during the Qing Dynasty, there were many porcelain shops. It is also a bustling area in the southeastern part of Beijing. After several rounds of street renovation, the appearance of Ciqikou Street has been improved, and some small gardens have been built. However, due to separation between modern streets and hutongs, small gardens are not convenient to reach, and residents rarely come; Site 2 is located around the Lama Temple Street. There are many historical and cultural buildings around the site, such as the Lama Temple and Guozijian. There are also many traditional hutongs. Similar to the other hutongs in Beijing, this site also lacks open space. Site 3 is around Zhushikou Street. The south side of the site is a modern street with office buildings and schools, the north side is the hutong where people live. The space on both sides of the hutong were split. People lack space for rest, and the parking of motor vehicles occupied the walking trails. It is necessary to increase green open space and dredge the traffic (Figure 2). Site 4 is located at Qianmen East Street. The site surrounded by apartments built for many years. People spontaneously grow vegetables and flowers in the garden, it's full of life. But the management of the garden is chaotic.

![Figure 2. Site status](image)
5 PLANNING AND DESIGN

5.1 Purpose of design

The status quo of the site generally has problems such as the separation of old streets from newly built blocks, lack of public open space, and traffic congestion. After interviewing residents and investigating the site in-depth, we fully understand their needs. Based on the survey results, the design goal is determined to integrate urban space, improve the quality of urban public space life, and through community participation to achieve community renovation.

5.2 Design concept

Based on the survey of the current situation of the site, we summarize the status quo of the four design sites as the conflict between garden and traditional street, the conflict between historic scenic spot and community, the conflict between business area and community, and the conflict between street and green space. Our planning and design focus on the boundary generated by these conflicts. From the perspectives of space, time, and people, we will build a resilient boundary and realize the concept of “sharing” through public participation.

In the following, take the planning and design of the site 3, which around Zhushikou street, as an example, to introduce the design process and results in detail.

5.3 Pro-phase research and interviews

In the pro-phase research, we conducted site research, resident interviews, and issued questionnaires so that to gain a deep understanding of the needs of residents and their vision of the community (Figure 3). Based on the survey results, we summarized the site problems into the following three points:

(a) The lack of connection between the modern city facade and the hutong: the south side of this site is a modern street with office buildings, and the north side is a hutong, which is the area where residents live. At present, the situation on both sides is quite different, and the connection between them is very weak. The opposing boundary between the commercial office area and the hutong was formed, and the space was separated.

(b) Motor vehicles parking occupied public space: Many vehicles were parked on both sides of the hutong. Although there were underground parking lots, they were not fully used due to lack of management. The parking of motor vehicles on the ground occupies a large amount of public space, and resulting in poor slow system. In addition, there are two schools in the site. During school hours, parents park their vehicles on the roadside to pick up their children, which often lead to traffic congestion.

Figure 3. Opinions and needs of residents
Lack of public rest space: In the past, Siheyuan was once the residence of a single large family. Each family is independent of each other, so there is almost no public open space in the community. This kind of historical community pattern is not applicable in the modern life. Nowadays, the community has a dense population, and residents need public space for recreation. During the investigation, we saw office workers standing on the steps behind the building to chat and eat. They needed space for tea and rest. And residents living in the Siheyuan placed a table at the door, they need a shaded space for chatting. People living here need more public open space to meet the needs of leisure activities, thereby improving the quality of life.

5.4 Design strategy

In the design, we will construct a flexible boundary and realize the ideal state of “sharing” with an open attitude. Each location is designed to suit different local conditions and break the boundary to share the city’s life at the same time (Figure 4).

First, we integrated the space, sort out the slow traffic system, and connected the hutong to the modern street. Overall, the walking path is separated from the motor vehicle lane, and part of the terrain is raised to prevent the motor vehicle from occupying the slow space. At the same time, the walking space is connected in series with each resting space, so that the various space as a whole. The space that connecting Zhushikou east street and hutong is designed as an open space to strengthen the connection between the two. For instance, the building now has a passageway in which a mirror device is designed, reflecting both the hutong and the facade of the modern street, visually breaking the estrangement. Besides, there is a ground parking lot on the west side of the site. After guiding the motorized vehicle to the underground garage, it will be converted into a plaza for residents to watch movies, sport and entertain.

In addition, in the survey, we found that people have different needs for site functions in different time periods. Therefore, we design different functions in different time periods according to the needs of residents’ activities, so that the space can be used in a compound way. For example, a three-dimensional parking rack is set in the current venue, which solves the problem that the vehicle has nowhere to park during working hours, but the usage rate is lower during off-hours. So during off-hours, a screen will be
suspended on the parking rack, and residents can use it to watch movies. The combined use of space at
different times makes the site more dynamic.

As the surrounding residents are the main users of the site, residents participate in community
renovation not only reduces construction costs, but also helps to maintain the locality and diversity of the
community landscape, and fosters community ownership of residents. This is conducive to mutual
supervision and mutual promotion of the group effect. We designed a community building manual to guide
residents to manage the community spontaneously (Figure 5). On the other hand, in the survey we
noticed that local residents are very fond of growing vegetables and flowers, which make them feel more
sense of life and belonging. Therefore, in the community construction manual, the residents are also
guided to establish a planting club, organize part of the green space on the site, and freely carry out
horticultural planting. This not only reduces the cost of construction, but also meets the needs of
residents.

Figure 5. Community construction manual

6 RESULTS AND DISCUSSION

Based on site research and interviews with residents, this design conducts research and practice
on actual community renovation. It improves the relationship between traditional communities and modern
streets, creates a pleasant space, and guides residents participate in community renovation through the
manuals and clubs, to build a shared resilient boundary.

This plan has been recognized by the judges and the public, and part of the design and concepts
will be applied to the actual construction in the future. In this design competition, the government, relevant
planning departments, universities and residents collaborate with each other: the government launched
the “Urban Public Space Renovation and Enhancement” pilot project, proposed a series of macro-
thinking and solution strategies for the site, and organized the design competition. The planning
department undertakes the competition and assumes the intermediary role between the government,
residents and college participants. In the early stage, the participants are organized to conduct site
research, explain the site situation and the government's intention to reform, and organize residents and
educators as judges to select design plans. Universities are the main participants. Through understanding
of the needs of residents, students conduct research and design on sites to explore new methods for
hutong renovation. Educators serve as judges and instructors, guiding students to improve their research
and design. Residents are the main beneficiaries, they make their request to the government and
designers, and participate in the plan selection to ensure that the design is more in line with the needs of
them. In this process, the government and planning departments have obtained the required plan, students
have gained experience in applying research to the actual site, and the quality of academic research has been improved. In the future, the plan will be applied to the actual construction, residents will also participate in the community renovation in the future. This achieves an engaged scholarship integrating education, research and social services.

But this practice also has limitations and shortcomings. The organizer of the competition assumed the role of an intermediary, and there is a lack of direct communication between the university and the community. This can be used to enhance direct communication between the two through exhibitions. For example, in Beijing, the Design Week is held in Hutong every year. In the Design Week, the research results of the students can be presented in various forms. Contents of the community renovation are included. Residents living in the Hutong come to visit and interact with them. They can look at the communities they live in from different perspectives, and they can also feed their opinions back to the participating students as suggestions for further improvement of their research.

7 CONCLUSIONS

Landscape architecture education needs to provide students with more practical platforms, and the renovation of urban public space requires excellent plan and research. The government and the community are involved in landscape education, providing a platform for students, city managers and residents to communicate and improve. This paper takes the hutong renovation design competition in Beijing as an example. Through the introduction of the plan based on residents’ co-construction, it summarizes the benefits and influences of relevant stakeholders participating in landscape architecture education. It may provide some useful reference for similar practices.

8 REFERENCES


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TEACHING LANDSCAPE ‘TRIAGE’ THROUGH FIELDWORK: SITE ANALYSIS AT WHITE PARK, MORGANTOWN, WEST VIRGINIA

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1 ABSTRACT
West Virginia University students contributed to site analysis through fieldwork at White Park, a brownfield characterized by layered cultural history and convoluted trails. In 1947, the City of Morgantown established the park from 17 acres of oil tank field purchased from Eureka Pipeline Company. The City added 128 acres in 1973, then exchanged some for land around Cobun Creek Reservoir in 1978 to bring White Park to 170 acres.

Lightning periodically ignited oil tank fires during 1899-1939, and the possibility of lingering contamination is of concern. An irregular grid of circular berms surrounded the oil tanks, helping contain oil spills and fires. The berms vary in diameter and include some concentric outer rings and straight segments – features similar to prehistoric Native American mounds. This unique terrain is covered with tangled trails used for mountain biking and ROTC military training.

Landscape architecture students contributed to research to inform White Park’s future programming, trail work, and public interpretation. Their work helped reveal the park’s rich cultural history, as the site of both Native American and early pioneer settlements. Some of the property line witness trees (predating the US Civil War) show scars from ‘tomahawk rights’ blazes that settlers used to claim territory.

White Park’s complexities challenged students to design for multiple objectives: remediate oil contamination, interpret cultural history, and minimize trail user conflicts. This project has applicability for educators as a case study of a complex cultural landscape student design project that required incremental collection of field data and encouraged thoughtful problem-solving.

1.1 Keywords
Service learning, brownfield, urban forest, trail design, witness trees
2 INTRODUCTION

Deciding which landscapes warrant long-term protection can require "cultural landscape triage" (Melnick 2016: 292). While understanding cultural landscapes characterizes the profession of landscape architecture (Goetcheus, Karson & Carr, 2016: xii), meaningfully connecting a site’s history with its redesign and "revealing forgotten stories and restoring damaged ecologies" requires a “rigorous and flexible research-driven design process” (Wolz 2016: 252). West Virginia University students investigated White Park as a cultural landscape with another form of triage. Rather than choosing which of several cultural landscapes to preserve, students analyzed several characteristics of one cultural landscape to puzzle out three main priorities for a design charrette: brownfield remediation, public interpretation of the site’s cultural history, and streamlining the convoluted network of trails. At White Park, landscape architecture students interpreted topographic maps in the field, used compasses to read bearings and navigate the site, and estimated the ages of larger trees -- all while incrementally documenting the locations of secondary trails and ‘witness’ trees which marked property lines and/or predated the US Civil War. Student work contributed to efforts intended to help guide future park programming, trail planning, and public interpretation efforts at White Park.

This paper presents a case study involving the site analysis of a mostly woodland urban park, in which student fieldwork helped decipher site elements, with the following goals:

1) **Trails:** Map the (hitherto undocumented) secondary trails in White Park, used for mountain biking and military training – a network which includes an excessive number of trail intersections, each with potential to cause conflicts between trail users.
2) **Brownfield contamination:** Examine the history of the area as an oil tank field, locate traces of oil, and other relics of the oil industry, and determine if there are areas that may require remediation;
3) **Cultural history:** Seek traces of early settlement and gather and interpret evidence that could indicate if any of White Park’s berms predate the site’s use as an oil tank field.
4) **Public interpretation:** Outline key aspects of White Park’s history as a basis for future interpretive signage.
5) **Learning outcomes:** Document opportunities inherent in landscape architect students’ fieldwork and site analysis, ‘unpacking’ a site with complex existing conditions and layers of cultural history.

3 METHODS

By scouting different sections of White Park in groups during plant identification field trips in the author’s course LARC 360: Natural Systems Design, landscape architecture students contributed to the author’s efforts to draft and continually refine a trail map through multiple iterations during 2014-2018. To document existing conditions, students worked in teams of 2-4 within assigned areas encompassing two or three oil tank wells, collecting data to:

1) locate the largest diameter trees and identify other native and invasive plant species present,
2) draft cross-sections of berm enclosures and identify the lowest outlet point in each tank well to determine maximum water depth,
3) identify factors limiting vegetation growth, including shallow, poorly drained muck soils, and
4) document oil traces and propose appropriate brownfield remediation strategies.

The author supported each student in taking an individual turn to lead the class group to the next tank well using the topographic map compass and a compass, while reading contour signatures on the landscape. This was the first experience of orienteering for about one quarter of the students. The author revised the draft trail map with class findings each year, using aerial photos, GPS tracks, and field notes on the topographic map. Also, the author and graduate assistants reviewed property records, historical accounts, and archival photos and news articles to ‘unpack’ more information about White Park’s history. Specific details about the investigative process accompany findings, below.

4 FINDINGS

Field-based exercises within a complex cultural landscape helped students build practical analytic skills towards a “combined understanding of the human activities, the physiographic and biologic processes, and the cultural associations that have shaped terrain, ecosystems, and perceptions over
time” (Goetcheus, Karson & Carr, 2016: xii). The fieldwork and analysis process shaped priorities for student design in charettes (fast-paced design exercises).

4.1 Trails

No trail map for White Park is publicly available. In recent years, volunteers have closed off some mountain biking trails and improved others with ramps and banked turns, linking trail segments into one continuous ‘blue loop trail’. Producing an accurate trail map helped students learn orienteering and topographic map reading skills – skills better to learn in class, rather than in front of a client on a site visit. The trail map provides an important resource for future volunteer trail work efforts and we hope it will facilitate asking volunteers to target specific problem areas.

In mapping trails, we found the capability of a handheld GPS unit (Oregon 600) of limited use under tree canopy cover, especially where slopes were steep. One teaching assistant attempted to map trails using the handheld GPS unit in the winter months, which was more successful. However, after half a dozen field days exploring the trails (and once walking around the same circular berm three times at dusk), he concluded, “Nothing about White Park makes sense” (personal communication, January 2019). The disorienting trail network explains why the Reserve Officers’ Training Corps (ROTC) uses White Park for military training: the unique topography provides orienteering challenges (personal communication, ROTC landscape architecture student). Given the site conditions, we found mobile phone activity tracking apps (especially ‘All Trails’) more effective than GPS for trail mapping, particularly when students worked in teams with some members marking trail locations on a paper topographic map. This helped students keep track of their bearings; not an easy feat, in an existing trail network that looks like someone threw a fishing net at White Park (Figure 1). Two students, in filling out project evaluation forms, lamented the “confusing” state of the trails; a third student noted “we also learned how to trail map.”

We mapped the overlapping and interwoven trail network and found that park descriptions of 5-miles (8-km) of trails at White park likely underestimate existing trails. The secondary trails favored for mountain biking cross gravel walking trails innumerable times, often with short sight distances, or through steep descents (‘gravity drops’) at gaps in the berms. We found a portion of one mound cut away to use...
as fill for a ramp, which raised concerns about encouraging mountain biking while protecting the general form of the berms as part of the cultural history of the site as an oil tank field from 1900-1940s.

4.2 Oil Tank Field

West Virginia’s oil boom was facilitated by West Virginia’s first state geologist and WVU professor I. C. White (1848-1927), who refined applications of anticlinal theory for oil drilling, making the oil and gas industries much more profitable after 1898 (Allen & Matchen, 2017; Armstrong, 2015). From 1906 to 1924, West Virginia was the top oil-producing state (Allen & Matchen, 2017). In 1889, following I. C. White’s advice, Eureka Pipeline Company drilled for oil at Doll’s Run west of Morgantown; “This well was so productive that within three months there were 20 other wells nearby” (Carvell 2013). In 1889, Eureka drilled near the confluence of Cobun Creek and Monongahela River, now a car dealership next to White Park on US-119. By 1890, Eureka Pipeline Company’s “24 wells produced 1,800 barrels of crude oil a day” (Dominion Post, 2012). Eureka Pipeline Company moved oil from West Virginia to “Philadelphia and the Atlantic Seaboard” (Callahan, 1926: 250), operating in Morgantown from 1890 to around 1940 as a subsidiary of Standard Oil Company (Dominion Post, 2012; Core 1983: 143).

Eureka Pipeline Company created the oil tank field at White Park, which at its peak capacity in 1926 could hold a million barrels of oil (Carvell, 2013) or even 1.5 million barrels by some accounts (Morgantown History Museum, 2012). In 1890, there were eight oil storage tanks near White Park; in 1900, there were 31 tanks; and by 1926, there were 55 (Callahan, 1926: 250). Each tank could store 25,000-30,000 barrels of oil (Morgantown History Museum, 2012). Lightning periodically ignited at least eight oil tank fires at White Park in 1899-1939, per archival photos and newspapers. In the 1899 fire, authorities fired cannon shots at a burning oil tank to spread 15,000 barrels of flaming oil on the ground (Core, 1982: 248; Morgantown History Museum, 2012). In 1916, 10,000 barrels of oil burned; in 1939 two 35,000-barrel tanks caught fire. In the local newspaper, a neighborhood resident recalled “a lake of oil” between the tanks and nearby Cobun Creek: “two oil tanks about 100 yards from our home were struck by lightning. There were balls of black smoke in addition to flames, and burning oil running toward Cobun Creek” (Samsell, 2013). Vegetation today suggests where some of these fires occurred. In their fieldwork, students found roughly 16 acres (6.5 hectares) of White Park are carpeted with ground cedar (Diphasiastrum digitatum), a clonal groundcover that thrives in areas of previous fire. The extent of remaining oil contamination on the property is unknown, but historical records suggest it may be considerable and students found traces of oil in several locations.

4.3 Possible brownfield contamination

Students drafted cross-sections and identified outlet points to estimate the maximum water depth and looked for factors limiting growth of vegetation in the former tank well locations. They found standing water, shallow muck soils, and traces of oil common in the former oil tank locations. A brownfield is a post-industrial landscape that is contaminated or perceived to be so. It remains unclear whether or not the site’s brownfield status has ever been addressed, even though the Cobun Reservoir at White Park, completed in 1957, still supplies 9.5% of Morgantown’s drinking water (Morgantown Utility Board, 2019; Core, 1984: 379). In 1957, construction of an earthen dam (with rock fill) created the 12-acre (4.9-ha) reservoir at Cobun Creek, which holds a 3-day supply of drinking water for Morgantown (Beard, 2018; Core, 1984: 317; Morgantown Utility Board, 2017).

The reservoir divides White Park into two halves, and the portion of the park across the reservoir had unique traces of the oil industry. During their fieldwork, students located remnants of oil pipes and even a large rusted storage barrel remaining (near tree #1, Figure 1). Portions of several oil tanks seem to be buried just below the soil surface; students discovered these when investigating the depth of (typically muck) soils by prodding the tank wells with a metal trekking pole from the well edges. The possibility of lingering oil contamination is therefore of great concern.

4.4 Designation of White Park (formerly Traction Park / First Ward Park)

One of the gaps in public interpretation at White Park is when exactly the park was founded, and for whom it was named. A 1929 archives photo caption children at a creek describes their setting as “Traction Park at Cobun Creek…. at the end of the trolley line in South Morgantown” (Raese & Raese, 2001). A 1938 map confirmed Traction Park’s location at present-day White Park (Recreation Council of
Monongalia County, 1938) implying unofficial recreation on Eureka Pipeline Company property preceded First Ward Park/White Park’s official establishment.

Once West Virginia’s oil boom dwindled, the City of Morgantown acquired portions of White Park property in 1947 and 1973 from Eureka Pipeline Company (Anderson, 1988: 6; Monongalia County deed records). The 1947 purchase of 17 acres (6.9 hectares) for $1,800 created what was then known as First Ward Park (Anderson, 1988: 6), named for the surrounding neighborhood. First Ward Park was established before the adoption of the National Historic Act of 1966; thus, early park improvements would not have been restricted by those guidelines.

In the 1960s, Eureka acknowledged neglecting to pay property taxes on 40 acres (16 hectares) for many years: according to a local newspaper “the mixup occurred because public service corporations pay taxes directly to state tax commissioner’s office, and this land was overlooked” (Young, 1969). In 1968, the school board purchased 26 acres of the old tank field from Eureka Pipeline Company to expand South Middle School (Core 1984: 442) just east of White Park. In 1972, voters approved a levy to fund an ice-skating rink at First Ward Park, along with other city park improvements; the rink opened in 1979 (Anderson 1988: 9-10) and is primarily used for hockey.

The City of Morgantown purchased another 128 acres (52 hectares) of Eureka Pipeline Company property, adjacent “to the City Park” bound by Mississippi Street and Hite Street, for $210,000 in 1973 (Monongalia County deed records, book 740: 209-220). Most of this property was designated for park use. In 1978, the city traded 7 acres for 40 acres surrounding Cobun reservoir in an exchange with the Morgantown Water Commission and then allocated 8 acres of the Eureka property for non-park use (a technical education center and fenced police lot are located near White Park), leaving White Park at 170 acres (69 hectares).

After the county withdrew financial support for the Monongalia County Consolidated Recreation Commission in 1981, the Board of Park and Recreation Commissioners of Morgantown (BOPARC) was established to steward Morgantown’s 260 acres (105 hectares) of public parks at the time, which consisted of the following parks: 1) Whitemoore (sometimes spelled Whilemore), 2) Krepp’s, 3) Marilla, and 4) First Ward/White Park (Anderson 1988: 5,12). In 1984, the Board of Park and Recreation Commissioners of Morgantown (BOPARC) commissioned a $30,000 “comprehensive master plan for future development of White, Marilla, and Krepp’s Parks” (Anderson 1988: 13), suggesting First Ward Park was renamed White Park by 1984-1988 at the latest. BOPARC has not been able to locate the 1984 parks plan (personal communication with the director, January 2019); the 1984 parks plan may be able to clarify the origin of White Park’s name and the site’s earlier designation as Traction Park.

It is possible that White Park was named after I. C. White (1848-1927), given his influence on Eureka Pipeline Company’s profits and also his record of public service. Morgantown’s first park, Whitemoore Park, however, appears to have been named for I.C. White and his second wife, Mary Moorehead White (1852- c. 1924) of Newcastle, Pennsylvania. In 1823, I. C. White founded Whitemoore Park on a steep wooded valley or “ingle side” (Callahan 1926: 299) by purchasing 8.65 acres “with the stipulation that it be used for a public park” (Anderson, 1988: 1). In 1941, the City founded Marilla Park through the purchase of 45 acres (18 hectares) from the land developer Peninsula Company (Anderson 1988: 4), for which I. C. White and his wife were listed among the principals in public records. I. C. White’s homesite Cherryhurst is now WVU’s main library and mineral industries building, White Hall (Armstrong, 2015).

However, White Park might be named instead for Frances J. White, the 1930s Director of the Monongalia County Recreation Council (Anderson, 1988: 3) -- or for Captain William White, a prominent and controversial character in Monongalia County’s settlement history. The 1985 bicentennial of Morgantown coincides with the probable time period when the park was renamed, 1984-1988. So far, research has not yielded a definite answer.

4.6 Fracking / the new Cobun Creek Reservoir

White Park surrounds the Cobun Creek Reservoir, which accounts for 9.5% of Morgantown’s water supply -- the rest comes from the Monongahela River (Morgantown Utility Board, 2019). Fracking (hydraulic fracturing) is underway just 1500 feet (457 m) upstream of the city’s drinking supply water intake on the Monongahela River (Board, 2014), across the river from White Park. Concerns about the integrity of Morgantown’s water supply led the Morgantown Utility Board to initiate construction in 2018 of the $47-million George B. Flegal Dam and Reservoir project, intended as a back-up water supply for
Morgantown if Monongahela River “becomes contaminated for any reason” (General Manager of Morgantown Utility Board Tim Ball; interviewed by Beard, 2018). The 125-acre (50.6-ha) site was purchased in 1960 for this purpose at the confluence of Cobun Creek and Mountain Run, upstream of White Park by 2.9 miles (4.7 km) near Kingwood Pike (Morgantown Utility Board, 2017). The expected date of completion is September 2020. The Morgantown Utility Board (2017) “has no plans of providing public access to the reservoir. However, MUB will permit BOPARC [Board of Parks and Recreation Commissioners of Morgantown] to conduct and manage public access opportunities if they choose to do so.” The new Cobun reservoir has potential, as an expansion of Morgantown area greenspace. Ongoing construction of the reservoir, however, appears to be impacting Cobun Creek’s water quality; during a January 2019 rainstorm, the author observed Cobun Creek running a darker orange-brown from sediment than was the case for other streams in the area.

4.7 Circular oil tank berms

A USGS aerial photograph shows that all but four of the Eureka Pipeline Company’s oil tanks were removed by 1960. Locating the oil tanks within circular berms presumably helped contain oil spills or provided fire breaks. Most of the circular berms that surrounded the oil tanks are still present today. The circular berms vary in diameter (130-315 ft / 40-96 m, as measured on topographic map) and are sometimes bound by concentric outer rings or include straight sections (Figure 2). Portions of the berms were well-vegetated by 1895-1920s according to archival photographs (obtained through the West Virginia Regional History Center), which show trees growing on berms. By comparing the archival photos and studying topographic maps, we determined in class which berms were photographed with trees growing on them, then we scouted in the field to see if any of those trees remained today. Students looked for possible ‘witness trees’ 30-48” (76-122 cm) diameter or greater (depending on species) and mapped their approximate locations. The author confirmed their tree identifications, and over multiple return field visits their mapped locations based on topographic contours. Students estimated trees’ trunk diameters in class and practiced estimating tree age using arborists’ growth factors (Table 2: growth factor x diameter in inches = estimate of tree’s age in years). The author followed up with measurements of circumference at breast height -- 4.5 ft (1.4-m) from ground. There were several cases when hillslopes were too steep for students to measure trees safely, in which case the author measured or estimated trunk diameter, as was feasible (Figure 3). Students found several older white oaks (Quercus alba) growing on or near the berms, some of which had been photographed in 1895 and the 1920s. The circumference of the tree trunks suggests these trees predate the Eureka Pipeline Company’s oil tank field by 90 years or more. Early archaeologists attempted to determine the age of mounds by trees growing on them, measuring trunk diameters or counting tree rings (Thomas 1887: 108); measuring the circumference of the oldest trees at White Park brings that tradition full circle, with educational opportunities for landscape architecture students.

When the lower trunk of a white oak of similar diameter was partly buried during trail construction at Morgantown’s Krepp’s Park, the certified arborist asked to evaluate the situation observed, “That tree doesn’t know it’s dead yet” (personal communication, 2017). White oaks’ general intolerance for cut and fill makes their survival at White Park on the oil tank berms seem incongruous. Students found several large white oaks growing on the berms at White Park (one estimated at 279 years old), which raised the research question: Are some of the berms possibly Native American mounds that predate the oil tanks, and if so, did the pipeline company repurpose important relics of Adena, Hopewell, Fort Ancient, or Monongahela cultures? An interpretive park sign (removed for unknown reasons c. 2018) informed visitors to White Park of the presence of Hopewell and Adena cultures in the area, of nearby archaeological sites (specifically Grave Creek Mound and Picture Rock petroglyphs, without mentioning their distance of 25+ miles from White Park), of early settlers of the property, and of Eureka Pipeline Company’s use of the site as an oil tank field – while omitting to mention the circular berms throughout the park (or their origin). The sign concluded, “The land has stories to tell; we just have to ask.” After reading this interpretive sign, students said they were confused about the berm’s origins and cultural significance.

As the author and students discussed in class, several similarities among other archaeological survey sites and White Park’s berms are worth noting. In an early regional account, Thomas Jefferson (1787: 103) noted numerous stone “barrows... of different sizes, some of them constructed of earth, and some of loose stones. That they were repositories of the dead, has been obvious to all: but on what particular occasion constructed, was matter of doubt.” In Monongalia County, prehistoric cultures left hill-
shaped mounds as well as enclosures consisting of "embankments, circumvallations, or walls, and all symmetrical in form. The defensive enclosures were always situated on well-chosen hills... the sacred enclosures are always found on level river bottoms; seldom upon table lands" (Wiley 1883: 18-19).

Excavations of concentric circle enclosure mounds in Kanawha County, WV revealed a "hard central core of brick-red clay" (Powell 1894: 424); trail erosion and downcutting at White Park has also revealed red clay within one berm. In West Virginia, circular enclosure mounds very similar to the berms at White Park were excavated (Powell 1894: 414, 424), as well as circular mounds (Munford and Lothrop, 1996; Frankenberg & Henning, 1994; Wall, 1994; Dragoo, 1963). Pre-historic Native Americans of the Hopewell culture built grids of circular mounds along Ohio's Scioto River (Squier & Davis, 1848), and "widely spaced circular structures" often characterized the even earlier Adena settlements (Clay 2009: 49). In Ohio, concentric ring mounds 1140-ft (347-m) diameter and 4-ft (1.2-m) tall were demolished from 1837-1856 to form a rectangular street grid in "the squaring of Circleville" (Reps 1965: 485). In Columbus, Ohio, a 1953 housing development demolished two mounds and their 400-ft (120-m) diameter enclosure (Baby & Goslin, 1953; Cramer, 2009). The roadside historic marker for the Columbus mounds site reads: "Preservationists stepped in, asking Columbus City Council to purchase the land to create a park. Members of the community countered, petitioning for removal of the mounds." Under-appreciation of the cultural significance of mounds was reported among Monongalia County's early settlers, who "were not interested much in antiquities, and would not stop long to examine any trace of camp, grave or fort" (Wiley 1883: 21). Well into the late 18th century, "stone-pile graves" were common (especially along Cheat River in Preston County, at the headwaters of Dunkard Creek, and near Point Marion in Pennsylvania), but these became scarce as their stones "hauled away" for re-use in the 19th century (Wiley 1883: 27). Involving students in the fieldwork for White Park presented opportunities for them to discuss shifting attitudes towards preserving and interpreting cultural heritage.

Figure 2. Berms and White Park’s relationship to Fort Cobun’s approximate location (inset). Diagram by author, based on: 1960 USGS aerial photo, Fort Cobun descriptions (Wiley 1883: 42, Core, 1974: 352), and quarry location marked on archival map (Lathrop, Penny & Proctor, 1886).
Along the Holston River in Sullivan County, Tennessee excavation of a 5-ft tall (1.5-m) circular mound revealed that it contained 12 stone-pile burials encircled by a stone wall (Figure 4, Thomas, 1887: 76). Similarly, students found a stone wall exposed within one of the berms at White Park, near a stone pile. One otherwise circular berm has a 90-degree corner, in which a dry-laid stone wall is exposed. On the other side of this berm, there is a loose pile of stones -- but in the middle of that pile, a rusted pipe connects underneath the wall (presumably part of the actual oil pipeline). A large white oak (#1 in Table 2, Figure 5) grows on the other side of this berm near the wall, suggesting the stone wall could be quite old – the tree likely dates to 1740. It appears the stone pile may have been excavated from underneath the mound in the process of laying the oil pipe. If the berm was constructed for Eureka Pipeline Company, neither its location – perched at the very edge of a steep slope -- nor the stone wall make sense. As the student who found this area said, “Why build a retaining wall at all?” This particular berm encloses an area considerably larger than the other oil tank wells (Figure 2). The closest oil tank (per 1960 USGS aerial photo) was located within a crescent-shaped (not circular) berm; the other tank wells nearby are also irregularly shaped and positioned just next to steep slopes. While it remains uncertain whether the berm, wall, or pipe here is the oldest, certainly these features distinguish this area from the other oil tank berms at White Park and warrant further investigation. This area is only lightly used for recreation, compared to trails across the reservoir. While exploring this area in class fieldwork, we noticed growing on top of some of the berms partridgeberry (Mitchella repens): a groundcover which we otherwise observed growing only in undisturbed forests on plant identification walks during 2014-2018.

The prehistoric Monongahela culture settled along the Monongahela River valley, including the area around Morgantown; prehistoric Fort Ancient, Hopewell and Adena cultures were present in West Virginia along the Ohio River valley. In the 18th century, historians recorded Delaware, Mingo, Shawnee and Iroquois in the area (Wiley 1883: 24; Withers, 1831; Lewis, 1889) with permanent settlements near
Pittsburgh and seasonal settlements in Monongalia County “at the mouth of nearly every creek along the Monongahela River” (Wiley 1883: 21, 24). One such settlement was located near present-day White Park “at the mouth of Cobun’s Creek” and “judging from its ruins as described by early settlers…. must have been of considerable size” (Wiley 1883: 24, 648). Wiley mentions piles of mussel shells at this settlement. Similarly, a “mass of mussel shells” accompanied burials at a village site along the Yadkin River in Wilkes County, North Carolina (Thomas, 1887: 71) and the first investigators of the Fort Ancient Buffalo Site (46 Pu 31) in Putnam County, West Virginia noted, “The field is covered with fragments of mussel shells” (Martin, 1936) where 1,031 burials were excavated by 1965 (Department of the Interior, 2018). Mussels, now rare, also attest to ecological change in freshwater rivers; some species are endangered or extinct.

As the author and students continue to work at White Park and make recommendations to Board of Park and Recreation Commissioners of Morgantown (BOPARC) for trail improvements, it will be important to be sensitive to cultural preservation. One possible trail, under discussion with the local Greenspace Coalition and Pedestrian Safety Board, would run next to Cobun Creek under US-119. As this is the location of archaeological site 46 Mg 2, further research is necessary. Monongalia County’s archaeological reports are housed as paper copies at the State Historic Preservation Office in Charleston, sometimes with duplicates at the Grave Creek Museum in Moundsville. To facilitate future research, Table 1 summarizes the archaeological surveys that seem to be closest to White Park; the author’s inquiry with State Historic Preservation Office regarding these survey locations is pending.

While archaeological survey site 46 Mg 2 does not include Cobun’s Creek in its description, this is likely the temporary village described by Wiley at the mouth of Cobun Creek (1883: 24); no other creek is near Dorsey’s Knob. Furthermore, an archaeological site described as “m2… Indian hunting camp… close to Cobun Creek Bridge” is mentioned in a report summarizing key cultural assets of Morgantown (Schmoyer, c. 1970: 66). The identifier 46 Mg 2 indicates this was the second site investigated in Monongalia County. Another archaeological survey potentially relevant to understanding White Park is Fort Hill (46 Mg 12), which included an oval ceremonial area (Harris, Thomas & Voreh, 2014). The Picture Rocks petroglyphs are located about 25 miles south of Morgantown but have been reburied for preservation (Wall, 1884; Swauger, 1963). According to a State Historic Preservation Office archeologist, no archaeological surveys were conducted along Cobun Creek, except one preceding recent construction of the new reservoir many miles upstream (personal communication, January 2019).

Table 1. Selection of archaeological surveys conducted near Morgantown, with bold type marking those located nearest to White Park (per personal communication, Grave Creek curator).

Compiled from: Green County, 2011; Preservation Alliance of West Virginia, 2005; Big Blue Archaeological Research Inc., 2003: 19-20.

<table>
<thead>
<tr>
<th>ID</th>
<th>Description</th>
<th>Dates to</th>
</tr>
</thead>
<tbody>
<tr>
<td>46 Mg 2</td>
<td>floodplain camp (?), near Dorsey’s Knob, mouth of creek</td>
<td>unknown prehistoric</td>
</tr>
<tr>
<td>46 Mg 3</td>
<td>Picture Rocks petroglyphs,* Hamilton Farm</td>
<td>unknown prehistoric</td>
</tr>
<tr>
<td>46 Mg 5</td>
<td>rock shelter on a hillside, overlooking creek/river confluence</td>
<td>prehistoric</td>
</tr>
<tr>
<td>46 Mg 12</td>
<td>Fort Hill, Monongahela village at Suncrest Towne Center</td>
<td>17th century CE</td>
</tr>
<tr>
<td>46 Mg 15</td>
<td>village, Pyle Farm (Osage USGS quadrangle)</td>
<td>late prehistoric</td>
</tr>
<tr>
<td>46 Mg 16</td>
<td>village on hillside terrace, tributary of Mon River</td>
<td>late prehistoric</td>
</tr>
<tr>
<td>46 Mg 17</td>
<td>village, south of Dorsey’s knob, terrace overlooking Mon River</td>
<td>late prehistoric</td>
</tr>
<tr>
<td>46 Mg 18</td>
<td>stone burial mound at LaPoe (Osage USGS quadrangle)</td>
<td>pre-historic?</td>
</tr>
<tr>
<td>46 Mg 20</td>
<td>LaPoe Monongahela village site (Osage USGS quadrangle)</td>
<td>pre-historic</td>
</tr>
<tr>
<td>46 Mg 21</td>
<td>LaPoe, circular village site in Monongalia County</td>
<td>16th-17th century CE</td>
</tr>
<tr>
<td>46 Mg 22</td>
<td>Baker village site, ridge top / hilltop west of Decker’s Creek</td>
<td>late prehistoric</td>
</tr>
<tr>
<td>46 Mg 23</td>
<td>Worley/South Hills camp, hillside bench, Aaron’s Creek</td>
<td>10th century CE</td>
</tr>
<tr>
<td>46 Mg 28</td>
<td>hillside bench camp (?), between Aaron’s Creek &amp; Cobun Creek</td>
<td>late prehistoric</td>
</tr>
<tr>
<td>46 Mg 29</td>
<td>Myer’s camp, ridge top and hillside overlooking Cobun’s Creek</td>
<td>unknown prehistoric</td>
</tr>
<tr>
<td>46 Mg 51</td>
<td>stone mound, on high knoll (ridge top)</td>
<td>unknown prehistoric</td>
</tr>
<tr>
<td>46 Mg 52</td>
<td>stone mounds, on a hillside bench (or high knoll)</td>
<td>late archaic / late prehistoric</td>
</tr>
<tr>
<td>46 Mg 66</td>
<td>camp, ridgetop and hillside</td>
<td>late archaic / late prehistoric</td>
</tr>
<tr>
<td>46 Mg 190</td>
<td>hillside bench</td>
<td>c.1851-1900</td>
</tr>
</tbody>
</table>
4.8 Early settlements along Cobun’s Creek: Fort Cobun

The first European settlers arrived in the Morgantown area in 1758, one mile north of White Park “at the mouth of what is now Decker’s Creek. In the ensuing spring [this settlement] was entirely broken up by a party of Delawares and Mingoes” (Lewis, 1889: 507). After land cessions negotiated in 1768 (Treaty of Fort Stanwix), homestead grants in Monongalia County more than quadrupled; the county at that time included portions of 3 present-day Pennsylvania counties and 22 West Virginia ones (Maxwell, 1900: 195).

Jonathan Cobun (or Coburn) was one of the earliest traders in the upper Monongahela River valley in the late 1730s (Lough, 1969: 91). By 1770, he settled near Decker’s Creek, and in 1778, Cobun’s Creek was named for him (Kenny 1945: 180). Jonathan Cobun supervised construction of Fort Cobun (Wiley 1883: 42). Area resident Lawrence Cox, in a 1966 interview, described Fort Cobun as located on a slight rise just north of Cobun Creek; the site was visible “from the Greenbag Cement Road in Morgantown…. marked by a small grove of trees, stones, and what appear to be primitive grave markers, standing alone in a field” (Core 1974: 352). In the 1970s, Fort Cobun was thought to be “near an old cemetery off of Dorsey’s Knob… in the shadow of Dorsey’s Knob” (Schmoyer, c. 1970: 56). The area matching these descriptions is highlighted with a red outline on the 1960s aerial photo (Figure 2, inset) – this is now City property, mostly wooded and just west a minimal security Federal Correctional Institution – just across Greenbag Road from White Park. Field reconnaissance is required to establish if any of the stones or grave markers are still visible, in this area. If so, this site is a prime opportunity for public interpretation, as it is already civic property.

4.9 Tomahawk rights

In 1777, the General Assembly of the Commonwealth of Virginia allocated 400 acres (162 hectares) to each homesteader settled on “western waters” including streams and rivers of Monongalia County by June 24, 1778 (Core 1974: 156). Settlers established their right to land in Monongalia County by living for a year on land or by raising a crop (‘corn rights’); often settlers marked the area they wished to claim by blazing trees to remove patches of bark (‘tomahawk rights’), which others acknowledged as effectively claiming territory (Core 1973: 156). “Tomahawk rights grew from four in 1768 to over 1,200 in 1776” (Rice, 1970: 66).

The author found ‘tomahawk rights’ blaze scars on several witness trees at White Park. ‘Witness tree’ has two meanings: trees old enough to have witnessed the Civil War, or trees used as survey markers to witness property lines. In West Virginia, the oldest tree locations tend to follow property lines, because of the local custom of leaving these trees unlogged to avoid enmity with neighbors and also to mark property lines in remote locations (personal communications with two rural West Virginian landscape architecture students, in 2015 and 2016). The two oldest trees we located at White Park were likely property line witness trees when Morgantown was first settled by Jonathan Cobun, witnesses not only to the Civil War but also the Revolutionary War. While the blazed trees appear to date to 1850s-1860s, their presence at White Park is significant and warrants further research, particularly in comparison with deed records and historic property boundary descriptions.

The ‘tomahawk rights’ scars form two patterns: a triangle or “L” shape on trees northwest of Woodland Trail near the reservoir; and a horseshoe or “O” shape with a central dot on one white oak on the other of the trail in the same area. The blazed trees are part of an allée of older trees along both sides the trail, demonstrating that the trail itself must date to the 1890s at the latest. A Methodist preacher wrote in 1790 about riding his “old baggage horse along a most dreary, grown-up path, to brother James Coburn’s” in Morgantown (Francis Asbury’s journal entry of July 22, 1790; cited in Core, 1976: 183). Certainly property owners after the Eureka Pipeline Company era (i.e., the City of Morgantown, Morgantown Utility) were not likely to blaze trees with tomahawks to mark internal parcel boundaries within the larger properties purchased in 1947-1979. It is possible that the blazed trees are far older than arborists’ growth factors indicate. One recently fallen black oak offers an opportunity to date the trees more exactly, and further research is required to establish the age of the blazed trees at White Park. The history of early settlement at Cobun Creek manifests in a physical way, with ‘tomahawk rights’ marked on witness trees.

To gain a better understanding of survey bearings and site dimensioning in the author’s course LARC 331: Landscape Architectural Construction II, students drafted property boundaries from deed descriptions at White Park in a class exercise; this work is ongoing. It will be useful for public
interpretation to determine which settlers marked their properties with the ‘tomahawk rights’ that can still be seen today.

4.10 Witness Trees

Witness trees offer insights into the local ecology at the time of settlement. Settlers arriving *en masse* in Monongalia County only after the 1770s, before which time Native Americans would have applied fire to hunting grounds to maintain more open landscapes and attract game with rich new growth (Cronon & Demos, 2003). "In many areas of the mid-Atlantic region, periodic fire by Native American activity and occasional lightning strikes may have been responsible for the maintenance of the original oak, pine, chestnut, and hickory forests" (Abrams & McCay, 1995: 221). The Fry-Jefferson map (1753) confirms the use of fire in the region, designating the area west of Morgantown as “Great Meadows”, consistent with early descriptions of buffalo hunted around Cheat River (Wiley, 1883) and nearby place names, such as: Buffalo Run, Monongahela Glades (at Decker’s Creek), and Colonel Evan’s black oak flats (near WVU’s Evansdale campus). The last wolves were observed in Monongalia County in 1823 (Wiley, 1883: 648), further demonstrating changes wrought to regional ecology by settlers. Game diminished without fire management and with increased hunting: for example, the US populations of white tail deer declined sharply beginning around 1850, but re-stabilized after 1950 (VerCauteren, 2003).

Excluding prescribed fire changed the character of the Appalachian landscape, affecting especially the open forest understory described in early settlers’ accounts (Cronon & Demos, 2003). By the 1880s, Monongalia’s pre-logging landscape was described as “Heavy forest... oak, [tulip] poplar and chestnut were the leading kinds. Large quantities of pine still remain on the headwaters of Decker’s Creek” (Wiley 1883: 648).

Most of the witness trees we located in the field were white oaks, consistent with previous findings (based on survey records) that white oaks comprised 32.7% of the pre-settlement canopy in Ridge & Valley ecosystems in West Virginia (Abrams & McCay, 1995: 222). As the author discussed with students, the open-grown form of the witness trees at White Park hints they developed their branching structure in an environment more like an oak savannah than a closed canopy forest (where competition for light would require young trees to grow straight trunks with minimal lateral branching). Archival photographs (1895-1920s) confirm much of White Park was used as pasture, preserving (until Eureka Pipeline Company’s purchase) an open oak savannah similar to what would have been promoted by regular burning.

Table 2. Summary of oldest trees located at White Park, dating to 1740-1911. Four (*) grew on the side of berms (1, 8, 22, 25); one (**) grew directly on a berm (18); at least five trees were blazed (4, 6, 7, 13, 15); and three well-established before 1895-1920s photographs (17, 18, 29). Data by author.

<table>
<thead>
<tr>
<th>Count</th>
<th>Species and common name</th>
<th>Tree locations, numbered on Figure 1</th>
<th>trees date to:</th>
</tr>
</thead>
<tbody>
<tr>
<td>13 (40.6%)</td>
<td><em>Quercus alba</em>, white oak</td>
<td>1*, 8*-11, 14-15, 18**, 19, 23-25*, 27-29*</td>
<td>1740-1876</td>
</tr>
<tr>
<td>8 (25.0%)</td>
<td><em>Quercus velutina</em>, black oak</td>
<td>4, 13, 20-22*, 26, 33-34</td>
<td>1827-1899</td>
</tr>
<tr>
<td>3 (9.4%)</td>
<td><em>Quercus rubra</em>, red oak</td>
<td>3, 5, 12</td>
<td>1857-1890</td>
</tr>
<tr>
<td>3 (9.4%)</td>
<td><em>Acer saccharum</em>, sugar maple</td>
<td>2, 6, 31</td>
<td>1788-1865</td>
</tr>
<tr>
<td>3 (9.4%)</td>
<td><em>Liriodendron tulipifera</em>, tulip tree</td>
<td>7, 16**,17</td>
<td>1883-1917</td>
</tr>
<tr>
<td>1 (3.1%)</td>
<td><em>Platanus occidentalis</em>, sycamore</td>
<td>30</td>
<td>1811</td>
</tr>
<tr>
<td>1 (3.1%)</td>
<td><em>Prunus serotina</em>, black cherry</td>
<td>32</td>
<td>1853</td>
</tr>
</tbody>
</table>

One tree growing at White Park is a white oak dating to around 1740 (*Figure 1*, #1). This tree is so large it is visible from the observation platform, across the Cobun Creek Reservoir. Among the witness trees we located, white oaks (#1, 18) are of particular interest because these trees grow directly on berms and feature large trunks, implying they predate the Eureka Pipeline Company by at least 90 years (Table 2). However, when the author and her son compared these trees to other large white oaks on site, we made a key discovery. White oaks growing on mounds are missing trunk base flare (*Figure 5*, at right), when compared to comparably white oaks on site (*Figure 5*, at left). This suggests Eureka Pipeline
Company did in fact partly bury existing white oaks during construction of the berms at the oil tank field. There may be difficulty protecting these witness trees; as they approach their second or even third centuries of maturity, more mortality can be expected. Measures to protect the oldest trees from compaction (even from foot traffic) are recommended, and the Board of Park and Recreation Commissioners of Morgantown (BOPARC) should consider asking volunteers to reroute some of the secondary trails to this end.

Figure 5. Some tree trunk bases were partly buried by oil tank berm construction, as evidenced from comparing trunk flares of witness tree white oaks (e.g., #8 vs. #18). Photos by author.

4.11 Learning outcomes
The complex nature of White Park warrants additional research and interpretation for park visitors. As one student observed: “I played hockey at White Park for more than two years and never knew the history of the site at all... It is an interesting hidden gem in town I feel is underappreciated.” Asked to reflect on their learning experience working at White Park in fall of 2018, landscape architecture students highlighted building skills in site analysis and brownfield remediation, an important need in West Virginia. One student commented, White Park is a “a prime example” of the type of “projects we will need to remediate…. it gave us a good idea of what to expect.” Another stated: “This project was my first look into working on a ‘brownfield’ type of site. I learned a lot about site analysis.” Building students’ analytic skills is important because “The issues confronting practitioners—climate change, global urbanization, economic inequality—are unprecedented…. Landscape architects engaged in the field of cultural landscapes today are building a critical and necessary dimension of continued and innovative success in design practice” (Goetcheus, Karson & Carr, 2016: vi).

Short, team-based design exercises (charettes) challenged students to address possibly oil-contaminated soils at White Park without excavating the culturally significant site. The best designs relied on shade tolerant wetland plant species to break down oil over time; some designs included clay caps to keep surface water from percolating contaminants into the groundwater and Cobun Creek Reservoir. A few designs incorporated boardwalks and interpretive signs. Students will work in future classes to propose a streamlined trail network, to highlight White Park’s most interesting elements, protect sensitive areas (e.g., reduce soil compaction around the oldest oaks) and minimize conflicts between walkers and cyclists, especially in areas where the mountain bikers are tempted to use high-speed ‘gravity drops’.

5 CONCLUSION
While local historians are consistent in portraying White Park as a retired oil tank field, the site’s history is certainly more complicated than that. Monongalia County’s second archaeological excavation
was conducted at the edge of White Park, under the Cobun Creek bridge at US-119, where there was a seasonal or hunting camp (46 Mg 2). An 1886 map marks a quarry just above this settlement; mountain bikers have scattered stones along trails throughout the park. “Traces of early settlements, the remains of industrial activities, and geological formations become allusions to the unique history of each landscape” (Wolz 2016: 237).

Eureka Pipeline Company built berms in White Park to surround oil tanks. Whether Eureka selected the White Park site because any berms were already present remains uncertain. Even if the berms are a relic only of industry rather than of prehistory, they still have cultural significance worthy of interpretation and preservation: they are unique landforms made more than a century ago.

Site analyses by students and a study of the area’s cultural history suggest that it deserves to be reinterpreted in ways that enhance mountain biking trails but preserve centuries-old trees; reduce contamination but promote ecological health through biodiversity of plant species; and introduce visitors to the history of Native Americans and early settlers in the area. In terms of next steps, students will engage with the Board of Park and Recreation Commissioners of Morgantown (BOPARC) and White Park’s volunteer trail crews to help plan streamlining trails and reconfiguring trails for legibility and to minimize potential conflicts between mountain bikers and walkers.

Students found navigating the White Park site challenging but conducive to building analytic skills. Future park planning should include deciphering the park’s many layers of history. Some of the witness trees show scars from ‘tomahawk rights’ – possibly warranting historic protection. The Morgantown parks director is excited about the learning opportunities this research presents for children in summer camps as well as for landscape architecture majors at West Virginia University.

6  REFERENCES


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ENGAGED LEARNING IN THE LANDSCAPE

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1 ABSTRACT

Land grant institutions have historically used the campus landscape as a classroom and laboratory for teaching, research and outreach on agricultural topics. Contemporary challenges urge us to expand this model of engaged learning to a diverse array of sustainable landscapes and practices. We are using our resources – our land, our students, our curricula, and our Facilities staff – to catalyze transformation of our campus landscape to a Living Laboratory, where students design, install, monitor, steward, and communicate landscape solutions to 21st century problems.

The Living Laboratory is part of a new University-wide initiative to enhance hands-on research and education through a network of campus resources and experiences in gardens, forests, and biodiversity collections to enhance and innovate college education, promote lifelong learning, and enrich human lives as part of sustainability and conservation of global natural resources. This program grew out of grassroots faculty, staff and student efforts and is supported by The Office of Academic Programs at the School of Environmental and Biological Sciences.

This paper describes our vision for engaged learning in the campus landscape, our early successes and current challenges. First achievements include a Living Lab meadow and garden complex at the New Jersey Institute of Food, Nutrition and Health, a student organic farm, and a historic arbor trail. Challenges inhibiting our success include an understaffed Grounds crew, conflicting definitions of landscape stewardship, and lack of education on natural ecological dynamics.

These student-designed landscapes are activating a conversation about engaged scholarship and sustainability on campus.
INTRODUCTION

"All education is experimental, whether we call it that or not."1

(John Dewey at a 1931 curriculum conference)

The ongoing "Campus as Living Lab" endeavor at Rutgers was jump-started by the Landscape Architecture Department, using engaged scholarship to create a more sustainable campus landscape. Experiential learning has a long tradition in land grant colleges whose mission has traditionally been to teach the practices of agriculture, science, military science and engineering. The School of Environmental and Biological Sciences (SEBS), the land grant campus at Rutgers, is searching for new ways to make this tradition more relevant to today’s challenges. This paper describes how we are creating new sustainable landscapes and practices through the landscape architecture curriculum and new collaborations. While there are sustainable landscapes at other universities, they are typically not designed, installed, maintained, monitored and championed by students. We hope that this case study can provide a blueprint for others.

Living laboratories is a broad term with various definitions, ranging from a research concept to a place in which to learn and experiment. Of particular interest to Landscape Architecture are notions of using the landscape as the ‘living’ component of living labs (both in terms of being composed of living materials and in terms of the landscape’s mutability) and how these laboratories relate to community in terms of research and innovation (such as participatory design or co-creation-- sometimes including user communities as a source of creation). We particularly like the idea that living labs could also form creative social spaces on campus for students to design and explore their future.

“A living lab is not a test bed as its philosophy is to turn users, from being traditionally considered as observed subjects for testing products/services against requirements, into value creation in contributing to the co-creation and exploration of emerging ideas, breakthrough scenarios, innovative concepts and related artifacts. Hence, a Living lab rather constitutes an experiential environment, which could be compared to the concept of experimental learning, where users are immersed in a creative social space for designing and experiencing their own future.”2

The origin of the Living Lab concept can be traced to MIT in the first decade of the 21st century. The MIT Living Lab is “a research concept defined as an open innovation ecosystem or environment centered on practices and uses in the field of Information and Communication Technology by the users themselves.” Key to the concept is user-centered design--the notion that the user provides feedback for technological innovation. Degrees of user involvement include becoming a “co-creator, a tester and a judge."3 Major product development activities include: Co-creation; Exploration; Experimentation; Evaluation. These Living Lab principles are applied to innovative technological products, but MIT has since applied the notion of a Living Lab to sustainability with the idea of using the campus as “a testbed and incubator for sustainability” with various scales of impact—campus, city, and globe (https://sustainability.mit.edu).

LIVING LABS AT RUTGERS

According to the Rutgers University and Rutgers-New Brunswick 2030 Strategic Plans, Rutgers would like to develop living laboratories on their campuses. Creating a sustainable world through innovation, engineering and technology, one of the five university masterplan themes, calls on the university to “create living laboratories for sustainability by performing discovery and applied research, and by implementing models of sustainable practices on our campuses in New Jersey.”

Our vision of creating a living laboratory is not an individual effort: it requires collaboration between students, faculty, and staff. Going into the development of living laboratories, our campus strengths lie in faculty and student engagement. Many faculty members on the SEBS campus include fieldwork in their course pedagogy. Teachers have been using the campus for teaching purposes in an ad hoc manner for some time (e.g., 11:550:233 plant identification using university trees; 11:067:205 animal laboratory practicum using the campus farm, etc.).

Building upon the existing faculty support for the living labs initiative, several SEBS undergraduate honors theses on different aspects of campus sustainability and on campus living labs have provided us with several frameworks for an overall living lab plan. Most recently, the Planting Design class has created several sustainable landscapes through the class curriculum.

4 LANDSCAPE ARCHITECTURE’S ROLE IN LIVING LABS AT RUTGERS

Our Living Labs movement grew out of grassroots efforts at first: faculty-led projects; student senior theses; the designed landscape for a new campus building; and Planting Design class. We discovered that Planting Design class was a very productive means for creating living laboratories. Planting Design is co-taught by two practitioners, an ecologist and a landscape architect who initiated a planting practicum to take planting design ‘off the boards’ and into the ground. This idea was inspired by HGTV and seeing the potential for a large class to create fairly instant, large gardens as part of its pedagogy: twenty-eight students, working collaboratively, can install their own planting design in a few class periods if managed efficiently. Students have grown up watching designed spaces happen almost magically (since most of the construction happens off-camera), and with our large class, we could create a big garden with moderate individual effort; with a crew of 28, we could collectively install a 1,000-perennial garden with each student planting only 35 plants. Students were the designers and producers of the garden.

Although we did not initially imagine transforming the campus landscape through the curriculum, the idea of tying together curriculum, experiential learning, and creating sustainable campus landscapes became the ultimate goal. Many of the living lab gardens cluster around the Institute of Food, Nutrition and Health, although our campus living laboratories also include community gardens, a student farm, a historical arbor trail, raingardens, and a conservation garden.

Our first official living laboratory garden was designed in response to the Academic Dean’s desire to create a campus social space in honor of Rutgers’ 250th anniversary. Initially, the Dean was not imagining that the proposed social space would be student-designed and student-built. Locating the new garden by a fairly popular new café seemed to make sense in terms of amplifying it as a social hub. The site was a sloping, seldom-occupied lawn amphitheater. Upon installing the new garden, landscape architecture students then programmed the space with a jazz concert and had an outdoor yoga class to “give permission” to other students to occupy this mostly deserted place.
Our second garden was also placed adjacent to the Harvest Café, located on the first floor of the Institute of Food, Nutrition and Health (IFNH) whose purpose is research in food, nutrition, and health with core values of interdisciplinarity and community responsibility. Its front yard is a meadow to demonstrate sustainable landscape best practices. Consensus on this vision proved to be tricky in several unexpected ways.

The landscape design took several turns. Sitting more than 10 feet above street level, IFNH perches above the street. The first roadblock came with a critique from Rutgers Facilities that maintaining the soft slopes would be difficult; their suggestion to replace the slopes with a series of flatter lawn areas and 4-foot retaining walls was deemed “too corporate” and too expensive. The flatter lawn areas would fit within traditional maintenance procedures; the non-traditional meadow landscape was not preferred by Facilities over the traditional campus mowed-lawn landscape. Facilities staff did not have meadow maintenance experience or protocol. With a lean staff dedicated to caring for a large campus landscape, they could not accept maintenance responsibility for the new meadow.

Despite the increasing complexity of the idea of a front meadow, the campus moved forward with the meadow installation. The meadow mix, tweaked by an ecologist from our department, was installed with a 2-year maintenance contract included in the scope of work. This mix of native grasses and forbs was augmented with non-native annuals to provide seasonal color, especially in the first year, until the forbs and grasses got established. Taking into account Joan Nassauer’s orderly frames, the meadow’s edges were surrounded by the consistency of a mowed lawn. That mowed lawn took on an additional role when an uproar ensued the first meadow season. A faculty member from Plant Science advised the administration of concerns that the meadow could catch on fire. Annual ryegrass is conventionally added to meadow seed mixes as a cover crop to reduce weed infestation during a planted meadow’s first year. The plant scientist saw the annual rye grass from a different vantage: annual ryegrass seeds contain an extremely high oil content. Although three sides of the meadow are surrounded by concrete walkways and terraces, and fire-spread seemed adequately limited by the adjacent hardscape, the campus made sure that safety concerns were addressed by the design. The plant scientist warned that the meadow could spontaneously combust. As a result, the 6-foot wide mowed lawn strips came to serve, design-wise, as firebreaks.

Approval of this new meadow landscape was not uniform. A planted meadow takes several years to mature. Many people viewed the meadow landscape as “messy”, asking when it would be properly landscaped—“Did they run out of money?” Conversely, with a campus full of biologists, ecologists and land managers, there were also positive reports about the use of native plants and increased biodiversity. The meadow’s mowed edge, an attempt to create order by wrapping the meadow with a continuous, uniform plant material may not have been completely successful in terms of creating Nassauer’s orderly frame. Perhaps the turf was too low to create a strong edge around the randomized forbs and grasses.

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5 IFNH Vision Statement, Retrieved January 21, 2109 from: https://ifnh.rutgers.edu/about.html
In addition, you could say that the turf also functioned as a ‘moat’, an undifferentiated no-man’s zone separating the viewer from the meadow, and not much was happening in this interim zone.

Perhaps by chance, perhaps partly the result of disappointment with the meadow, a 6-foot tall wrought iron fence was installed to separate the sidewalk in front of IFNH from the meadow. No one can say exactly why this happened, but rumors have it that students might sled down through the meadow into the street (a short fence would provide sufficient safety). As a result, the meadow now had several layers of ‘separation’ from people, with the result being that the landscape was nearly empty other than people going up and down the front stairs: The upper terrace overlooking the meadow was always empty—no one ate there; no one sat down on the bench to take in the view over the meadow and out to the farm; and no one stopped along the long climb up the stairs.

Could the landscape be modified to create more interaction between people and the meadow? Landscape architecture students were asked to envision a new transition between the meadow and hardscape areas to better integrate the meadow while thinking of new ways to use the meadow as a living laboratory. The Academic Dean gave Planting Design studio a budget to transform the stairway edge of the meadow. Students studied the meadow plant palette and combined meadow plants and their garden cultivars with edible plants to refer back to the IFNH mission. A review team comprised of individuals from campus administration and campus facilities selected a design, and students installed the design with occasional collaboration from Facilities.

Figure 2: Meadow Border Planting Plan and installation

The spatial framework of the selected design extends the stairway platforms into the landscape to create moments of interaction with the meadow at flatter, terraced areas. One surprise outcome of the design selection was the suggestion that the design be modified to showcase different Rutgers turf grass varieties in these semi-circular lawn areas, surrounded by massed meadow perennials. One of the turf demonstration areas is a low-mow fescue that flops over like cowlicks and consistently receives positive feedback. The review panel also asked that the design include a path to a bench located inside the meadow, as seen in other student designs. Although the designers readily drew the meadow bench in their design, ecologists who preferred to keep people outside the meadow itself did not roundly embrace this proposal. This design element is on hold.

Initiatives to continue to improve the IFNH landscape included replacing a sedum and native grass rooftop garden within the IFNH dining terrace with a kitchen garden to provide fresh herbs for the Harvest Café. This garden was designed by a landscape architecture studio and installed by a freshman seminar in collaboration with the student farm and the kitchen chefs.

5 IMPACTS

“Campus as Living Lab” remains a new endeavor on campus; we have only begun to evaluate the many impacts it has had on our campus community. Future plans include collaborating with social science classes to measure these effects. We will reach out to the Human Ecology Department and the Collaborative Center for Community-based Research and Service to broaden and evaluate impacts. Since we are a science campus, we foresee including more science studies and collaborations in these outdoor living laboratories.
5.1 Learning

To be successful in preparing our students for the future, we need an additional type of cross-disciplinary mission that provides reality- and experience-based curricula. Students of today might be highly educated in theoretical scenarios based on textbook lessons but are often under-experienced in how to solve problems on (and in) the ground. Personally relevant and locally-based experiences create a sense of ownership, place, and importance that can encourage lifelong love of learning and exploration in a wide variety of subjects within or outside of student’s chosen career track. Reality-based education involves interaction with a diverse set of faculty and operations staff, local ecosystem, and campus landscape, and makes students active participants instead of passive observers or memorizers. This type of teamwork education creates skills and expertise in creativity and flexibility so as to prepare successful students in our changing environmental, social and economic circumstances.

Our goal is to transform the campus into an environment where students are immersed in sustainability with living labs at the heart of this strategy. All of our landscape interventions support sustainability in one or more ways (e.g. Amphitheater Garden = Social; Pollinator Garden = Environmental; Low-input Turf = Economical). Student interest in sustainability is very high, with twenty student organizations coming together as a coalition to advocate for a University Office of Sustainability.

Living Labs reach a broader student body through the following directives: Scarlet Day of Service (university-wide volunteers who assist with garden stewardship); Green Team (student stewardship jobs); Tours for STEM middle schoolers; Rutgers Day (university-wide community day); classes outside the Landscape Architecture Department (Freshman seminars; Science Communication); Minors in Sustainability and Green Tech. The youngest study body touched by Campus as Living Lab is the Culture of Health Academy Nursery School (vegetable wagons to grow healthy snacks and teach about plants and nutrition).

Our campus living labs also reach out to other university communities. For instance, the historic Arbor Trail Living Laboratory at the Rutgers Inn and Conference Center’s student involvement included: unearthing the trail network and former stream raceway; creation of a landscape management and environmental education plans. Through a collaboration with the Rutgers Makerspace, this landscape will be interpreted by a mobile app.

Living Labs are an invaluable opportunity to practice Landscape Architecture on our campus. Planting Design class, and three freshman seminars have been actively tied to these sites as research sites and as design installations. These projects function as a living laboratory for landscape architecture students in several ways. As a practicum, they learn how to order plant material from a wholesale nursery (pricing and availability). They take a design from “the boards” to the field, testing and amending the soil, accepting the plant delivery, laying out and planting the material, and stewarding the landscape (watering, weeding). For the meadow border installation, two planting methods were used: stripping of existing sod and planting into bare earth; killing existing sod and direct planting into it. This allows students to observe...
differences in weed propagation as the garden is established. Although it is uncommon to see planting crews of twenty-five people, collaboration has been high-level. Students with landscape installation experience mentor fellow students. The large, moderately efficient crew transforms a landscape quickly (similar to HGTV), adding to positive feedback, even before project completion. One derogatory comment came from a faculty member who referred to the class as a “chain gang,” but for the most part campus reaction to the modified landscape has been positive. Students watering and weeding the gardens have received only positive feedback from people climbing the entry stairs to go to work, eat at the café, or cut across campus. The installation and stewardship component also brought unexpected benefits: It is assumed that receptivity to the landscape is positive in part because of the overt display of the students’ efforts. Installation and stewardship have also created a deeper connection between the students and the garden—a sense of ‘ownership’ that extends to the department level in terms of pride of campus. Students who have graduated come back to visit the gardens they planted—a type of living legacy. Many of the students have also won student chapter design awards for their gardens.

5.2 Research

A turfgrass living lab demonstration site was installed next to IFNH as part of Dr. Kristen Nelson’s (University of Minnesota) USDA-funded study, “Transitions to Sustainable Vegetation: The Case of Fine Fescue Turfgrass on Higher Education Campuses”. As much a demonstration plot as a research site, Dr. Nelson will study people’s reaction to low-mow, low-input fine fescue turfgrass in a campus setting. Nelson was intrigued by the location because we had used no-mow turf in the Meadow Border. Results from this study are intended to benefit public land managers in terms of benefits and efficient management approaches in order to promote conversion of public lands or residential lawns.

An Advanced Landscape Plants class exercise developed a methodology for assessing raingarden landscape performance. They visited three on-campus and several off-campus raingardens. Starting with campus raingardens, an initial exercise taught plant recognition for measuring biodiversity, quantification of stormwater capacity was compared to potential stormwater runoff, and an aesthetic scoring system was developed based upon a suite of factors. After the method was documented, it was applied to off-campus raingardens. Students produced a final booklet reporting the methodology and results that can be found on the LAF website.

Pollinator gardens support the food theme at IFNH. Designed by Planting Design students to support native bee conservation, these gardens are the focus of a freshman seminar co-taught by Dr. Christina Kaunzinger and Dr. Kimberly Russell. Students counted and identified bees attracted to different garden designs, identifying the most successful plant palettes. These pollinator gardens have a conservation purpose because they support specialist bees which require a specific and narrow plant palette to survive.

![Pollinator Garden](image)

**Figure 4: Pollinator Garden**

(a)Specialist Bee Diagram (b)Bee Collection (c)Pollinator Garden installation

5.3 Equity

The Harvest Café supports the Rutgers Center for Adult Autism Services by hiring some of its clients. Their clients work inside the Harvest Café in the winter and outside on the grounds in the summer as part
of the Green Team when the café is closed. The Green Team is a student group that steward and promote the Living Labs on campus. One of our landscape architecture students took the Autism Center’s training program and worked side-by-side with the client and his advisor. Horticultural therapy clients may also join the Green Team. While we are not training our students to enter psychology careers, we are exposing them to different modalities of inclusion and valuing the diversity of people in the community.

5.4 Community Transformation

Looking at our collection of IFNH living laboratory gardens, the meadow was the landscape change that generated the most controversy. The student meadow border planting appeared to have helped to ‘change the tide:’ many people walking through the construction site on their way to work stopped and commented positively about the work. Several other endeavors on our part helped to develop community acceptance by revealing the dynamic nature of meadow biodiversity: a model depicting the meadow as a garden, placed, like a sculpture, on a student-designed and -built pedestal placed in the café across from a view of the meadow; ecology research interns created Weekly Meadow Bulletins which revealed the changing biodiversity of the meadow.

Community engagement related to the meadow increased. Faculty members occasionally assisted with onerous tasks like mulching in 90-degree heat and planting four 14’ tall multi-stem Honey Locusts. Subsequently, initiatives were launched by IFNH personnel to increase appreciation of the meadow landscape. The first initiative came from within the IFNH building. As the meadow evolved in its second spring, staff began to champion the meadow on social media. An informal “meadow watch” was started by building staff (namely Cindy Rovins, Agricultural Communications Editor, and Jennifer Chudy Simon, Editorial/Media Relations Specialist) who noted (and photographed) the increase in bird activity at the site as well as butterflies, dragonflies, and other insects, in addition to the changing plants in bloom. People were starting to admire the meadow as they walked up the stairs or looked out of their windows. To capitalize upon the growing interest in the meadow, we created a Living Laboratory exhibit at the Harvest Café, showcasing student designs and exposing the gardens’ curricular underpinnings. The Harvest Café asked us to leave the exhibit up for their intercollegiate symposium, “Menus of Change.” Conference attendees remarked on an innovative tie-in between plant-forward menus, food sourced from adjacent gardens, and a plant-based diet.

Figure 5: Community Engagement: (a) What’s in bloom this week (b) Living Laboratory Exhibit

At a larger scale, living laboratories are part of a new University-wide initiative nicknamed the Scarlet Pimpernel project that aims to enhance and link hands-on research and education through a network of on- and off-campus resources and experiences in gardens, forests, and biodiversity collections. This new network enhances and innovate college education, promote lifelong learning, and enrich human lives as part of sustainability and conservation of global natural resources. The project creates connections to arts and humanities, as well as business, engineering, medical programs, and more--within the university and reaching to the world outside of Rutgers, together becoming more than the sum...
of our parts and serving as a model for how integrative and experience-based learning works inside and outside of the classroom.

6 CHALLENGES

Of course, it’s not all that easy.

Whereas indoor laboratories have been part of the built environment at campuses for a long time, outdoor labs bring new constraints. Staff support for living laboratories is an extremely important aspect of ensuring the success of the living lab endeavor--involvement by University Facilities, responsible for the repair, maintenance, replacement, support services, and construction could make or break an individual project or the overall framework. Many things converge here that make building a positive relationship with Facilities on our campus more complicated: understaffing; different aesthetic goals; incompatible maintenance guidelines; etc. We share a common understanding that faculty and staff must both provide support for student learning.

Challenges inhibiting our success include an understaffed grounds crew, conflicting definitions of landscape stewardship, lack of education on natural ecological dynamics and ecosystem services. Here are some of the remedies we are trialing: The director of our soil testing lab volunteered to develop continuing education classes in Landscape Best Management Practices which she has offered for grounds staff; the student Green Team maintains the teaching landscapes; we operate with a general spirit of goodwill despite differences in priorities.

The Institutional Planning and Operations website says that they “are committed to serving the university community by providing the appropriate environments for living, learning, teaching and working, all in support of the university’s mission and goals.” As a result, we receive a higher level of cooperation with Facilities when we are installing a new garden in a class. Younger staff are enthusiastic about interacting with students, but lack authority to make decisions about time allocation. One member of the grounds crew is enamored of our planting installations because the students work so hard and create a finished product. We enjoy collaborating with him for delivery and moving heavy materials (mulch, soil, compost, stone, etc.) and overnight storage of plant material that was not installed. Facilities has also removed trees and heavy structures from our garden sites. We have to hire outside contractors for grading, moving large trees, and other highly skilled labor or specialized equipment.

7 CONCLUSION

In conclusion, the IFNH landscapes provide rich educational landscapes but not without challenges. Pedagogically, they easily become living laboratory components and reflect the University’s mission for outreach, teaching and research. As we noted in our examples, the program has created a sense of ownership amongst the students who are involved, developed support from the administration, and has found ways to collaborate with Facilities.

Yet it came as no surprise that resistance to these non-traditional landscapes centers around a negative reception from Facilities. In comparison to mowed lawn, these new landscapes require more weeding and watering. Plant varieties are not recognized, and distinguishing between a native meadow perennial and a weed is difficult without retraining. One solution under trial is the partnership between the student Green Team to work in conjunction with Facilities to maintain these new landscapes. Because these new landscapes represent and reflect the campus’ core values, and because they have pedagogical importance, our campus administration is willing to continue funding their upkeep, even if it means devising new types of maintenance delivery.

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6 Rutgers Institutional Planning and Operations Mission Statement, Retrieved January 21, 2109 from: https://ipo.rutgers.edu/facilities
The parsing of what is an acceptable campus landscape is a side effect of these new projects. Another critique of these landscapes comes from campus faculty. Reception of these landscapes by students has been less fraught than by some faculty who may be trained to "see" and understand plants differently than a lay person. The discussion of what is a 'good plant' has ensued: Should we be planting native plants only, to restore degraded natural ecosystems? Are cultivars of native plants worthy of positions in these landscapes? What is the role of ornamental plants? Of weeds/ novel plant assemblies? Thus, the social dimension of the plantings has great nuance and has generated discussion and even conflict while interdisciplinary collaboration (between LA, turf science, urban forestry, ecology) has occurred in the design and even installation phases of the project. Perhaps the campus landscape can develop in ways to more effectively demonstrate these different epistemologies to deepen the campus dialogue.

8 REFERENCES


IFNH Vision Statement, Retrieved January 21, 2109 from: https://ifnh.rutgers.edu/about.html


Rutgers Institutional Planning and Operations Mission Statement, Retrieved January 21, 2109 from: https://ipo.rutgers.edu/facilities


ENGAGED FIELDS: THROUGH LANDSCAPE PHOTOGRAPHY AND LANDSCAPE ARCHITECTURE LINKS

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1 ABSTRACT
The landscape of the United State contains palimpsests of infrastructure: rail lines, power lines, water lines, section lines, and pipelines, all built and rebuilt on Jefferson’s square-mile grid. Historically, artists and landscape architects observed and mapped our most significant American environments as this grid made its indiscriminate march westward. Many of today’s highest culturally valued landscapes, paramount to American identities, were recorded, interpreted and preserved by landscape architects and artists at the forefront of environmental and cultural advocacy.

This paper traces a history of synchronous and sometimes inadvertent conversations, between landscape architects and artists beginning with photographer, Carleton Watkins and landscape architect, Frederick Law Olmsted in the 1860s and their contemporaries William Henry Jackson and Timothy O’Sullivan and H.W.S. Cleveland. At a time when few had knowledge of or access to the lands debated by public officials, the photographs, maps, and written arguments created by Olmstead, Watkins, O’Sullivan, and Cleveland helped introduce and connect the public to national land resources and decisions over their management. The work also looks to Robert Smithson and more recent collaborators, photographer Richard Misrach and landscape architect, Kate Orff as a bridge to our own work aimed at interpreting the large-scale social and environmental impacts of accelerated oil and gas extraction in the Bakken region of western North Dakota, with the recent Dakota Access Pipeline incision.

Our collaboration examines how the disciplines of landscape architecture and visual arts can explicate the multifaceted impacts of infrastructure development in a local region. Rather than foreground the individual photographer’s feelings towards or interpretation of a given space, environmental photography highlights the role of biological and engineered inputs in shaping a landscape. Together, we identify with J.B. Jackson’s description of a landscape as “a ‘synthetic’ space, a man-made system of spaces superimposed on the face of the land, functioning and evolving...a composition of man-modified spaces to serve as infrastructure or background for our collective existence” and this perspective guides our work in the Bakken. Through our own cross-disciplinary conversation we ask what we can do as environmental designers and artists to foster and support public dialog about the development of natural resources--as did our disciplinary predecessors and show as a result one example for engaging with large-scale social and environmental challenges of this century.

1.1 Keywords
Environmental Photography, Environmental Planning, Oil Extraction, Olmsted, Watkins
2 INTRODUCTION

The landscape of the United State contains palimpsests of infrastructure: rail lines, power lines, water lines, section lines, and pipelines, all built and rebuilt on Jefferson’s square-mile grid. Historically, artists and landscape architects observed and mapped our most significant American environments as this grid made its indiscriminate march westward. Many of today’s highest culturally valued landscapes, paramount to American identities, were recorded, interpreted and preserved by landscape architects and artists at the forefront of environmental and cultural advocacy.

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Our work in the Bakken region aims to bring together the perspectives and analytical tools of fields within landscape architecture and photography: environmental planning and environmental photography. Both are process-driven disciplines that produce work to represent places and issues in the context of time. Within the discipline of landscape architecture, environmental planning is considered “the theory and practice of making good, interrelated decisions about the natural environment (natural resources, wildlife, and natural hazards), working landscapes (farms, forests, and lands from which minerals are extracted), public health (waste disposal, air and water pollution, and toxins), and the built environment (Daniels and Daniels 2010). Environmental photography describes a mode of landscape photography in which the artist examines the landscape in relation to its use and management. Rather than foreground the individual photographer’s feelings towards or interpretation of a given space, environmental photography highlights the role of biological and engineered inputs in shaping a landscape. Together, we identify with J.B. Jackson’s description of a landscape as “a ‘synthetic’ space, a man-made system of spaces superimposed on the face of the land, functioning and evolving…a composition of man-modified spaces to serve as infrastructure or background for our collective existence” and this perspective guides our work in the Bakken.

2.1 To Access Dakota

In Fall 2016 the construction of an oil pipeline drew national and international attention to the northern plains. Created to transport crude oil from the Bakken shale fields (See Figure 1.) in northwestern North Dakota, the Dakota Access Pipeline is now incised across four states and runs underground for 1,172 miles. Planning for the 3.78-billion-dollar project began in 2014 and...
construction was completed in May 2017. An estimated 520,000 barrels of oil now flows through the 30-inch diameter pipeline each day.

Substantial public opposition to the monumental infrastructure project grew in response to protests by members of the Standing Rock Sioux tribe over the pipeline's route, which passes underneath Lake Oahe (a man-made reservoir on tribal land) and in proximity to the reservation's water inlet. Protesters (water-protectors) argued that the new pipeline poses a significant risk to their drinking water supply and construction activities threatened sacred sites, conspicuously missing from cultural inventory documents. Thousands of native and non-native supporters traveled to North Dakota to voice their objections to the project. Across the world, many more individuals expressed solidarity through local marches and social media platforms.

Alongside declarations of support over the David-and-Goliath plight of the Standing Rock Sioux, protesters raised their voices against a host of other issues related to pipelines and large-scale infrastructure development. Why are massive pipelines being built to support the development of fossil fuel industries? Who benefits from their construction? What are the risks of pipeline development and who is most affected? Who approves a pipeline? How and when can an individual or group object? What information are they allowed to see and how is it communicated to the public?

Their questions reveal gaps in knowledge about the process of planning infrastructure projects and how the public can participate in the discussion over shared resources. Further, the conversation generated in response to the construction of the Dakota Access pipeline corresponds to a broader pattern of disconnect between the general public and planners who orchestrate infrastructure construction in the United States. Rarely does the average citizen confront the entirety of large-scale projects such as the Dakota Access pipeline until they fail? And once a spill, for example, occurs, a public airing of concern or questions over the merits and impacts of a project like a pipeline has little recourse beyond the waning news cycle. Finding little room for impact leads to public disengagement and, too, often, a feeling that any kind of infrastructural project is inevitable.

Designers and visual artists have an important role to play in addressing public knowledge of resource management processes, infrastructure development, and land use. Designers can distill large amounts of publicly-available data into clear communications and demystify the process through which elected officials and corporations execute infrastructure projects such as the Dakota Access Pipeline by using drawings, illustrations, and photographs.

Collaborations between landscape architects and photographers offer one such example of a design-based, multidisciplinary strategy for increasing knowledge about infrastructure development. Such partnerships have a long history, extending back into the late nineteenth century when environmental designers and photographers worked in tandem to influence the development of natural resources in the American West.
3 Historical and Field Research

Archival and field research for our collaborative work in North Dakota finds precedent in nineteenth and early twentieth century partnerships between landscape architects and visual artists in the American West. Historically, the contemporary works of photographer Carleton Watkins (See Figure 2.) and Central Park landscape architect Frederick Law Olmsted were instrumental in preserving the Yosemite Valley of California in the 1860s. The photographs and land management reports of the distinctive montane environment “provoked public reaction” like nothing before (Jarvis 2016). Photographs taken by Watkins captured the imagination of President Abraham Lincoln and helped lead to the deeding of the Yosemite Valley for "public use, resort, and recreation" in 1864. As DeLuca and Demo note, the pristine views of Yosemite captured in Watkins' glass plate negatives and tonally-rich albumen prints "quickly became iconic of an American vision of nature itself" and attest to the "fundamental role of landscape photography in the creation of Yosemite as the world's first wilderness area." (DeLuca and Demo 2000).
In August 1865, Frederick Law Olmsted delivered an address of his report, “Yosemite and the Mariposa Big Tree Grove,” in which he made an urgent appeal for public management of iconic environments. In this address Olmsted duly credits the paintings of Bierstadt and the photographs of Carleton Watkins as having, “given to the people on the Atlantic some idea of the sublimity of the Yosemite, and of the stateliness of the neighboring Sequoia grove, that consideration was first given to the danger that such scenes might become private property and … their value to posterity be injured.” (Olmsted 1865). These concerns are warranted once again as the Department of the Interior shifts its priorities, significantly constricting publicly accessible land of historical, cultural and environmental value and proposing “exorbitant new fees” for access to National Parks (Green 2017).

Elsewhere in the West, William Henry Jackson and Timothy O'Sullivan, contemporaries of Watkins, similarly established a role for visual imagery informing valuations of the American West through their work in conjunction with survey expeditions. Jackson’s photographs of Yellowstone made visual accounts of geysers, waterfalls, and other landscape features that were unknown to many Americans. The popularity of his imagery created widespread support for congressional action to designate the area as a national park. O'Sullivan's photographs of territory visited by the Wheeler survey in the early 1870s attested to the discursive potential of
landscape imagery as an analytical instrument akin to the work of geologists and other survey specialists. Robin Kelsey observes that O'Sullivan's work for this particular expedition borrowed conventions from scientific disciplines and "devised a specialized pictorial rhetoric to persuade viewers that the survey was securing practical gains in knowledge and that his medium could take part in this effort" (Kelsey 2006).

Together, as antecedents, the photographs of survey photographers such as Carleton Watkins, William Henry Jackson, and Timothy O'Sullivan's established a clear role for environmental imagery in the development of land as a natural resource. Their visual interpretations framed environments about a series of objectives and, in doing so, revealed a set of values towards land. Early photographs of the American West taken by survey photographs alternately foreground the landscape as a locus of American identity, a spiritual resource, and a source of economic development. Through the lens of these photographers, landscape photographs act simultaneously as documentation of a given space (See Figure 3.) and how it is valued by its viewers.

Figure 3. Meghan Kirkwood, DAPL marker, archival pigment print, 2016
3.1 The Wants of the West Revisited

In addition to the photographs and writings of Olmsted, Watkins, and O'Sullivan, nineteenth-century landscape architects began to take inventory of the landscape itself as infrastructure for economic and moral benefit; even before ecological benefits were identified. For example, landscape architect, H.W.S. Cleveland, a contemporary of Olmsted, created civic and public spaces and municipal park systems in both Minnesota and North Dakota that link and incorporate significant natural features. Cleveland was primarily concerned with the planning and arrangement of grounds (mainly) to adopt them "most conveniently, economically and gracefully, to any of the varied wants of civilization."

In designing his works, Cleveland collected and analyzed data related to regional infrastructure, calculating the board feet of raw lumber needed to satisfy the expansion of railway, roads, and cities through the west. From this research, he appealed to both "real estate proprietors, and the welfare and happiness of all future occupants" and, in an 1873 essay, 'Forest Planting on the Great Plains' Cleveland laid out a plan to renew resources (trees) ahead of future infrastructure demand. "The demands of roads which in time will certainly intersect the country in every direction," he wrote, "it is obvious that to forego the advantages which may thus be secured, is indicative of a 'penny wise and pound foolish' policy which is inconsistent with the energy and enterprise which resulted in the construction of the transcontinental railroads" (Cleveland 1873).

Together, these examples highlight ways in which designers and photographers used their respective processes to take part in any further public debates about the use and development of public lands and natural resources in the late nineteenth century. At a time when few had knowledge of or access to the lands debated by public officials, the photographs, maps, and written arguments created by Olmstead, Watkins, O'Sullivan, and Cleveland helped introduce and connect the public to national land resources and decisions over their management.

3.2 Infrastructure Reframed

Large-scale infrastructural developments such as the U.S. Highway system and Dakota Access Pipeline are planned to maximize the efficient transport of automobiles and oil between two points. Underground channels are cut in straight lines across varied terrain in order to minimize the use of materials and property litigation. As a result, pipelines and highways are often routed with minimal -- or secondary -- consideration for local geography, or other factors such as watershed boundaries, animal habitats, and cultural resources that shape regional landscapes. Imre Szeman observes that pipelines often operate both "in and outside of the logic of a region;" they draw upon regional resources -- such as Bakken Shale oil -- as points of entry and exit, but everything in between is an obstacle, whether due to scale, geology, or impacts on "communities that might challenge its logics and imbedded presumptions."

The similarities in government-sponsored railroad projects of the 1860s, for example, and government approved and/or subsidized infrastructure projects of 20th and 21st centuries are striking. In such a capacity Pierre Bélanger argues that modern engineering projects function as
colonizing projects. "Removed more and more from regional resources and dynamic biophysical processes," he writes, "the neutralization and normalization of a process are heightened by the security found in quantitative logic and numerical precision. Anthropocentric economies of expediency and exactitude simply externalized ecologies of race, class, and gender. The assumed neutrality of infrastructure is perhaps its most dangerous weapon” (Bélanger 2018). As linear, closed systems, large-scale pipelines create systems that isolate other life forms and minimize complexity. These types of infrastructure exert a divisive power that is often overlooked due to their complexity and banal reputation.

By attending to the dynamics of the local spaces impacted by a proposed or operational pipeline route -- just as nineteenth-century landscape architects and photographers revealed the complexities of public lands -- designers and visual artists can support a public understanding of the impacts of infrastructure. "Regions," Imre Szeman asserts, "are where the consequences of technologies—whether physical technologies such as pipelines or the technē of governments that establish borders and property—are felt most determinately." And though region lacks a precise definition Szeman suggests that “every region can be seen as a type of ecology—an environment (a contiguous geographic zone), the subjects that animate it (whether these are animals and plants, specific religious groups, the resources that lie beneath the ground, or the strata of the inanimate), and the relation between these two.” He further argues an understanding of regional dynamics must precede any attempt to challenge the indifferent systems of infrastructure and politics that carve up and control everything in their orbit” (Szeman 2018).

Understanding regional dynamics and the complex ways infrastructure impacts local communities, overlapping ecologies, and economies require collaborative and interdisciplinary efforts to decode current "use-value" modes of assessment. By combining views, maps, drawings, and photographs, for example, designers can elucidate the flow relationships between entities at stake on the landscape. "Since infrastructure is encoded with information systems and is exercised with power (democratic or not)," Bélanger observes, "mapping is a means of decoding externalities generating collective empowerment ‘and can underpin a social justice agenda by valorizing previously neglected people and things.’” (2018).

For example, our project brings together environmental photographs, maps, and site analyses that highlight disruptions created by large-scale infrastructure development in the Bakken region (See Figures 4 and 5). These combinations aim to provide ground-level views that can support a broader discussion over how North Dakotans want to develop the Bakken region. A photograph of a lonely, empty shopping cart or man camp buildings, for example, signals the decentralized and excessive form of the newest land developments in western North Dakota, which are further referenced in site analyses. In the context of our collaboration, such images can make further reference to the divergence between the development of the Bakken area during the most recent oil boom and the goals set forth by the state's current and previous leadership, such as former governor Art Link. In 1973, Governor Link said, "we simply want to ensure the most efficient and environmentally sound method of utilizing our precious ...
resources for the benefit of the broadest number of people possible” (Link 1973). The aims of balancing efficiency and impact fall appear at odds in the interpretive images and maps generated through our collaboration.

In sum, complex regions such as the Bakken -- which contains both the entry and first stages of the Dakota Access Pipeline -- environmental designers and photographers are in a unique position to interpret infrastructure impacts. Through site analyses, environmental designers can identify the scale and cost of interrupting biological, physical, and cultural relationships impacted along a pipeline route. Environmental photographers, by visualizing spaces and ground-level views of a region can return a sense of place to areas abstracted by the scale of a pipeline route. Together, by combining and blending modes of representation such as charts, section profiles, site analyses, and photographs, designers and artists can create a context for interpreting risk and benefit from multiple perspectives while attending to the complexities of a local region.

Figure 4. Dominic L. Fischer, Wells over Teddy, digital print, 2016

3.3 For the Land and Its People: A Collaborative Response

In the Bakken, as in many production areas, there is a healthy amount of publicly available data and research about extraction activity, but too often it is presented in formats ill-equipped to inform citizens or to ground public discourse: data sets, uncommon file formats, annual reports. The Bakken formation extends over 200,000 square miles, and the issues are affecting this area are as vast as its geography. The oil and gas development underlie an arc of physical implications that can be seen from space in the Earth’s low orbit, but little has been done to inform rural communities on the main street level.

As designers and visual artists, we are learning from the dialectics of our disciplines’ early practitioner pioneers and they have sought to develop a collaborative practice aimed at explicating the regional dynamics and impacts of natural resource activities in the Bakken region---from the Dakota Access pipeline to natural gas production. This collaborative practice
has developed over the past four years and has included a variety of initiatives: public exhibitions of our work at local research extension stations, panel discussions, class field trips and projects with our students, and an evolving portfolio of cross-disciplinary conversations about the Bakken region.

The contemporary work of landscape architect, Kate Orff, and photographer, Richard Misrach in *Petrochemical America* offers an important example of an intentional collaboration between the two disciplines, and their work has greatly informed our work in the Bakken region. Orff's richly detailed and researched maps and drawings provide a panoptic view of issues plaguing cities along oil trails in Louisiana and throughout the world. Misrach's images provide a ground-level context for the information put forward in Orff's boards. But whereas Orff and Misrach teamed up on a revisit of Misrach's 1998 series "Cancer Alley," which focused on the Mississippi Delta, we set out to provide collaborative representations in tandem through field visits, collaborative studio projects at North Dakota State University, and independent explorations. Further, our approach remains more forensic than the emotive and speculative aspects of Orff and Misrach's collaboration. We draw upon historical imagery and interviews to understand communities' cultural values and large geospatial data sets to uncover what has been clandestinely inserted into the fields of shale oil.

Our respective mapping of pipeline and well footprints in the Bakken region offers one example of how we use our disciplinary frameworks to interpret and visualize infrastructure development for a public audience. Hydraulic fracturing or "fracking" ignited the exponential growth of oil development in North Dakota, but artists have been grappling with the effects of oil drilling for much longer. For example, photographs by Edward Burtynsky and Chris Jordan were largely taken in the 1990s (Feldman 2012). Our works in tandem aim to explicate the physical, biological, and social impacts of new infrastructure put in place during the most recent oil boom and build upon models that primarily exposed hazards of development as an aesthetic experience.
One of the ways we explore the effects of new oil development in the Bakken region is to create works that render visible the structures that are designed to be unseen by the public. In a series of data visualization diagrams, Dominic Fischer offers a below-ground map (inverted on the surface) of a section of the Bakken region surrounding the cities of Williston and New Town. Each pink line corresponds to an individual well, and, together, the collection of linear forms protruding out from the landscape offers a new perspective on the footprint of recent development. In her photographs, Meghan Kirkwood also attempts to visualize the scale of new oil infrastructure put in place as part of the most recent boom. In *Pipeline Scar* and *Fields*, *Pipeline* she shows the footprints of two new pipelines in the landscape. Now installed and covered over with topsoil, the pipeline path remains visible through the discoloration of newly planted vegetation and reminds viewers of the presence of invisible infrastructure. In a different photograph, *Well pad near Church, Stanley* Kirkwood explores the density of new oil
infrastructure represented in Fischer’s diagrams by providing views of the narrow boundaries between oil extraction sites and residential areas.

Our research into the impacts of accelerated natural resource extraction also considers the impacts on iconic landscapes and tourist attractions, such as the Theodore Roosevelt National Park. The 110,000 square mile preserve is situated on North Dakota's western edge--ironically smack dab in the middle of conglomerate oil company leases, several of which can be seen from the rugged badlands near trust-busting President Roosevelt's 1883 Elkhorn Ranch.

Our diagrams and photographs explore the scale of development in and around the park area and make a comparative reference to the work of pioneering landscape architect, Weldon Gratton, who sought to develop the park in a manner consistent with its character. In 1935, when Gratton arrived at the Recreation Demonstration Area, later to be named Theodore Roosevelt National Park, he brought with him a design philosophy that respected the rustic, craftsmen, and prairie style precedents set at Yellowstone, but sought out collaborations with local ranchers and artists, specifically, blacksmith Einar Olstad, to find and express the identity of the park (Unknown Author 1963).

Gratton recognized the significance of ecological phenomena and master planned a system of roads and trails that allowed visitors to experience them in an optimized fashion. He oversaw a great deal of the park’s construction as a supervisor for a CCC camp of regional men who collected local prairie stone to build Gratton’s signature piece in the park: a panoramic overlook shelter framing a sweeping view of the Little Missouri River. At a time when the panoramic views Gratton framed so skillfully are being impacted by the discordant of natural gas flaring in the neighboring oil fields, our diagrams and photographs portray the challenges in preserving this important area.

In other sets of boards and photographs, we bring together different datasets to explore the relationships between new development and regional cultural resources. For example in one set of works we examine the proximity of new infrastructure development about cultural heritage sites in the Bakken region. In one board Fischer shows the locations of a set of "areas of interest" identified by the North Dakota Industrial Commission and active well-pads -- many of which were installed during the most recent boom. In a complementary image, Rodeo, Richardton, Kirkwood displays a trio of riders against a backdrop of a new ethanol plant. Other images, such as Mosque, Ross, North Dakota, show the site of the first mosque built in the United States, highlight other cultural resources in the Bakken.

Our collaborative work has also looked at the costs of new infrastructure development for North Dakota residents. In one board Fischer maps out the cost per North Dakota resident on new road construction in a single year. His research highlights the rapid rate at which cities have grown their footprints in response to an influx of new residents and businesses during the most recent boom--even though data and speculative mapping show contradicting needs. In her corresponding photographs, Kirkwood looks at new housing developments and road construction, many of which are empty or underutilized following the drop in oil prices and
waning oil development activity in the region. Furthermore, there are literal disconnections in
the hastily planned and built infrastructure, exacerbating land-use and road congestion issues.
3.4 Conclusion

The emergence of megapolis regions fueled by economies of mass scale and resource distribution makes it important to show where environmental liabilities are being created. In looking to spaces where the landscape is vast and sparsely-populated -- such as in rural North Dakota --, our collaboration works to identify disruptions of natural and cultural systems and give them a truthful scale and image. As a case study, our work in the Bakken region offers one example of how photographers and landscape architects can address the challenges of informing a public audience about the impacts of large-scale infrastructure development at a manageable and accessible scale.

Our process credits pioneering collaborations between designers and visual artists from the nineteenth century onwards and explores how collaborating across academic fields can make visible and actionable the perceived and real threats to the physical, social, and biological resources in a complex region such as western North Dakota. By combining our views of this dynamic setting we aim to not just provide accessible information regarding natural resource extraction impacts, but to create a forum in which qualitative, immeasurable factors assume agency: the feel of a transformed landscape, the way in which human presences are marked on the land, and the shifting scales through which residents feel impacts. Collaborative mapping projects such as ours seek to, as Bélanger describes, render “regional complexities more palpable, and closer to the ground,” and in doing so foster, “an emerging agency formed by senses and sensations, between uncertainties and interactions, content and contingency, the temporal and the transmissive, that ultimately lie between image and imagination.”
4 REFERENCES


ENGAGED SCHOLARSHIP THROUGH EXTENSION LANDSCAPE ARCHITECTURE: A MODEL FRAMEWORK FOR ASSESSING IMPACTS

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1 ABSTRACT

Many landscape architecture programs have rich legacies addressing tangible design dilemmas through community engagement, service-learning, and engaged scholarship. Those situated in land-grant universities often frame these activities as contributory to their institutions’ missions. While land-grant outreach is often stewarded by Extension faculty, few Extension faculty are housed within landscape architecture programs, despite the discipline’s rich legacy of community engaged projects. Of the few programs that maintain Extension landscape architecture faculty, little research has been published on how Extension augments and facilitate programs’ engagement of community-based design issues. This study assesses impacts of Utah State University’s Extension landscape architecture program’s known engagement work over several decades. Archival research identified the program’s extensive body of work, comprised of over 300 known projects performed over four decades. During this initial investigation, projects were inventoried, characterized, and catalogued according to project typology, site scale, geographic setting, decade initiated, and level of engagement with departmental faculty, students, community members, and others. From these known projects, 20 projects were selected for further investigation. The study found significant variation among projects’ outcomes, potential for projects clustered within proximity to achieve regional impacts, and the role of the department’s vertically-integrated annual charrettes in catalyzing additional work for both the department and professional design firms. As design programs strive to accurately assess the value of their work, this study offers a model framework for how programs can maintain comprehensive records and ongoing assessment of their community-based design engagement for retaining institutional memory—and future research investigations.

1.1 Keywords
Extension, impact assessment, community engagement, land-grant
RESEARCH METHODS WITHIN THE MLA: IMPLICATIONS FOR SCHOLARLY INQUIRY IN LANDSCAPE ARCHITECTURE

1 ABSTRACT

Many landscape architecture programs have rich legacies addressing tangible design dilemmas through community engagement, service-learning, and engaged scholarship. Those situated in land-grant universities often frame these activities as contributory to their institutions’ missions. While land-grant outreach is often stewarded by Extension faculty, few Extension faculty are housed within landscape architecture programs, despite the discipline’s rich legacy of community engaged projects. Of the few programs that maintain Extension landscape architecture faculty, little research has been published on how Extension augments and facilitate programs’ engagement of community-based design issues. This study assesses impacts of Utah State University’s Extension landscape architecture program’s known engagement work over several decades. Archival research identified the program’s extensive body of work, comprised of over 300 known projects performed over four decades. During this initial investigation, projects were inventoried, characterized, and catalogued according to project typology, site scale, geographic setting, decade initiated, and level of engagement with departmental faculty, students, community members, and others. From these known projects, 20 projects were selected for further investigation. The study found significant variation among projects’ outcomes, potential for projects clustered within proximity to achieve regional impacts, and the role of the department’s vertically-integrated annual charrettes in catalyzing additional work for both the department and professional design firms. As design programs strive to accurately assess the value of their work, this study offers a model framework for how programs can maintain comprehensive records and ongoing assessment of their community-based design engagement for retaining institutional memory—and future research investigations.

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INTRODUCTION & BACKGROUND

Many landscape architecture programs have rich legacies of addressing tangible design dilemmas through community engagement, service-learning, and engaged scholarship (Angotti et al., 2012; Horrigan, 2014; Lee, 2008; Chanse, 2011; Thering & Chanse, 2011; Yocom et al., 2012). Those situated in land-grant universities often frame these activities as contributory to their institutions’ missions. While land-grant outreach is often stewarded by Extension faculty—both on-campus and county-based—who share applied, technical, and research-based information with statewide and local constituents, few Extension faculty are housed within landscape architecture programs, despite the discipline’s rich legacy of community engaged projects. Little research has been published on how presence of dedicated Extension personnel lines among landscape architecture faculty augments and facilitates engagement of community-based design issues (Sleipness, et al., 2016). To fill this research gap, this study employs a combination of archival research, surveys of program students and alumni, interviews of key informants, and physical evaluation of project locations and built works to assess impacts of Utah State University’s Extension landscape architecture program over several decades. Following discussion of the project’s context and methodology, we discuss key findings and implications for community engaged scholarship in landscape architecture programs.

2.1 Engaged Scholarship as Design Response

As in other locales around the United States, Utah is faced with complex planning and design issues. Unevenly distributed population growth, rapid urbanization within an arid landscape, and large-scale landscape changes present a unique set of design challenges amidst the backdrop of the fast-growing context of the Intermountain West. Within the milieu of shifting demographics, economic transformation, water scarcity, natural amenity-driven rural migration (Howe, et al., 2012), complex relationships between Utah’s urbanizing Wasatch, rural communities, and nationally significant public lands (Winkler et al., 2007) is a geospatial context ripe with design opportunities.

Nationally, university landscape architecture programs have established themselves at the forefront of engaging complex issues through a variety of models of community engagement, service-learning, and engaged scholarship (Armstrong, 1999). Through collaborative service-learning models, they endeavor to address community-based economic, physical, and social dilemmas through collaborative processes that synthesize the creative and technical expertise of the university with local knowledge of the community (Angotti, Doble, and Horrigan, 2012). While these endeavors often employ a co-design process (Lee, 2008) during which end users are involved in a collaborative design process. In contrast with traditional design delivery models, these collaborative design models co-create shared knowledge between both stakeholders, faculty, and students. Relatedly, participatory action research (Reardon, 2000) engages stakeholders, design faculty, and students in collaboratively identifying and solving community-based problems. Within architecture, the East St. Louis Action Research Project at University of Illinois (Reardon, 1998) and the Rural Studio at Auburn University (Hinson, 2007) are particularly well known. Within landscape architecture, the Rust to Green NY Action Research Initiative (Horrigan, 2014), is just one example of participatory action research, service-learning, and other forms of engaged scholarship have become prominently enculturated within university landscape architecture programs. Collaborative models of design engagement often reflect a full spectrum of local settings along a rural to urban continuum.

2.2 Extension Landscape Architecture

While university design programs have enthusiastically embraced opportunities to engage communities through design, land-grant universities have other mechanisms for engaging the public in addressing tangible local needs—particularly through Extension programs. As publicly funded universities founded for the purpose of furthering agricultural and technical knowledge, land-grant universities have a heritage of applied teaching, research, and outreach oriented toward solving local challenges. First enabled by the Morrill Acts of 1862 and 1890—land-grant universities were originally established for teaching, research, and outreach of applied subjects, originally focused on agriculture, engineering, and technical disciplines. Their locations and year designations are illustrated in Figure 1. In the contemporary era, Extension programs are charged with extending applied research to local
constituents, often stewarded by Extension faculty—both on-campus and in county-level Extension offices. They share applied, technical, and research-based information with statewide and local constituents. However, very few landscape architecture programs at land-grand universities have faculty within their programs with formally enumerated Extension appointments. While by no means an exhaustive list, universities that have Extension landscape architecture programs include University of Kentucky, University of California Davis, Iowa State University (Evans and Anderson, 2016). With three faculty with formal Extension appointments, nationally Utah State University’s Landscape Architecture program has one of the largest Extension landscape architecture programs to augment and facilitate studio engagement of community-based design issues.

Figure 1. Land-grant universities within the United States, based on designation year (Source: USDA, n.d.).

Over the past four decades, Extension landscape architecture at Utah State University has played a major role in engaging local community stakeholders through a variety of engagement formats. These formats include serving an advisory role with the US National Park Service (NPS) Rivers Trails and Conservation Assistance Program, in which a designated USU Extension landscape architecture specialist provided assistance in reviewing and evaluating applications for local design assistance. Second, USU Extension landscape architecture specialists have provided design consultation to local community-based entities including municipalities, governments, and other non-profit groups in collaboration with other Extension personnel. In this capacity, they have also supervised both graduate and undergraduate students in assisting delivery of design assistance. Third, USU Extension landscape
architecture specialists have spearheaded, organized, and led annual week-long department-wide vertically integrated design charrettes. During the last seven years, Extension landscape architecture has also organized and overseen community design teams in which the university’s student chapter of the American Society of Landscape Architects (ASLA) have completed several community-based design projects. Lastly, Extension landscape architecture personnel have played an active role in soliciting, reviewing, and recommending community engagement projects into individual design studios—many of which are taught primarily by non-Extension landscape architecture faculty. Collectively, since 1973, these engagements encompass over 300 projects undertaken throughout the Intermountain West, with a concentration of projects within Utah, their locations illustrated in Figure 2. While many of these activities are not unique to Utah State University’s landscape architecture program, their occurrence under the official auspices of Extension is unique, considering that most landscape architecture programs nationally do not have designated Extension landscape architecture personnel. In order to fill the research gap on Extension landscape architecture programs, this study assesses impacts of Utah State University’s Extension landscape architecture program’s known engagement work over several decades.

Figure 2. Concentration of USU Extension landscape architecture project locations in Utah.
3 METHODS

The process of data collection and analysis followed a sequence of steps that included: identification of known Extension LA projects, construction of a project database to allow comparative analysis of their feature profiles, and identification of a smaller subset of projects for further in-depth study. During initiation of the study, the research team interviewed key program personnel and delved into a close review of departmental archives in order to compile an initial body of work comprised of over 300 known Extension landscape architecture projects from the previous four decades. During an iterative process of identifying, gathering, and reviewing archival documentation, overall and specific project profiles were constructed. Project documentation format ranged from original hard-copy drawings master plans and projects digitally stored in a variety of formats, some constructed using computer applications no longer widely available. Additionally, documentation was digitized so that archival data could be more easily accessed and quickly viewed. Concurrently with accessing, scanning, assembling, and organizing a digital archive of known projects, an overall digital profile was created, illustrating which projects were lacking in key documentation, as well as those that contained more complete documentation of project process, products, outcomes, and known identity of key informants who might provide additional clarifying information.

3.1 Initial Profiling and Selection of Projects for In-Depth Study

During the initial archival research of identifying the program’s extensive body of known work, projects were also inventoried and characterized according to project typology, site scale, geographic setting, decade initiated, and format of engagement by departmental faculty, students, community members, and others. From these known projects, 22 projects were selected for further investigation based on selection criteria including: availability of original design documents, willingness of key informants to be interviewed, and diverse representation of project typologies, setting, scale, and other dimensions. In-depth investigation of select projects included on-site observation and documentation, semi-structured interviews of key project informants, and examination of project impacts within their local and regional contexts.

3.2 Reconnaissance of Physical Sites and Interview of Key Informants

Upon selection of projects for further in-depth study, the research team conducted on-site reconnaissance, during which project sites were visited for observation and documentation. During these site reconnaissance visits, project features were mapped, photographed, and assessed for similarity—as well as substantial deviation from original design proposals reflected in the project documentation. Additionally, apparent human activity, condition and care of the built environment, and adjacent and surrounding land uses were documented to record substantial changes of land use within the immediate context of project sites. These observations during physical visits enabled comparative analysis between original designed uses and contemporary conditions. In conjunction with physical site reconnaissance, semi-structured interviews were conducted with key project informants. Interviews yielded additional data which—when juxtaposed with information gleaned from site observations and review of project documents—provided clarity on original project intent, as well as events following USU Extension landscape architecture project involvement.

4 FINDINGS

The study found significant variation among projects’ outcomes, potential for projects clustered within proximity to achieve regional impacts, and the role of the department’s vertically-integrated annual charrettes in catalyzing additional work for both the department and professional design firms. Following is a summary of key findings.

4.1 Erosion of Memory and Ripple Effects

When over 300 known Extension landscape architecture projects were first identified, the research team found the process of assembling, profiling, and categorizing the body of known project work required a substantial investment of time. With changing technology and data storage formats, accessing and retrieving digitally stored project data proved complex and required care. When coupled
with the inevitable personnel changes, retirements, and loss of key informants from previous decades, constructing a complete profile for each known project proved elusive. While we recognize this reality as a limitation of our study, we believe this logistical reality is also a key finding—particularly for programs nationally as they strive to study their own bodies of community engagement projects over time. Of all examined projects, vertically integrated charrettes—during which all members of the department participate in a week-long intensive design experience—were found to result in ripple effects and initiation of additional projects, akin to sparks cast from a fire. Engagement of community-scale projects were found to yield additional project opportunities—both for design as well as research.

5 IMPLICATIONS & DISCUSSION

As design programs strive to accurately assess the value of their work, this study offers a summary of a model framework for how programs can maintain comprehensive records and ongoing assessment of their community-based design engagement for both retaining institutional memory—and facilitating future research investigations. Demonstration of the value of our work, requires a clear institutional collective memory of our work, our partnerships, and our value.

While frameworks of data collection and organization (Francis, 2001) are imperative for future research investigations using design program project data, there is also a need to integrate processes that normalize maintenance of institutional memories. Duhigg (2012) identifies the routines of habit at the individual, organizational, and societal level that can support achievement of broader goals. Perhaps landscape architecture programs should adopt processes to habituate retention and archival of their program’s body of work in order to know what has been done before, to study impacts of previous generations of academicians, and celebrate the achievements of the work that we all know is valuable. Setting up process loops of cues, routines of habit, and celebration can assist in making institutional memory a habitual practice for design programs. Within the context of change, determining the original spark of combustion that initiated positive change can be difficult to ascertain. And often, these changes occur organically, quietly, and humbly—through relational bonds established over decades during the course of the project and carried forth by personal commitment of local champions. Personal humility of those stewarding the process is often key to establishing and maintaining relationships of trust. However, the low profile of key players—resulting from their concern for project outcomes and less on credit for those outcomes—can also make it difficult for future generations to identify those whose efforts deserve celebration. As opposed to simply categories of information to collect, maintaining institutional memory of projects requires a process of continuous and habitual maintenance of relationships that facilitates ongoing connection to projects.

Within landscape architecture’s broad narratives of design dialog, projects and associated design dilemmas addressed by engaged scholarship are akin to Bitzer’s (1968) exigencies described within a rhetorical situation. Like rhetorical exigencies—urgent needs intrinsic to a circumstance that cannot be left unaddressed—the design exigencies addressed by engaged scholarship are similarly paramount for local quality of life, economic stability, and global health.

While examined projects demonstrate profound and positive impacts, convenient and comprehensive data on the full roster of projects from the program’s four decades proved elusive, due to changes in personnel, technology, and erosion of institutional memory. Community engagement is increasingly viewed as a core competency—essential for landscape architecture practice readiness. Even within the context of increased expectations for research outputs, universities also recognize the value of community engagement activities, as evidenced by their striving to achieve Carnegie Community Engagement Classification (Carnegie Foundation, 2019). Value of these activities is noticed, particularly in fulfilling the land-grant mission and community service brand identities of universities. Universities are also beginning to measure
6 REFERENCES (Section title: Arial 11 CAP bold)

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PAVING THE WAY FOR BUILDING INFORMATION MODELING (BIM) ADOPTION IN LANDSCAPE ARCHITECTURE: A PRACTICE-BASED STUDY

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1 ABSTRACT
For those landscape architects who have up to this point been hesitant to adopt BIM, peer mentorship and experimentation are generating opportunities that were not available even a year or two ago. A growing body of emerging innovators are actively tackling the work of adapting BIM tools to meet the specific needs of the landscape architecture profession. Employing homegrown software workflow strategies from within the discipline, these innovators are charting a course for their peers, and a BIM landscape adoption roadmap is beginning to emerge. Drawing upon interviews with firms and practitioners conducted over six months, this paper profiles innovators who are creating and sharing their BIM workflows. Examples of BIM adoption in practice as well as academia are illustrated, serving as examples of the advancement in software modeling and visualization of landscapes that are a result of this model of open-source information sharing. Findings on benefits and drawbacks of BIM adoption within landscape architecture are included, establishing a baseline of the state of BIM adoption within the field. These findings explore common concerns voiced by academics, students, and professionals with regard to BIM adoption in landscape architecture: the issues stemming from lack of digital coordination between architects and landscape architects; the concerns over missing out on the increasingly large share of projects which mandate BIM proficiency; concerns over the investment necessary to train staff and purchase new software, and broader concerns about the ability of BIM tools to capture the unique aspects of landscape architecture.

1.1 Keywords
BIM, digital, simulation, modeling, 3D, data, technology
2 BACKGROUND

Building information modeling (BIM) is ubiquitous within the design-build industry, contributing to significant improvements in the efficiency of project delivery and maintenance. In contrast, landscape architecture workflows, particularly those in the United States, traditionally rely on hand-drawn sketches, 2D computer drafting, and 3D schematic massing models, with most professionals still working in AutoCAD and Sketchup (Sipes, 2014). Yet there a growing need for information modeling of site plans which current landscape architecture software cannot meet. This demand for complete project deliverables produced in a BIM application is driven by several factors: the interdisciplinary nature of many projects which involve the exchange of digital files with architecture and engineering teams which use BIM software; the increase in BIM requirements for public projects at the local, state and federal government levels, and the emphasis on sustainable sites and green buildings.

Although some landscape architects have adopted BIM workflows, there is evidence to show that attitudes towards BIM and landscape architecture are changing in the United States and abroad. For example, The American Society of Landscape Architects published the second edition of Integrating BIM Technology into Landscape Architecture in 2014, a lengthy manual which provides an overview of numerous BIM workflows. More recently, Landscape Architecture Magazine recently published two articles on BIM: The Limits of BIM (February 2016) and BIM There, Done That (August 2017). The British landscape Institute recently published the book BIM for Landscape (August 2016) in response to the recent BIM mandate on all public projects in the UK. The LandArchBIM website (landarchbim.com) is an independently-operated website which features dozens of tutorials on adapting Revit for landscape architecture. In 2016, Autodesk University featured a lecture by Raquel Bascones Recio of Autodesk titled The Secret to Landscape Modeling With Revit.

The factors that have driven the embrace of BIM by the architecture community, such as centralized collaboration and lifecycle management at all stages of production (Ding, 2015), will likely cause the adoption of BIM among landscape architects as well. The recent increase in literature and tutorials on BIM for landscape architecture indicates that landscape architects are testing these waters, perhaps indicating that the coming years will see dramatic shifts in the software used by landscape architects. This study aims to learn about the state of BIM in landscape architecture, and emerging trends that can be incorporated into new professional workflows as well as digital media curriculum in landscape architecture education. The research aims to capture the current and emerging practices in digital media within the field of landscape architecture as well as within the Architecture, Engineering, and Construction (AEC) profession. Through this study, landscape architecture digital media curriculum can be better calibrated in order to reflect the cutting edge of BIM in the AEC world, in turn better preparing landscape architecture students to become design leaders within the profession.

BIM is a technology, not a specific software program. Several pieces of software include aspects of BIM, most notably Autodesk Revit and Nemetschek Vectorworks. References to BIM describe the overall technology area, whereas specific references to a certain software title are intended to specifically discuss that particular application.

3 METHODS

The primary goal of this study is to understand the level at which landscape architecture projects are using BIM workflows, focusing specifically on BIM adoption in the United States, and supplemented with information from international landscape architecture design practice. The study was designed to capture information on several areas of BIM in landscape architecture: the current level of BIM adoption in landscape architecture projects; the profiles of firms which are adopting BIM in landscape architecture; the benefits and drawbacks of adopting BIM in landscape architecture; designers’ goals for the future of BIM and landscape architecture; common non-BIM workflows in landscape architecture; and attitudes of landscape architects towards BIM adoption within the profession. The study focuses on learning from practicing professionals who are in some way impacted by BIM in landscape architecture.

In order to capture this information, meetings and interviews with landscape architecture and AEC firms were conducted in order to learn about how BIM is being used in landscape architecture and site design. Firms of as many sizes as possible were represented in the study. Although the smallest firms are unlikely to be implementing BIM at this point in time, we felt it was important to capture the current digital media practices of smaller firms as well as larger interdisciplinary offices. Landscape-only firms which collaborate with architects were included in the study, as well as interdisciplinary and architecture-
only firms. Whenever possible, the research has taken the form of visits to design offices, where open-ended discussions with practitioners has enabled us to hear their challenges with BIM. In cases where landscape architecture firms had begun using BIM in practice, the interview would often include a demonstration of the software, and a presentation of the landscape projects which had been designed using BIM technology.

For the study, 20 firms were interviewed to understand their views on BIM in landscape architecture. Of these firms, 18 were located in the United States, one was located in Norway, and one was located in London. The decision to focus on U.S.-based firms was intentional. 21% of surveyed firms were under 10 people, 55% of firms were under 100 people, and the remaining 14% of firms were over 100 people. Two of the surveyed firms were primarily architecture-focused, one was interdisciplinary, and the remaining firms were primarily landscape architecture. Interviews were not structured similarly, but instead took the form of conversations led by the subject, focusing on discussion of project lifecycles, digital file management, and interdisciplinary collaboration.

4 FINDINGS

The research uncovered several recurring themes among practitioners. These themes included the lack of landscape-oriented BIM tools and menus, and the absence of a structured roadmap for the development of these tools. Other themes included comparisons between the United States and Europe regarding the speed of BIM adoption in landscape architecture firms; the importance of less visible work being done by architects to model the landscape in BIM; the benefits of file collaboration and coordination; and the presence of new visualization expectations which put further pressure on BIM software to accurately model the landscape. The findings from conversations and interviews with practitioners are summarized into generalized trends and patterns. Although these are broad findings, they do serve to “take the temperature” of the status quo, using a small sample size of willing participants to help identify the most meaningful areas of future exploration. The findings can therefore be used to develop a framework for studying specific aspects of BIM adoption in landscape architecture.

4.1 Lack of Landscape-Specific BIM Tools

Revit, the most popular BIM software among those interviewed, currently does not have a fully-functional toolset for landscape design. Moreover, the interviewees indicated that they do not believe that there is a documented roadmap for improving site design tools in Revit in the future. Some landscape architecture firms have opted to adopt Revit completely into their design workflow, and have found that the benefits outweigh the challenges. One firm that was interviewed uses Revit increasingly for entire projects, although they did mention that they rely primarily on AutoCAD and Sketchup. Several practitioners have found that using Revit has allowed them to constantly document the realities of project construction, whereas previously they would have unresolved questions which could not be answered completely without further project documentation. One firm’s practitioners mention that Revit has allowed them to hold contractors accountable, because the digital model leaves little room for interpretation of design drawings.

Several roadblocks exist which prevent the fast-tracking of BIM workflows into landscape architecture. First, the profession is small compared to architecture, and software manufacturers unlikely to refocus much of their energy outside of the AEC industry. Second, many landscape architects mention their hesitation about the initial investment vs. long-term benefits of adopting BIM. These costs include includes cost to purchase Revit, employee training, and any slowing down of project delivery while designers learn new software. Third, many landscape architects who were interviewed described a personal belief that the complexities of landscape architecture systems cannot be adequately supported by a single piece of design software.

4.2 Benefits of Digital File Collaboration

For the majority of landscape architecture firms surveyed who have not yet adopted a BIM workflow, interdisciplinary collaboration presents the most significant challenges. In the typical AutoCAD workflow described by practitioners, the design process is not automatically coordinated with the architect’s BIM documentation. Typically, in such workflows, the architect sends building plans which may have been updated to change façade details and building entrances, and which no longer coordinate with the grading
plan. The landscape architect will in turn regrade and send the new site plans over, only to discover that in the meantime the architect has created further changes which in turn affect the site plan. In contrast, collaboration through a centralized digital model allows rapid design advancement without file conversion or exchange. Many practitioners emphasized that whenever their digital files were converted, sent, or received between parties, gaps were created in the digital workflow. BIM collaboration eliminates these gaps – everyone is in the same model. When landscape architects do not use BIM, these gaps are amplified every time they exchange files with architects. Over weeks and months, practitioners described how these gaps could cause nearly unworkable lapses in collaboration between both architects and landscape architects.

4.3 Increased Adoption of BIM in Landscape Firms

One landscape architecture firm that was interviewed has been using Revit for close to a decade, and has developed many proprietary methods to create interoperability with other software such as Rhino and Sketchup. Specifically, this firm uses AutoCAD, Civil 3D, Rhino, SketchUp, Revit, some GIS via Map 3D, and the typical Adobe Creative Suite products. Although they described Revit as their BIM software of choice, they emphasized that Rhino was the clear leader in form-making. Those interviewed at this firm indicated that it was not feasible to train everyone on BIM all at once. Instead, they have maintained a specific project team of 4-5 people that works on all of their BIM projects.

UK and Scandinavian firms are generally scaling up their BIM proficiency quickly. This is due to both BIM mandates as well as specific project requirements where heavily infrastructure projects require interface with architects and civil engineers. Scandinavian firms are using Revit and Dynamo to overcome the issues with Revit topo modeling, and are also using Civil3D to do some topographic modeling work. Much of the push these firms mentioned regarding BIM adoption is due to the builders, who are no longer using drawings onsite, but rather are using software such as Navisworks to manage the construction process. One engineer in Norway leads a team that includes approximately 40 landscape architects who are learning Revit and Civil3D.

4.4 Architects Model Landscape With BIM

Out of necessity, architects who were interviewed mentioned using Revit for basic site modeling. In scenarios where they work with a landscape architecture firm tasked with designing just a small site adjacent to the building, the architects will be left to model the larger context for analysis and visualization. Architects mentioned that several days could be spent simply modeling the existing building context in Revit.

Architects also indicated that site design in Revit presents issues with visualization. Although Revit offers the ability to draw completely flat surfaces such as interior floors, exterior surfaces must be graded for drainage, and these surfaces require triangulation. Revit automatically triangulates any surface that is sloped in more than one direction, and materials applied to these surfaces appear fragmented. Architects have found that they must use Photoshop post-production in order to make these fragmented materials look correct. Because architects typically rely on Revit to offer a complete package for design modeling and output, and expect Revit to seamlessly export visualizations, these landscape-centric issues disrupt the seamlessness of the architects’ workflow.

The architects who were interviewed also indicated heavy reliance on virtual reality to communicate with clients. Virtual reality scenes require some site context to be believable by the viewer; buildings and site features cannot be floating in space. Yet with the many difficulties of accurately modeling the immediate site context in Revit, 3D rendered buildings often appear to float without any ground plane, or have other gaps in the site context. Architects also spoke of the time issues related to exporting their work in 2D for the landscape architect, as well as receiving landscape architect work in 2D – which then needs to be integrated into the 3D BIM model

5 DISCUSSION

During these interviews, landscape architects mentioned that because building design iteration is occurring within the architect’s centralized Revit workflow, the iterative process occurs much more rapidly than it did before BIM was a prominent workflow for architects. Both architects and landscape architects
mentioned that although the potential uses of BIM in landscape architecture (drainage, scheduling, families) are important features to have, the immediate and most common problem they face is the lack of interdisciplinary digital collaboration. This lack of collaboration may form its own self-created barrier to BIM adoption by landscape architects, where shared digital file management with architects seems like a difficult or impossible structure to manage.

Despite the slow pace of BIM adoption in landscape architecture and the lack of fully-functional landscape modeling tools, most of the participants interviewed indicated that they felt BIM would eventually become a common way of working digitally in landscape firms. Although barriers to adoption exist, most individuals expressed interest in learning to design the landscape with BIM tools, and expressed apprehension at the idea of missing opportunities to work on projects which have BIM documentation standards as part of their requirements. Overall, these interviewed not only provided insight into the problems and benefits of working with BIM for landscape architects, but they also indicated that BIM is a persistent concept which most landscape architects now clearly comprehend. Through persistence, BIM landscape workflow strategies are beginning to gain a foothold within some design firms, and these workflows are documented and disseminated to increasing numbers of landscape architects. From within the discipline, these innovators are charting a course for their peers, and a BIM landscape adoption roadmap is beginning to emerge.

6 REFERENCES


Visual Communication: Application Research of Virtual Reality Technology in Landscape Exhibition

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1 ABSTRACT
The purpose of this paper is to analyze and evaluate the immersive experience modes effects of Virtual Reality (VR) technology commonly used in landscape exhibitions. As a good way to spread landscape knowledge to the public and promote communication, landscape exhibitions have become maturer in China in recent years. With the development of digital technology, VR technology has been used more frequently in landscape exhibitions instead of the traditional two-dimensional performance. VR technology creates a virtual environment for users in a simulated way through the perceptual behaviors, users can create a feeling of immersing in the virtual environment, which helps them better understand the scale and experience the content of landscape design, with a strong interest and interactivity.

Firstly the paper introduces the VR technology types: fixed-end VR and mobile-end VR (they have 2 modes: interactive experience mode and 360-degree panoramic photo mode). Then the paper analyzes the specific VR technology workflow (modeling-rendering-display and interactive participation). The research uses indicator evaluation methods by comparative case study based on 4 representative projects (Sihe garden, Chaer courtyard, Slender West Lake, North Central Axis), which were displayed in “Green Corridor 2020” exhibition hosted by Beijing Forestry University during 2016-2018 Beijing International Design Week. The results reveal the effect levels of different VR modes in terms of immersion, participation, operability and convenience, its proved that different modes make diverse interaction effects with visitors, and further suggestions for optimizing the display effects of VR technology in landscape exhibitions are discussed at last.

1.1 Keywords
visual communication, virtual reality technology, landscape exhibition, immersive experience mode
2 INTRODUCTION
As a cutting-edge technology, Virtual Reality (VR) technology has been applied to urban and rural planning, landscape design and landscape education. Due to the interactivity, immersion and imagination of VR technology, it has been widely used in landscape exhibitions. VR technology can intuitively present landscape changes in the scene. The substitute and visual characteristics of virtual reality will give people a comprehensive and meticulous experience, allowing visitors to interact better with the scenes, thus promoting visual communication. Since China's landscape exhibition industry started late, there are not many researches on the application of VR technology in landscape exhibitions. Most of the researches are about the characteristics, classification, methods and application prospects of VR technology[1-5]. The combination of VR technology and landscape exhibition is the development trends in the future, so the analysis of VR technology applications in landscape exhibitions can help better understand the effects of VR technology and provide reference for future development of VR technology.

2.1 VR technology mode
According to different types of VR playing devices, the paper divides into two modes of VR: fixed-end VR and mobile-end VR. Fixed-end VR refers to Oculus Rift, HTC Vive and Sony PS VR represented with external computers and professional sensors device. Mobile-end VR refers to devices that use Gear VR, Days VR, and Google Cardboard, kinds of low-cost recommended glasses, as the main device and mobile phones as players[6]. The table 1 compares the device differences, superiority and shortage of the two modes.

The fixed-end VR (interactive experience mode) has a deeper immersive experience than the mobile-end VR (360-degree panoramic photo mode). Since the device can capture the user's activity status and feed back into the VR environment, the user can directly interact with the design program, which enable users to more accurately assess the design. The platform display of the fixed-end VR often needs to construct an independent VR experience space, which includes the construction of sensing devices, transmission devices, and calculation devices, and requires a certain amount of space. It is more complicated and requires higher equipment that is less convenient. With the development of technology, there is an all-in-one VR with both various function and portability. It is a VR head-mounted display (virtual reality head-mounted display device) with independent processor, which can make independent operation, input and output. The function, although not as powerful as the external VR head-mounted display, is not bound by the connection, the degree of freedom is higher, which is the direction of VR development in the future.

The mobile-end VR often utilizes the linkage between the cloud platform (like 720yun.com) and the mobile phone software. The hardware end only needs to provide the mobile player and VR glass like Google Cardboard. Logging in to the cloud platform allows you to view the uploaded panoramic images, which is very convenient. The superiority of the mobile-end VR is that it is portable and the price is relatively cheap. The shortage is that it relies heavily on the performance of the mobile phone. The higher the resolution of the mobile phone, the clearer the picture and the experience will be better. However, since this mode mainly introduces and views images through 360-degree panoramic photo shooting, there is still a certain gap compared with the real immersive experience of the fixed-end VR.

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Figure 1. Fix-end VR and mobile-end VR (2018) Photo by the author.
2.2 VR technology workflow

VR technology requires three major processes from implementation to final presentation: modeling-rendering-display and interactive participation. The first step is modeling. Modeling is to use the Sketch, Up Rhino, 3DMax and other modeling software to build a 3D digital model in a computer[6], transform the design into a physical space model, and prepare for the subsequent rendering. For the immersive experience mode in the fixed-end VR, since the user can walk around in the model at random, basically requires comprehensive modeling, and the fineness of modeling requirements is very large; for the 360-degree mode, which just need some certain angles of view panorama, the amount of modeling will be greatly reduced. The second step--rendering, is the process of visualizing the model, relying on V-ray, Lumion, 3DMAX and other rendering software to render the light environment and material model, fixed-end VR animations often require continuous images, so workload and equipment are more demanding. In addition, some auxiliary software such as Adobe Photoshop, Adobe Premiere, and Adobe After are also applied to other auxiliary work, including icon production, soundtrack production, etc. The final step is to interactively display to the users, which be completed by rendering model imported to the device side and displayed using the VR device described above.

2.3 VR technology display function

The main application of VR technology in landscape exhibitions currently is the effect expression, but its experience is not only as simple as the enhanced version of the renderings or the advanced version of the animation, with the sound and even the sense of touch, there will be a real immersive "station" in the scene with VR device, because the fixed-end VR has an immersive experience, so in the scene users can also take a step like the real walking, or “moving in the moment” through the handle, they can better perceive the landscape environment. The light simulation function can simulate the change of illumination in the real landscape. The designers can also use the light simulation to evaluate which parts of the site will be blocked by the building, and which light time is longer. This information can guide the plants selection.

VR technology is not only an expression tool, but also has the potential to subvert the design industry in the future. It can truly assist users in interactive design, improve design results and work efficiency. Now it is possible to carry out some design and operation in the VR scene, such as grabbing and placing objects, changing the material and color of the building skin, changing the style and material of the interior furniture, replacing the pieces in the landscape, even directly design the terrain in the garden. In addition, the VR technology can achieve the designer's long-awaited collaborative work: as long as the VR device is worn, multiple people can be immersed in the same virtual scene to discuss the project. Users can also use the brush to annotate in the scene, and take a photo to generate a panorama and send it to phone for real-time viewing. So VR technology has great potential in terms of interactivity and operability.

The information of various elements can be directly reflected in the VR scene. For example, a city scene can show the city's population, building density, shopping mall information, etc., to facilitate the operation and management of the city; if it is a model room of real estate, it can display the size, price, and material of various furniture and building materials; in regard to landscape scene that can display various plant information and can play the role of science education. In VR scene, hidden information that was previously invisible can be directly and clearly expressed, and visualized expression of information can be realized. Smart navigation can also be implemented in VR, similar to Google Map in the virtual world, which can identify the position and orientation in the map in real time.
3 METHODS & RESULTS

This paper selects four typical project cases, which were exhibited in the “Green Corridor 2020” sponsored by Beijing Forestry University during the 2016-2018 Beijing International Design Week. The “Green Corridor 2020” is the first series of landscape-themed exhibitions in Beijing Design Week. It shows the planning and design achievements and project practices of teachers and students, and has produced good social influence. A total of dozens of projects were made into VR in 3 years, among them the four projects belong to two different VR modes: the immersive experience mode and the 360-degree panoramic mode. The scales and project types are different: the Sihe garden is a small-scale (0.1ha) exhibition garden, and the Chaer hutong courtyard is also a small scale (0.02ha) project about urban renewal, Slender West Lake is a medium scale (100ha) scenic area, and the North central axis is a large-scale (1000ha) urban planning. These four projects are selected as research objects to explore the display effect of the VR mode corresponding to different types of projects (figure 2).

Figure 2. Four different VR projects (2018) Diagram by dream deck.

3.1 Indicator evaluation

In order to evaluate the effects of different VR modes and different types of projects in the exhibition, this paper has established four evaluation indicators through interviews and surveys of visitors and some professionals, including immersion, participation, operability and convenience. Immersion is the degree to which visitors participate, integrate, and feel in the virtual environment. The degree of refers to the degree to which visitors can interact during the experience. The operability refers to the ease of operation of the device by the visitors, and the convenience reflects the difficulty of building a VR scene in an exhibition. In the evaluation process, the degree is indicated by “●”, and the more “●”, the higher the evaluation result is, the highest degree is 5 “●”.

Table 2. Information contrast and evaluation between four VR projects.

<table>
<thead>
<tr>
<th>VR mode</th>
<th>interactive experience mode</th>
<th>360-degree panoramic photo mode</th>
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<tbody>
<tr>
<td>project</td>
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<tr>
<td>project scale</td>
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<td>Chaer hutong courtyard</td>
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<td>operability</td>
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<td>convenience</td>
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3.2 Evaluation results

After scoring the four projects, the paper can get the table 2. The results show that the immersion and participation of Sihe garden are the highest, but because the equipment is more complicated to use,
the operability and convenience are relatively low. After field statistics, the number of visitors is the most during the exhibition, the feedback from the participants is also the best; while the evaluation of the other three 360-degree experience mode is basically similar, but because the scale of the project is different, it is found that the small-scale scenes in the exhibition are better reflected like the actual scene. Large-scale projects use more of a larger bird's-eye view and pay more attention to the overall atmosphere, so the immersion in exhibition may not be as well as the small scale projects. In addition, the 360-degree panoramic photo is a completely realistic shooting for the built project. It is highly attractive to visitors who have not been to the site, but not to whom has already been to. Of course, this mode only needs to use a 360-degree camera for imaging, so the pre-production cost and workload are very low.

4 DISCUSSION

Based on the above analysis and research, the paper can get some suggestions for improving the VR effects in the exhibition in the future:

- Both the fixed-end VR and the mobile-end VR have their own superiority and shortage. Especially in the case of limited funds and space, it should be selected according to the actual situation in the exhibition. The emerging all-in-one VR can better integrate the advantages of both, which should be widely used in the future.
- Visitors pay more attention to immersion, interaction and amusement in the exhibition, so the fixed-end VR is more attractive to visitors, but the first-time experiencers often do not understand the use of the device, so professionals need to assist the visitors recognizing the environment to get a better experience.
- Different landscape projects have different characteristics, so exhibitors should choose which VR mode to apply according to the characteristics of the project. At the same time, in the early modeling process, the psychological needs of the visitors should be fully considered, and the special perspectives closer to the real experience should be selected to develop more interesting interactive functions.
- At present, through the mobile-end VR visitors can directly watch the mobile phone by scanning the QR code, which is more friendly to the visitors. This way can meet the situation of large traffic of visitors. Simple VR glasses make communication more visible, which is a good medium in landscape exhibitions.

5 REFERENCES


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FILM PHOTOGRAPHY AS A TECHNIQUE TO REVEAL AND ARTICULATE LANDSCAPE PHENOMENA

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1 ABSTRACT
This paper presents work from a paired, undergraduate design studio and digital representation class in landscape architecture conducted in fall 2018 at Cal Poly San Luis Obispo, in which students explored representation and visualization techniques as part of the early stages of the design process, and develop a deeper understanding of the landscape and of its potential for design. Methods, results and interpretation using film photography in order to capture landscape qualities are presented in this paper. The purpose of the film-based technique contrasts and highlights traditional photographic methods with the current, widespread use of digital devices -such as smartphones- for photographic documentation. This paper interprets the results of student work and identifies successes and challenges of using the film method. Results make the case for the relevance of film photography during the site analysis phase and identify ways of seeing and framing the landscape that have been replaced and substituted by the iniquitousness of digital photography. Carefully framing an observation with photography can help students see and understand the landscape in ways that have been replaced and substituted by the omnipresent digital photography. Photography is a valuable observation and documentation tool, but photos are no longer solely associated with the purely visual or fine arts. The camera and image become extensions of our memory and thinking as we rely on captured images to recall key information, data and moments. What are future opportunities for photography in landscape architecture then? What are the opportunities for photography in landscape architecture education?

1.1 Keywords
Photography, film photography, smartphone, site analysis.
INTRODUCTION

This paper presents work from a paired, undergraduate design studio and digital representation class in landscape architecture conducted in fall 2018 at California Polytechnic State University (Cal Poly) in San Luis Obispo. Through repeated site visits, photography and discussion, students explored representation and visualization techniques as part of the early stages of the design process in order to develop a deeper understanding of the landscape and of the potential for design. This exploration included film-based photography, digital photography and post-production/post-site visit techniques across multiple assignments. Methods, results and interpretation using film photography in order to capture landscape qualities are presented in this paper. The purpose of the film-based technique is to help students develop a deeper understanding of the landscape during a site visit and to contrast and highlight traditional photographic methods with the current, wide spread use of digital devices for photographic documentation -particularly the multimedia functionality of smartphones. This paper interprets the results of student work and identifies successes and challenges of using the film photography method: results make the case for the relevance of this type of photography during the site analysis phase and identify ways of seeing and framing the landscape that have been replaced and substituted by the iniquitousness of digital photography.

2.1 The Prevalence of Digital Photography and the Smartphone

The number of digital photographs taken annually has grown at a compound annual rate of 9% with an estimated 1.2 trillion digital photos to be taken in 2017; of these, 85% were estimated to be taken by a smartphone (Perret, 2017). Smartphone photography has become the dominant device for the production and sharing of photographic images. The camera phone has not only replaced the digital camera (sales of digital cameras have declined from 121.5 million in 2010, to 24 million 2016), but it has reconfigured our relationship with photography by setting up new processes for image making, for the perception of photography, and for establishing new ways of seeing. Their ease of use, connectivity, accessibility and relative low-cost make them ideal for capturing, editing, storing and sharing visual representations of personal or collective experiences.

Within the studio and classroom, both authors have observed the rise of use of the smartphone by students. The smartphone has become an extension of learning and often supplants traditional forms of observation and notetaking. Although some may argue the smartphone is a distraction in the classroom, the authors regularly observe students taking notes, verifying information, searching references, collaborating via cloud-computing and capturing images of slides via their smartphone. During site visits, the authors have noticed students seeking directions, exploring site context via a satellite imagery, tracking routes, making notes, researching background information and documenting conditions with photography. Although students had the opportunity to share, edit and arrange site photos as part of the design process, the authors observed that most photos remained connected with the smartphone. Site conditions and key moments informing the design process were often reviewed with students and faculty by interfacing with the smartphone. Students would scroll, locate and open the photo using the touchscreen interface, then move to the next image. Within the structure of the application and interface, students would chronologically retrace their site visit and provide narration and interpretation to the images.
2.2 Understanding the Landscape through Recording Techniques

Inventory and site analysis methods are utilized by students and professionals during the early stages of the design process. Understanding site is central to the design process for landscape architecture students and professionals. In the influential essay, *Four Trace Concepts in Landscape Architecture*, Christopher Girot advocates, “Each time a landscape project begins there should follow an extended period in which one may simply discover what already exists, most of which will not be obvious or quickly ascertained. The introduction to a site project has all too often been reduced to systematic and quantitative formulas for analyzing the site from a distance.” (Girot, 1999, p. 65). While Girot asks designers to tap into personal intuition and perception, techniques of recording observations and perceptions are left to the designer and other authors. Laurie Olin connects learning about the world and drawing because it “makes you look at it, sit still... think about what's in front of you and what makes it tick.” (TCLF, 2013, 0:25) and Caroline Lavoie notes that drawing “creates an awareness of place that is a distinct form of information gathering and of understanding the landscape.” (Lavoie, 2005, p.13).

Photography holds potential to deepen the connection and understanding of site. Photographs embody a finding that is unrepeatable; they hold an otherwise imperceptible time still for eternity (Corner, 1996). Although, the *Journal of Landscape Architecture, Thinking Eye* contributions explore “critical investigations into visual concepts, methodologies and media” and utilize ‘original ways of visually documenting, conceiving, evaluating, or changing perceptions of landscape.’ (JOLA, 2017), the use of photography techniques for landscape architecture remains allusive in the literature. Photography can instead be found in association with design representation and photomontage (Cantrell, 2015; Amoroso, 2015; Belanger, 2014).

2.3 Purpose

Within the paired courses, students explored various photography techniques to observe, record and reveal the landscape. Several research questions helped frame the structure of the coursework, including: what is the role of photography in understanding a landscape? what are the opportunities and limitations for smartphone technology in recording and revealing the landscape? what new techniques can help students understand traditional site inventory and analysis methods? Assignments and outcomes provided instruction and direction for using specific techniques with the goal of both understanding and revealing the landscape. This paper focuses on one technique using film-based photography. The purpose of this technique helps students utilize, consider and evaluate the use of photography in understanding the landscape, specifically in the early stages of the site inventory and analysis phase of the design process.

3 METHODS

Sixteen students enrolled in the paired design studio and digital representation courses during fall quarter. Both courses shared an emphasis on site exploration, recording and representation techniques and common goals for having students develop deeper understandings of place during the early stages of the design process. A study site of approximately 350 acres was selected from a larger 8,000-acre landscape. Located in Montaña de Oro State Park, the site contained a diversity of cultural remnants from the 100+ years of agricultural use and a transect of natural features ranging from tidepools to distinct geologic outcroppings to coastal bluff ecological communities. The site also contained the main attractions and visitor infrastructural elements such as trails, information signs and parking. A series of photography-based exercises guided students
recording and representation techniques over the course of four weeks. The courses shared learning outcomes emphasizing site visualization, recording techniques and representation exploration.

For the film photography technique, the process of both understanding and recording the study site began using a limited number of photos during a first site visit. Although most students had not used film photography, the media and associated techniques were not entirely new. Some students either owned or had worked with a film camera as either a hobby or part of art-related courses. Students were confronted to rethink the accessibility, ease and reliance on the digital photo, particularly those taken with the use of a smart phone. Thirteen images were allocated to each student through a disposable camera. Instructions directed students to capture observations and impressions through the careful and purposeful use of the film-based camera. Observations could range from sensory qualities, views, materials, uses or unique experiences. Students were required to carefully consider both the topic and how the topic was captured with the viewfinder. Before clicking the shutter, critical thinking was required and students were coached to not worry about ‘being a photographer.’ An additional selfie image was required with the disposable camera to place the student into the study landscape and to help identify student photos. Cameras were collected by the instructors, developed outside of class with both digital and 4"x6" prints returned to the students. Students received the thirteen, 4"x6" glossy print photos and access to digital files approximately one week after the initial site visit. Upon return of the physical and digital photos, students were required to review the images and format a display that represented an understanding of the landscape conditions. Students were required to utilize the images, either digital or physical, for subsequent presentations with the overall layout, size and order determined by each student. Film photography images and formatted displays were used throughout the quarter in order to portray student understanding of the landscape.

4 SEEING DIFFERENTLY

Modern visual technologies have transformed the way that we see. The world we live in now is not the same as it was 20 years ago, when film and film cameras dominated the market, or just 5 years ago, when an estimated 1 trillion digital photos were taken worldwide. Changes in technology are happening more rapidly, and these changes shape how we see the world. This process is accelerated by modern visual technology, and the vastly expanded quantities of imagery and dynamic changes that we are exposed to in everyday life. For example, playing video-game improves both central and peripheral visual perception: research done in these types of electronic games has shown that it increases attentional resources and facilitates visual selective attention (Green & Bavelier, 2006), and gamers have improved hand-eye coordination. We can be taught what to see, what to pay attention to, and what to ignore: the act of seeing is not done exclusively with our eyes, but it takes place in our brain. What we see with the eyes is in fact, “less like a photograph and more like a rapidly drawn sketch”. (Mirzoeff, 2016, p. 71). An example that demonstrates the ability for the brain to learn to see is Daniel Simons’ “The Invisible Gorilla” an experiment that demonstrates inattentional blindness, a form of invisibility that depends not on the limits of the eye, but on the limits of the mind. In this experiment, people were asked to count how many times three basketball players wearing white shirts passed a ball; at some point a gorilla strolls in the middle of the action, faces the camera, and walks away. In 1999, half of the people who watched the video missed the gorilla -it appeared as if the gorilla was invisible. Simons showed the
video to experienced basketball players, and the number of seeing the gorilla jumped to about 70 percent (Chabris, 2009).

A population that has grown up with video games and smartphones sees things differently. In our site visit exercise, students were seen perceiving a view while walking or scouting the site, and then seeing it through the viewfinder. Many times, after framing the views through the camera, students decided not to take the photo. Probably the detail that they were looking for was not shown in the photo, or maybe when the photo was framed -and limited- by the viewfinder it did not show what the student was expecting. In general, we noticed that the influence from smartphone photography asked students to define a new image making process and to reconfigure their engagement with photography and seeing the landscape.

4.1 Image making process

In general, students felt that the limited number of photographs they could take required additional site exploration. In fact, restricting the number of photographs encouraged not only exploration, but also asked students to see differently the landscape: photography as an activity was no longer a documentation of what exists, but a set of conditions for what could be. During a site visit, the virtually unlimited number of photographs that can be taken with a smartphone or digital camera asks for a post-review and assessment process at a later time. When students use a digital device, they are more interested in collecting an overabundance of snapshots, than on capturing essential elements or conditions of the site. Digital photography is less preoccupied with the creative potential of the site, and more with the production of redundancies: a collection in which something of interest may be found at a later time (it is not uncommon that students end up with hundreds of photographs after a site visit). In our site documentation exercise, limiting the number of photographs to thirteen, asked students to not only make informed decisions about the photographs that they would be taking, but also about the images that they already took:

*Each time I took a photo, I reflected on the previous ones I had taken and made sure that I avoided taking more than one photo of the same object or view. I think that it is interesting that all the photos can somewhat be merged together because similar colors and textures overlap amongst them.*

*Student Isabelle Bertolas*

Students had to create a mental map of the images taken with the disposable camera by remembering the scenes that they have photographed, and also had to imagine how they would turn out when developed.

*A traditional media puts the photographer under grave attention to take the best shot, as perceived through the lens only, while feeling a certain uncertainty of what the images will actually render.*

*Student Ioanna Bruno*

The redundancy of images enabled by the smartphone camera allows experimentation and error: if something of interest is seen, there is little or no impediment to take the phone out and film -or photograph- it (Berkeley, 2014). The smartphone eliminates the time lapse between wanting to take a photo and actually taking it.
However, it also promotes redundancy, as something of interest may be found in the
digital pictures when analyzed at a later time. This delayed visualization is done through
a smartphone touchscreen or a computer: these views are not experienced directly, but
on screens that “appear to offer unlimited freedom but are carefully controlled and filtered
views of the world” (Mirzoeff, 2016, p. 14). Screens may limit the appreciation and
understanding of the site and its phenomena: the images that are used for
documentation are often inspected in a different context (like sitting in front of a computer
or a desk in the studio), and more importantly, the review process is generally a
chronologic recreation of the site visit, a linear organization based on the order in which
the images were taken. Each time a student looks for a particular image in a smartphone,
he or she has to scroll quickly through the album by swiping or flicking rapidly across the
touchscreen. The narrative of the site visit is re-created chronologically: the same spatial
sequence used during the visit is repeated, moving forward and backward, until the
specific image is found (Figure 1).

![Figure 1. Student using the Photos app to find a specific image, after scrolling and swiping
through a chronological sequencing of the site visit imagery (2018). Photos by Joseph
Ragsdale.]

4.2 Engagement with photography

After the film from the disposable cameras was developed, students were given
the digital version as well as printed 4”x6” photographs. The established conventions
associated with photography, such as a desire to document or preserve our memories of
people, places and events (Barthes 1981; Benjamin 1936), were seen in the way
students engaged with the printed photographs, with unexpected findings when images
were seen together:

*Upon receiving the printed images, I was able to organize the photos by how
I framed certain views. I found the similarities striking…. Upon completing this
extensive, unorthodox site analysis, I found that I learned many things about
not only the site, but about myself as a designer. Beginning with site
exploration with a disposable camera and sketch paper, I would say that was
the most comfortable part of our site analysis.*

*Student Elizabeth Walinder*

Students had an opportunity to organize the photos to create new narratives of the
site, and the images were arranged based on physical conditions, materiality, textures,
phenomena, colors, vegetation, etc., effectively eliminating the chronological order in
which the images were taken (Figure 2). The sequential organization that the images originally had in the film was no longer present, allowing new relationships and narratives to emerge.

Smartphone photography defines new ways of thinking about the way we use photography in our daily lives: photography is no longer a static medium to be hung on a wall (Keep, 2014). This cultural baggage for traditional photography was evident in the way students perceived the printed images: there was care in the way these images were displayed on their desks and during reviews. Along with the printed copy, students were provided with digital files, and it was expected that these images would be edited in Photoshop to highlight or enhance a particular condition or characteristic. The disposable cameras were loaded with S-TRA 400 film, which is good for action shots or in medium to low lighting conditions. The cameras had fixed-focus lens with no other adjustments except for a flash switch, and the prints were expected to have fine grain. Therefore, it was assumed that students would digitally adjust light and contrast, temperature, white balance, framing and composition, etc. However, this editing was not a required task for students, and we are unsure if this was the reason for not doing post-editing, or if they were satisfied with the outcome just like “film photographers are often much happier with the results of their photography” (Marquardt, 2016) (Figure 3).

The first exercise was typical in that it utilized photography, but unique in the fact that the number of photos taken was restricted, and because there was no post-production work required.

Student Zoe Kulli
Figure 3. There were unexpected results when photographs were developed, such as fingers visible in the photo (top row) and poor focus for close-ups (bottom row). However, students seemed satisfied with the results and did not edit original files (2018). From top left, in clockwise order, photos by Carter Terranova, Daniel Wilson, Laure Goode, Nicholas Clark and Isabelle Bertolas (last two images)

A new type of engagement with photography, which was the word of the year in 2013 for the Oxford English Dictionary, was selfie, defined as “a photograph that one has taken of oneself, typically one taken with a smartphone or webcam and uploaded to a social media website”. In that same year, 184 million pictures were tagged as selfies on Instagram alone. The selfie shows to others the status of the person depicted, and is a fusion of the self-image, the self-portrait of the artist as a hero, and the machine image of modern art that works as a digital performance. Detached from the machine, the selfie loses its power and authority, and becomes a portrait. A selfie is a performance of a person as they hope to be seen by others. It has defined a visual vocabulary for itself: a selfie looks better when taken from above with the subject looking at the camera, and the picture usually concentrates on the face with the risk of making a duck face, which involves prominent pout of the lips (Mirzoeff, 2016). The portrayal of oneself asks people to pose themselves in the most flattering way they can: multiple snapshots and careful review of the images on a digital device ensures that only a perfect shot is made public.

Students were asked to take a selfie to help identify student photos once they were developed, as well as a way of placing the student into the study landscape (Figure 4). Out of the 16 students enrolled in the studio, three students chose not to take selfies, and preferred a regular portrait taken by someone else. It is unclear why they decided to proceed this way, but it is clear that for a selfie requires the machine image to exist.
Figure 4. Selfies taken by students run the risk of not fitting with the set visual vocabulary for a standard selfie (top row). Some students preferred to take a portrait instead of a selfie, probably aware that they would not know how the image would turn out (2018). From top left, in clockwise order, photos by Sarah Maloney, Isabelle Bertolas, Eliana Parkerton, Jacob Scally, Daniel Wilson and Elizabeth Walinder.

5 DISCUSSION AND OPPORTUNITIES

The camera in the smartphone is no longer an optical instrument to capture still or moving images, but an input device for a complex set of instructions like scanning documents or playing augmented reality games. Smartphone photography is no longer preoccupied with the established aesthetic conventions of traditional photography, but with the complex visual language system of our networked lives. The current use of photography in social media transforms the photograph into a device that requires feedback and becomes alive in virtual communities and networks: our bodies have become extensions of data networks, clicking, linking, and taking selfies (Mirzoeff, 2016). How should then photography as documentation be framed in a design studio, and during site visits?

Through multiple traditional and digital photographic techniques students engaged with the landscape, developed a deeper understanding of place and experimented with representation techniques. One technique, film photography with a disposable camera, referenced in this paper, helped students connect with place but more importantly helped connect them with the methods and practices of capturing and recording place. The use of the camera became a creative activity, instrumental for both the engagement and appreciation of the landscape. While students uncovered and projected an understanding of the landscape, they also contemplated opportunities and constraints associated with using a finite versus infinite number of images. Reflections point to students valuing being forced to slow down, carefully consider and purposefully capture what they are seeing on site. This deliberate action of thinking, framing a subject and carefully considering the observation helped students understand site conditions and uncover design possibilities for a future design study. As Caroline Lavoie notes of drawing, this exercise revealed similar possibilities for photography in the landscape to
“create an awareness of place that is a distinct form of information gathering and of understanding the landscape setting.” (Lavoie, 2005, p.13).

This paper interprets the results of student work and identifies successes and challenges of using a singular photographic method. Results make the case for the relevance of film photography during site review, but the conscious and deliberate use of photography can be extended to digital media as well. Carefully framing an observation with photography can help students see and understand the landscape in ways that have been replaced and substituted by the ubiquitousness of digital photography. Photography is a valuable observation and documentation tool. As cameras are more prevalent than ever, accessible within a smartphone, captured photos are no longer solely associated with the purely visual or fine arts. The camera and image become extensions of our memory and thinking as we rely on captured images to recall key information, data and moments. What are future opportunities for photography in landscape architecture then? What are the opportunities for photography in landscape architecture education? A gap in literature connecting photography to the landscape architecture design process is apparent. This paper reports on efforts to include photography in the landscape architecture education not for the sake of making images, rather as a tool for seeing and understanding the landscape. As students rely more on photography to take notes during class, document observations and position themselves in the landscape through selfies and social media posts, will the profession adapt to these transformations?

6 REFERENCES


Multi-stakeholder Communication and Public Engagement in Coastal Hazard Mitigation and Resilience Planning

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1 ABSTRACT

Rates of sea level rise are more than 50% higher than the global average in Long Island Sound, Connecticut, United States, according to the Connecticut Institute for Resilience and Climate Adaptation (CIRCA). Projections estimate that sea level will be 20” higher than the national tidal datum by 2050. This data has prompted the Connecticut Senate to pass Senate Bill # 7, which recognizes the threat of climate change and the need to prepare for sea level rise. As a result, this legislation has challenged coastal cities and towns across the state to consider mitigating solutions.

This paper discusses the role of the University of Connecticut’s Community Research and Design Collaborative (CRDC), working with CIRCA on a sea level rise project in the city of New London, CT. It describes CRDC’s role to connect science to decision-making and the development of a series of design solutions intended to mitigate the socio-environmental impacts of sea level rise while spurring economic development. CRDC’s approach focuses on public engagement to ensure community participation in the design process, exploring innovative design ideas in real-time.

This experience demonstrates that a combination of government cooperation and public engagement to address socio-ecological concerns can result in cost-efficient and feasible solutions. In the context of sea level rise, determining solutions goes beyond environmental processes, and depends on economic and social factors.

1.1 Keywords  
coastal hazard mitigation, sea level rise, resilience planning, public engagement
INTRODUCTION

The state of Connecticut has been heavily impacted by rising waters. According to the Connecticut Institute for Resilience and Climate Adaptation (CIRCA), rates of sea level rise are more than 50% higher than the global average in Long Island Sound, Connecticut, United States. Furthermore, projections estimate that sea level will be 20” higher than the national tidal datum by 2050. Such data has prompted the Connecticut Senate to pass Senate Bill # 7, named “An Act Concerning Climate Change Planning and Resiliency”, which recognizes the threat of climate change and the need to prepare for sea level rise. As a result, this legislation has challenged coastal cities across the state to consider mitigating solutions. Cities, however, need support to understand the problems ahead and form a vision to achieve a sustainable future.

The University of Connecticut’s Community Research & Design Collaborative (CRDC) is the umbrella organization for the outreach work of faculty in the Landscape Architecture program. Focused on its mission to be a regional leader in sustainable planning and design, the CRDC has taken up the challenge to aid communities in Connecticut to address sea level rise and conceptualize potential solutions. It attempts to plan and design affordable, equitable, and ecologically healthy environments with community participation. Moreover, it promotes academic-based collaborative research, connecting communities to the scientists, and supporting transdisciplinary efforts to emphasize the need to address complex problems through sustainable development.

In 2017, the CRDC was tasked by CIRCA, funded by a 10-task grant from the Connecticut Department of Energy and Environmental Protection (DEEP, 2014), to develop a planning methodology, using CIRCA data, for municipalities in counties affected by Superstorm Sandy, for the assessment of infrastructure vulnerability, to inundation by storm surge and coastal flooding, now, and in the next 25 to 50 years, when it is likely that sea levels will be higher and precipitation statistics different; and provide policy and financing options for resilience projects for Connecticut's municipalities.

CIRCA selected the city of New London, Connecticut as the pilot project to apply flood risk information for the development of a vulnerability assessment and a conceptual design solution. This paper presents this case study to illustrate the process of how landscape architects, researchers, council of government, property owners and other decision-makers can collaborate to develop appropriate design solutions. The participatory design process included workshops and public engagement, combining research communication with physical design modelling methods. It aims to exemplify a way forward for the development of coastal vulnerability assessment, hazard mitigation strategies and resilience planning in the context of climate change and sea level rise.

KEY CONCEPTS

3.1 Resilience in design and planning
Given the challenges of climate change, coastal communities across the United States have challenged scientists, decision-makers and designers to aid in the adaptation of cities to sea level rise and flooding. Many of these plans and designs use the theory of resiliency, in the creation of projects that seek to promote adaptation and mitigation of foreseeable hazards. Resilience in the design fields has derived from the original definition of ecologists (Holling, 1973). It focuses on how fast a system, or in this case a city or site, returns to a state of balance after it has suffered a disturbance. Other authors, such as Eraydin and Tasan-Kok (2013), referring to city planning, have gone beyond Holling’s definition of resilience and has incorporated three specific concepts. The first being the city or site’s ability to absorb or buffer disturbances and still maintain its primary attributes. The second is its ability to self-organize and the third is its capacity to learn and adapt with change. Furthermore, the concept of resilience in design and planning has taken a holistic approach, recognizing the physical, environmental and social aspects of coping with natural hazards in urbanized landscapes.

3.2 Principles of Planning
In order to develop resilient designs, the CRDC followed simple principles of planning and design. First, designs must prioritize pedestrian views, and avoid landscape walls exceeding 5’ – 6’ and in close proximity to the user, because high walls negate the concept of “defensible space” and can create a
claustrophobic feeling to the user. Second, the downtown buildings would support the street level economic activity. The more classified building uses and land uses the better. Roofscapes and upper level balconies offer pleasing amenities, but they do not substitute for street level activity. Lastly, successful urban streets function as both memorable pathways and landmark destinations. This is especially important in this case study, where the downtown street connects intersects with two train tracks crossings to the waterfront.

4 CONTEXT AND ANALYSIS

4.1 Sea level rise projections for Connecticut

Among the impacts of natural hazards in coastal areas, flood caused by storm surge and sea level rise (SLR) has triggered concerns with mean global rise projections ranging from 18 cm (IPCC 2007) to 2 m (Pfeffer, Harper, & O'Neel, 2008) by the end of this century. However, the rates of SLR observed in Long Island Sound, Connecticut, is more than 50% higher than the global average during the same time period, which is about 1.6 m (6.5 inches) per century. According to SLR projections, produced by the IPCC (2013), CIRCA has advocated for planning solutions that anticipate a sea level rise of 0.5 m (1ft 8 inches) higher than the national tidal datum in Long Island Sound by 2050 (Figure 1).

![Sea level rise projections for Connecticut based on local tide gage observations (blue), the IPCC (2013) RCP 4.5 model simulations near Long Island Sound (yellow line), the semi-empirical models (orange line) and ice budgets (magenta line) as in CPO-1.](image1)

Figure 1. Connecticut Sea Level Rise (SRL) Projection by CIRCA

4.2 Case study

The city of New London, Connecticut, is a seaport on the northeast coast of the United States. Located at the mouth of the Thames River, it has experienced flood damage from several recent hurricanes. Over the last 100 years, a total of eight hurricanes have hit the southern Connecticut shoreline (1903, 1938, 1944, 1954, 1960, 1972, 1985 and 1991). The strongest storm to hit the area to date has been a Category 3 hurricane with sustained winds of 110 to130 mph, also known as the 1938 Great New England Hurricane (Zavar & Hagelman, 2018). This storm wiped out many buildings along the New London shoreline and flooded the downtown waterfront. In 1954 Hurricane Diane reached an elevation of 8.9 feet (SCCOG, 2017). Statistical analysis indicates that New London could be threatened by a serious hurricane in the near future. This has greatly impacted coastal properties, which are losing value due to the risk of storm surge and flood hazard (White & Whelchel, 2017).

New London is densely developed, with several open spaces. According to land use data from the Southeastern Connecticut Council of Governments approximately 83% of city's land cover is developed, 12% has been dedicated to open space, and 5% remains open to development (SCCOG, 2017). However, most of New London is currently under-going redevelopment projects and the city is striving to ensure that these projects are resilient to the natural hazards, loss of life and extensive damage (Figure 2).
4.3 **New London downtown vulnerability analysis**

Through the analysis of FEMA and CIRCA flood maps for New London it became evident that Waterfront Park, AMTRAK, and the historic buildings situated between South Water Street and Bank Street are extremely vulnerable to storm surge and coastal flooding. This shoreline area is composed of a mix of residential, commercial, municipal and industrial development. Based on CIRCA 2050 SLR projection and FEMA flood insurance requirements, the base flood elevation (BFE) is set at 10’. New London requires that new construction or substantial building improvements be elevated, or flood proofed at an additional 2’ above the BFE as freeboard space, thus the building floor elevation is actually set at 12’. However, the existing elevation at grade is approximately 6’, which makes the study area vulnerable to a high risk of storm surge and flood hazard.

Current trends, based on preliminary CIRCA data, indicate that there are approximately 87 buildings vulnerable to flooding. Projections indicate that the 100-year storm flooding event will be 2’ higher than estimated by FEMA’s current flood insurance maps (Rath, Kelly, & Beahm, 2018). In fact, the 100-year storm event, as defined by FEMA, may occur every 20 years.

The vulnerability analysis, using CIRCA’s projection, point to long-term risks of flooding along Bank Street and South Water Street, however, there has already been recurrent flooding in this area. The buildings between Bank Street and South Water Street currently treat their waterfront property, as a backyard or service area facing the Thames River, using parking lots, loading docks, unattractive facades, etc. These waterfront-facing properties don’t energize the street and appear vacant and unwelcoming to the general public. The street functions more as a service road, instead of a civic expression of a safe, public and welcoming path and/or destination that engages with the riverfront. This untapped amenity of waterfront business activity has not yet inspired property owners to invest in building renovations and some properties are left vacant.

5 **THE PROCESS OF COASTAL RESILIENCE PLANNING**

5.1 **Conceptual design for coastal resilience**

Focused on developing conceptual designs for coastal resilience (White & Whelchel, 2017), was tasked to apply CIRCA data on sea level rise and produce both drawings and models to clearly communicate the effects of projected water rise over time in the downtown Bank Street and South Water Street area. By developing a series of design solutions intended to mitigate the potential impacts of sea
level rise and storm surge, they simultaneously seek to promote economic growth, create a sustainable approach to flood mitigation and improve the ‘sense of place’ in the downtown riverfront area.

As a result of the multi-stakeholder engagement, the CRDC proposed 3 major design options to mitigate the flood hazard, based on the needs identified by the community (Table 1). Option 1 proposed a waterfront park with a 6-foot high berm, combined with a deployable flood gate system, that would protect South Water Street from rising water. Option 2, in its first iteration, proposed the construction of a 3-foot high flood wall, combined with an added 3-foot high plexiglass wall. This design was intended to create protection from flooding, while maintaining a visual connection between South Water Street and the view of the Thames River. Option 2 was later revised, based on public input, proposing a 3-foot rise of the South Water Street road, using a 3-foot high flood wall. It also promoted raising the elevation of the existing properties, making a stronger connection between the businesses and the street, while promoting a more prominent view of the river. Lastly, Option 3 proposed elevating South Water Street 3-feet, in combination with 3-foot deployable flood barriers, requiring property owners to elevate basement walk-outs where appropriate. In all three options the designs sought to create protection at a minimum elevation of 12’. Considering that the existing ground elevation is approximately 6 feet, the proposed protection needed to be 6 feet higher to meet the minimum requirement of 12 feet.
As the design process evolved, low impact development (LID) methods such as pervious pavement, bioswales, bioretention and drainage system were incorporated to address stormwater run-off. Additionally, the berm system proposed will serve multiple functions, protecting property while promoting the recreational use of the city's waterfront. This process of design using public engagement supports CRDC’s objective of creating a healthy socio-environmental landscape that enhances the community’s connection to the river.

5.2 Public engagement and planning process

In this study, public involvement was key to the development of the design solutions. Participants included city officials, property and business owners, public works and municipal planners, with participation of members from CIRCA. CRDC worked in collaboration with an expert in public engagement and outreach, to moderate the discussions and ensure that all voices were heard during the public engagement. (Bostick, Holzer, & Sarkani, 2017; Novak, Fernandez-Anez, & Shiraishi, 2017). In each workshop, participants were asked to examine and appraise each of the design solutions. Multi-disciplinary researchers in the fields of urban climatology, natural sciences, engineering, economics, and environmental law were also asked to collaborate in the process, giving scientific support to practical solutions as problems were identified by the stakeholders. The CRDC’s design team, composed of landscape architects, architects, and urban planners, in turn, created solutions based on the culmination of the data and resources provided.

New London’s mayor showed a keen interest in the project and offered several design suggestions, although the initial interactions with the Bank Street property owners were challenging. Participants seemed resistant to ideas and were somewhat distrustful of municipal funding, however, a trust was built through frequent 1-hour meetings occurring on a monthly basis. The process allowed the CRDC team an opportunity to educate about coastal hazards and discuss the existing and potential risks
to property owners. The frequent interaction with the public provided the building blocks necessary to propose CRDC’s design solutions. During the design revision phase, participants were offered the opportunity to vote anonymously on their preferred designs, and afterwards, make comments on the ‘pros’ and ‘cons’ of each of the design options (Table 1).

Table 1. Participant comments during the first public participation, comparing options.

<table>
<thead>
<tr>
<th>Option</th>
<th>Pros</th>
<th>Cons</th>
</tr>
</thead>
</table>
| Option 1: Berm system | ● Aesthetic value/beautification of riverfront area  
● Community building opportunity  
● Adds value and offers protection (two for one value)  
● Least amount of disturbance  
● Located on city property, so feasibility of implementation is higher  
● Least intrusive to private property owners | ● South water street not affected/improved  
● Need to shut down Amtrak for gate at State Street  
● South water street not affected/improved  
● Need to shut down Amtrak for gate at State Street |
| Option 2: Plexi-glass floodwall | ● Improves S. Water Street  
● Individuals can choose whether they want it  
● Aesthetic  
● Value/beautification | ● Uncertainty about plexi-glass upkeep and maintenance  
● Reliance on individual property owners may hinder full implement-ability  
● Limits existing space which may affect accessibility to businesses  
● Uncertainty about plexi-glass upkeep and maintenance  
● Reliance on individual property owners may hinder full implement-ability  
● Limits existing space which may affect accessibility to businesses |
| Option 3: Elevating roads | ● Ground level walk-in  
● Can keep views  
● Least expensive  
● Could have positive implications for flood insurance  
● Could improve energy efficiency | ● Loss of views  
● Uncertainty about whether there are successful examples of this option  
● Loss of property/square footage  
● Concern about access to businesses  
● Different buildings would have different conditions (not a collective, consensus-based approach) |

Through this iterative process, designers were also able to interact with the stakeholders and better understand their vision for downtown New London. Their input resulted in revisions to Options 1 and 2, which supported their desire to connect to the riverfront and enhance the business activity along South Water street. Furthermore, the design concepts presented were respectful of the individual property owners’ wishes, proposing flexible design suggestions, rather than impositions.

The process of public engagement supports a transdisciplinary approach to decision-making and design. Along with the active involvement of CIRCA’s data, CRDC consulted with researchers who specialize in LID techniques and with Connecticut Sea Grant about shoreline sustainability. Design solutions were also presented to the mayor, the Council of Planning, and the State Commerce Department for additional comments and suggestions.

The framework for design with public engagement shows the need for education about flood hazards and mitigation measures. Raising community awareness is extremely valuable in ensuring that design projects reflect a community’s vision for the future. Moreover, it allows researchers and designers to understand the concerns of the participants, enhancing their ability to respond to issues in a way that respects and supports cultural ties to the land. From this perspective, design enables the public to visualize ‘what could be’ and help to decide ‘how’ to design their vision for the future.

6 CONCLUSION

Though climate change and SLR have been controversial issues to address in the United States, many coastal communities across the country have strived to adapt and find paths to coping with the eminent dangers of rising waters. However, the development and implementation of resiliency plans has proven to be the biggest challenge of addressing SLR. To start with the public struggles to understand the risks associated with SLR, and how that might impact their lives. Furthermore, the solutions proposed have to address more than just the physical aspects of hazard mitigation, but also be cognizant of the needs and desires of the local society.

In this study, the multi-stakeholder engagement and interdisciplinary cooperation played a critical role in developing designs that address coastal hazard and promote resilience. In this process, scientists were able to examine “what is” (hazard projection and risk assessment), landscape architects and planners explore “what could be” (resilience planning and design), council of the city suggest “What’s the
feasible”, while the public participants were able to gain a voice and to contribute to decision-making. The combination of collaboration and public engagement to address socio-ecological concerns results in cost-efficient and feasible solutions. The visualization of flooding scenarios and the presentation of physical design model of multi-option designs are efficient, and helpful for stakeholders’ support.

As designers, planners and researchers, we have a diverse set of skills, however, the best fit for a specific location, depends on more than quantifiable and physical aspects of the environment and its ecological process, it is also dependent on economic and social factors. As supporters of decision-making, through design and science, need to promote flexible processes for the exchange of knowledge and the production of sustainable outcomes. It is imperative that we have an open mind to explore varied possibilities and combine multiple voices, to determine the trade-offs and decide on localized options.
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REVEALING THE FRACKLANDS: A FRAMEWORK FOR ADDRESSING THE WICKED PROBLEMS OF HYDRAULIC FRACTURING

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1. ABSTRACT:
In recent decades, traditional methods of oil and gas extraction in the United States have been fortified by hydraulic fracturing, or fracking. Fracking has unlocked access to once unobtainable reserves. While increased production has strengthened some sectors in the U.S. economy, it has also renewed a reliance on non-renewable energy, and compromised the well-being of communities, and the environment.

While research into the process of fracking and its effects are common, little discussion has been generated regarding the broader impacts of the systems required to construct, supply, and maintain fracking operations. The processes of fracking contain a dense-array of components that effect both the present and future state of communities, environments, and economies.

This research presents the Fracklands, a comprehensive telling of the landscapes of hydraulic fracturing. Fracklands offer insight into what a dynamic and complex system of modern oil and gas extraction infrastructure looks like. To define these systems, I present a classification framework for defining the Fracklands. Organized by four approaches – Systems, Typologies, Trends and Futures – this Framework utilizes a set of descriptive methods conducted in three U.S. regions to present and discuss the Fracklands.

Results reveal a more complete picture of fracking’s effects on the American landscape today, while giving hints of what the Fracklands will present in the future. The Fracklands are a little understood system of components and processes that profoundly affect land, people, place, and society. With the Fracklands revealed, footholds are set for a methodology to be adapted and used in future study.

Keywords: 
Hydraulic fracturing, landscape classification, visual storytelling, mapping, systems-based thinking
2. INTRODUCTION:

Welcome to the Anthropocene, an era where the grip of human influence and exploitation encompasses the entire planet. Best characterized by climate change, this era has given way to major change that yields complex and opaque dilemmas no longer able to be met by straight answers and known solutions. From social injustices, mass migrations, food insecurity, climate change and sea-level rise, land degradation and resource depletion, deforestation, and more, the Anthropocene is an era of dilemmas that humanity has never had to face until now (Dalbotten 2014).

Such impasse will require a level of attention unlike any other. It will be necessary to acknowledge that these dilemmas are inherently wicked, where no true cessation or resolution exists (Rittel and Webber 1973). Their complex nature will require inter-disciplinary collaboration and novel thinking; warrant for the creation of new methods for finding solutions. These are callous and continually evolving issues. They are dynamic systems of complex inputs and outputs. These are the wicked problems of the Anthropocene.

2.1. Energy: An Increasingly Wicked Problem

Human progress and history has been vastly shaped by consumption and production of energy. It is the fuel of the human machine. For the past 150 years that chief fuel has been fossil fuels – oil and natural gas. They have formed the root of global economy, conflict, and change. As humanity progresses further into the Anthropocene, the wickedness of global energy demand and the resources that fuel that demand will grow with it. This rapid unrenewable energy production and consumption has led to global conflict, human induced climate change, mass land exploitation, and reckless growth created by and for the sake of combustible resources. Researchers fear that to meet this growing demand, irreparable damages to the environment will need to take place (Bradshaw 2010). Global energy use has exceeded predictions, near doubling in the past two decades (EIA 2017d). As this demand grows, the resources that have been relied upon to fuel that demand – coal, oil, and natural gas, are dissipating (EIA 2017b, 2017d). Today, easy access resource reserves have grown thin.

The depletion of easy access energy and the continued reliance on oil and gas has created a “desperate search for ‘extreme energy’” – sources requiring extreme methods to be reached (Butler and Wuerthner 2012). These extreme, or unconventional sources will require extreme and unconventional methods to reach them. Unconventional methods consist of offshore oil and gas drilling, tar sand and oil shale strip mining, and shale oil and gas hydraulic fracturing (Ma and Holditch 2015). Modern energy has always been exploitative. Land and community has routinely been sacrificed for energy and economy. Extreme energy and unconventional extraction methods have amplified this doctrine of sacrifice, paving way for a vast network of unique and pervasive energy infrastructure that threatens both communities and the natural environment. For the United States, its own extreme energy policies have flourished due to hydraulic fracturing.

2.2. Hydraulic Fracturing: The Despot of America’s Extreme Energy

Hydraulic fracturing or ‘fracking’ for oil and gas has quickly become a dominant form of energy production in the United States. It is a resource intensive process that uses a sand, water, and chemical mix to be injected into the earth, freeing up trapped pockets of oil and gas. While this injection process is synonymous with fracking, the process represents the entire story of oil and gas; extraction, production, and depletion. Altogether it is a complex network of facilities, large amounts of extracted resources, and vast fields of diffuse land that represents what the process of fracking really is.

By the end of the 20th century, hydraulic fracturing technology would be ready for mass implementation across the country. Fracking has allowed the country to continually meet and increase its demand for unwearable energy and its reliance on oil and gas. Entire regions of the U.S. have been greatly shaped by the process, transforming the fabric of social, ecological, and economic system.
Hydraulic fracturing’s influence is creating unique fracturing related facilities which are playing host to their own unique dilemmas as well.

Hydraulic fracturing in the United States has become, and will continue to grow as a wicked problem, nested within greater dilemmas of energy supply and demand. The depletion of oil and gas reserves will lead to growing energy desperation. This desperation in-turn will lead to the marginalization of boundaries set between the facilities and landscapes of fracturing and their surroundings. As fracturing’s influence grows, its facilities are encroaching upon more places unaccustomed to its trials and tribulations. In addition to these blurred lines, the future of what becomes of these places remains uncertain.

The dilemmas of extraction and environmental sacrifice are no longer an issue left to rural communities. The complexity of these processes and the future of fracturing infrastructure will leave effects being felt far beyond immediate extents. Problems that arise will become problems of the masses.

These trends trace the current path U.S. energy production is on. While many may be well aware of fracturing, literature shows few see the systematic effects of fracturing and even fewer its implications for the future. This is the most wicked problem of hydraulic fracturing; the lack in seeing and understanding the extents, phenomena, trends, and future of fracturing and its many landscapes.

2.3. Investigating Hydraulic Fracturing: Focusing on Landscape

While complex, much of the dilemmas surrounding hydraulic fracturing can be traced back to the landscape. Yet there is a common disconnect in looking at the entire story of fracturing and relating that to the spaces it inhabits. In addition to the oil and gas wells where the fracturing or injection occurs, the complete process of fracturing discussed before requires an array of components to function. Together these pieces, not just the wells, play a significant role in shaping the landscapes and populations that interact with them. While they may share commonalities, each landscape and its components associated with the process of hydraulic fracturing has its own unique story. Each influences their surroundings in different ways.

As for the future of these landscapes, each share a common path. As unconventional oil and gas reserves shrink in size, the desperation to meet energy demands will increase fracturing’s presence within landscapes. While more than a million fracturing landscapes exist in the U.S. today, millions will be created tomorrow. Likewise, as reserves empty, these landscapes will be left in limbo; to decay or returned to a state that is neither nominal nor productive.

Being a problem transposed in landscape, landscape architects are in a unique position to address these dilemmas. Research and design discourse has laid out a critical path. However, while landscape architects have the tools and abilities to address the landscapes of hydraulic fracturing they lack an understanding of them. These landscapes must be delineated into a more workable system. Strong understanding and knowledge leads towards better telling of what these landscapes are today, what they will be tomorrow, and what they can be tomorrow. Once understanding is grafted, then landscape architects can lead discussion over how we address these landscapes today and how we address the evolution of these places tomorrow – from landscapes of industry and waste, to landscapes of social, economic, and ecological armature.

2.4. Background Research, Guiding Inquiry, Research Goals

Outside of this paper a vast amount of research was conducted to uncover the totality of fracturing, what is being done about it, and what can be done about it. The most influential of findings are highlighted below. These findings shaped the direction and goals of this research:

- Oil and gas fracturing is a highly complex process that significantly impacts the social, ecological, and economic systems within its context. (Kaden and Rose, 2015)
• U.S. and Global oil and gas reserves are not infinite, and will likely be depleted before 2100. (EIA 2017b, 2017d; Hughes 2014; Korpela 2007)
• The point of peak production is unknown, however production declines will require fracking operations to increase by up to 4 times to meet consumer demands. (Hughes 2014)
• Current discussions with community members and leaders, design and planning professionals, and scholars and researchers are remiss in addressing the landscapes of a post-oil and gas future.
• Be it resource depletion, alternatives, or bans, the landscapes of oil and gas will cease use as landscapes of production providing opportunity to be re-adapted for forward thinking outcomes. Time to prepare for these dilemmas before they become a reality is shrinking.
• Oil and gas companies are not planning for such a future and are not being held accountable to do so. (Jenkins and Sutton 2017; McGranahan, Fernando, and Kirkwood 2017; Gold 2015)
• Planning and design professionals are ill-equipped to handle the landscapes of unconventional oil and gas today let alone tomorrow, and have expressed the need to develop new means of doing so. (Green 2014; Murtha and Orland 2014; Sorvig 2014b)

From these findings the primary question of this research is: What are the landscapes of hydraulic fracturing and what needs to be done to better understand these landscapes in order to properly address the wicked problems that they have and will initiate?

Three goals to answer this question were constructed:

• Understand Hydraulic Fracturing:
  o What is it? Why has it become a mainstay for U.S. energy production? Where is it predominately located? What are its benefits and its costs? What is its future?
• Understand the Landscapes of Hydraulic Fracturing:
  o Understand these landscapes from a systems-based perspective. Classify these landscapes into the “Fracklands”, arranged in a series of typologies. Delineate common and regional trends of the Fracklands. Explore the future of the Fracklands and develop preliminary design discussion on alternatives to these futures.
• Understand Actions for Addressing Hydraulic Fracturing:
  o What is being done today by citizens, government, planners and designers? What related discussions in the design field can be drawn upon? What discussion regarding complex landscape systems can be utilized?

3. Methods:

The methodology of this research is a classification scheme that focuses on defining the Fracklands, which are a reorganization of and analysis of the landscapes of hydraulic fracturing and their components. The classification of this landscape system into the Fracklands was fit for both parsing through dense amounts of existing information while enabling new findings to be made. This methodology was predicted to be a better telling of what these landscapes are today, what they will be tomorrow, and what they can be tomorrow.

3.1. Classification Framework

Developed and implemented in this research was a framework for the classification of the Fracklands. The first attempt at arriving at a methodology best fit to tackle the dilemmas presented throughout. The framework was organized into four unique approaches: System, Typology, Trends, and Futures. Each approach as defined below sought to understand, organize, and discuss findings on the Fracklands and their components via different modes of research, thought, visualization, and subject matter.
• System: Investigated the Fracklands and their components from a systems-based perspective. It connected the processes of fracking to other phenomena within the landscape and investigated how these processes create a connected network.

• Typology: Organized the Fracklands and their components, differentiating them into four distinct types: Persisting, Veiled, Transient, and Phantom type Fracklands.

• Trends: Examined the differences of the Fracklands from place to place. It investigated how local and regional context effects the structure and operation of the Fracklands across the country.

• Futures: Investigated the future of the Fracklands rather than their present conditions. It bridged background research and field findings with concepts from contemporary landscape architecture theory to develop a set of typological design alternatives for the future of the Fracklands.

The primary focus of the classification scheme would be on the components that define and compose the Fracklands. Various field and remote based descriptive methods were utilized for researching these components, which were determined to be the vital pieces of landscape infrastructure required for fracking related processes, and the Fracklands. Eleven components identified from background research – Wells, Processors, Communities, Pipeline, Transport-Infrastructure, Frac Sands, Workscapes, Storage Sites, Disposal Sites, Orphans, and Wounds – were explored in depth through four constructed descriptive strategies defined below:

• Definition: Defines the component; its operations, extents, scale, and timeline. Generally common information, background research and literature review was utilized.

• Field Reflections: Reactions and perceptions of the author towards the Fracklands and their components. Documentation of evidence of Fracklands and their components. Reflections were documented through field study, and remote geospatial analysis.

• Stories: How various people are experiencing, interacting with, perceiving, and reacting to the Fracklands and their components. Told through secondary sources – interviews, surveys and questionnaires, and ethnographic studies.

• Patterns: Examine the spatial phenomena of the Fracklands and their components. They are critical thought-based maps and diagrams which reveal unique spatial relationships through quantitative and qualitative data.

3.2. Regions of Study

In addition to delineating the methodology, Section 2 of this report defines the regions of study. The descriptive strategies described in the methodology were to be conducted both in the field and remotely. Eight regions were identified and three selected for study, weighted by various selection criteria. Chosen were Weld County in Northern Colorado, Tarrant County, the seat of the city of Fort Worth, Texas, and frack-prone areas of Pennsylvania and West Virginia. Each region selected exhibited unique contextual and phenomenological qualities to be investigated.

Specific areas of interest in these three regions were then selected for visit or remote study. Multiple field visits to Weld and Tarrant counties were conducted. Areas of Pennsylvania and West Virginia could only be researched remotely due to limitations discussed in the next chapter. Other study areas such as the Bakken oilfields of South Dakota and Frac Sands of the Midwest were remotely researched in order to study specific phenomena unique to that region, or used as a substitute if information/data for the primary study areas were absent.

3.3. Figures and Tables
Figure 1. Methodology Diagram. (Lanning, 2018)

Figure 2. Frackland Components Diagram. (Lanning, 2018)

Figure 3. Overview of the 13 Components of the Fracklands. (Lanning, 2018)
4. FINDINGS

Findings are presented through the four approaches of the classification framework (System, Typology, Trends, and Futures). Results reveal that fracking is deeply ingrained not just in the regions researched, but across the American landscape. Results reveal that fracking is deeply ingrained not just in the regions researched, but across the American landscape. Over 200 pages of images and notes compiled outside this paper were produced. The findings delineated below, discuss the Fracklands through these four unique lenses and through various facets of description, visualization and reflection.

System: Findings revealed how the Fracklands operate and weave their components together. It showed that while components may appear as self-sustaining or independent from fracking, they can be linked by various means. Diagrams in this chapter focused on these component connections from a conceptual level, how they connect via the functional processes of fracking, and how they connect spatially in the actual landscape. The concept of these components and the Fracklands themselves of an interconnected and complex system would be echoed throughout the rest of the section.

Typology: Most findings from this research came from research of Frackland components, and the organization of said components into a typology. The typology itself was made up of four types:

- Persisting Fracklands: Those which are fixed, known, and/or finite entities in the landscape.
- Veiled Fracklands: Those which are hidden physically and/or by association to fracking processes.
- Transient Fracklands: Those which are ephemeral and subject to change rapidly. Activity is infrequent.
- Phantom Fracklands: Fragments, physical or metaphysical left behind by fracking processes.

Each Frackland type plays host to its own set of components which evoke the nature of that type. It is these thirteen components that this chapter most heavily explored. Each component is presented the same; with the four descriptive strategies highlighted above in the order of Definition, Field Reflections, Stories, and Patterns. As a whole results from these methods present the Fracklands through various modes of evidence. 80+ photographs accompanied with written descriptions and field reflections document how the Fracklands have come to define entire regional landscape systems.

Throughout the typology, each component was represented through a thematically similar “story”, a review and discussion of already documented sociological phenomenon. These12 stories document how fracking has unhinged lives of both rural and urban dwellers, how the structures of entire communities have diminished, and how it has pitted people against one another and against their changing landscape.

Within the Typology 33 different "pattern" maps and diagrams document how the Fracklands’ components are fixed in the landscape. This imagery ranges in scale from the site scale to the entire nation, and portrays information both qualitatively as well as quantitatively. Told throughout the course of the chapter, these maps were created to show not only the system of the Fracklands spatially, but show the Fracklands from a granular perspective, and the variation of components from region, community and place. The nation, and portrays information both qualitatively as well as quantitatively. These maps were created to show not only the system of the Fracklands spatially, but show the Fracklands from a granular perspective, and the variation of components from region, community and place.

- 10 maps represented information across the entire country highlighting how components are spread across the nation and how their processes are connected to and/or affect the Nation as a whole.
- 6 regional maps highlighted unique phenomena in specific areas despite relative homogeneity between the distribution of Frackland components as shown in the national maps.
- 13 site/community scaled maps displayed unique spatial interfaces within a specific place. Most of these maps focused on communities and neighborhoods and their interface with hydraulic fracturing activity.
- 4 diagrammatic maps investigated specific Frackland components, revealing them as more than just symbols on a map, showing their physical footprint and more.

Trends: Findings on Frackland trends came from the findings from remote and field based study. It focuses on shared and unshared themes seen across the regions of study. Its primary focus was how social, ecological, and geographical context affected the Fracklands and their components from place to place. Trends documented were finely and broadly detailed. Numerous trends within the research could be uncovered, those highlighted were examples of the many trend types that were evident. Trends discussed in this chapter not only revealed extensive obtrusion in the American landscape today, but gave hints of a future where the Fracklands become abandoned, stagnate, or cleared for standard uses.

Futures: Investigation into the futures of the Fracklands discussed the potential future of the Fracklands and their components post-oil and gas (positive or negative). The outcome of Reclamation was the primary focus of this chapter as it presented the most potential for design and innovation to be
made. Discussed was why design should be considered, and considerations for designing around the Fracklands from findings made in the research. Findings concluded that there are three primary outcomes that occur from today’s reclamation practices but that they lack social, ecological, and economical welfare needed in the 21st century. Three alternative, reclamation practices were proposed:

1. Reform the Fracklands: Supporting social based outcomes. People, place, community.
2. Rewild the Fracklands: Ecologically based outcomes.
3. Recycle the Fracklands: Replacing the industry and energy lost with the loss of fossil fuels.

These three concepts were proposed to be adapted to address not only the social, ecological, and economic, dilemmas created by fracking itself, but those created by the overarching economy of energy.

5. CONCLUSION

Findings from this research suggest fracking will become more ingrained within society as oil and gas demands grow, further complicating matters. Now is the time for landscape architects and decision makers to address the dilemmas highlighted across this research. To begin understanding the Fracklands. Findings made clear that fracking follows geology not geography; the lines between extraction landscapes and all others will increasingly become blurred. As stewards to the land, landscape architects cannot sit idle and watch these landscapes fester. This report presented and tested a framework for understanding the various phenomena of the Fracklands. It has also presented means of moving decision makers forward towards a future where these landscapes can become armatures of community and society, ecology and nature, economy and low-impact energy.

The methods of this research are significant in that they set up a framework for further study. What’s been established is a methodology that can be readily adapted and applied to any region or place. Many regions of study were left out of this report, but can be filled in by future study. Future study can reveal more components and more about the Fracklands. This is just the beginning for understanding a complex and wicked problem that is the Fracklands.

The classification scheme of the Fracklands is the first attempt at developing a methodology to clearly define the landscapes of hydraulic fracturing. It is meant to be adapted, used and improved so that these landscapes can be completely understood, more-so than they are here in this text. Additionally the Fracklands are ever changing and growing. Many more Fracklands will be created and need to be understood beyond the ability of this text. The hope is that Landscape architects, planners, and all other decision makers who are concerned about both the future and our lack in understanding of these landscapes can use this methodology to find new answers.

Decision makers should see this report as a first step amongst many more. An establishment of approaches to thinking about the complex landscape system of hydraulic fracturing. With addressing wicked problems becoming a zeitgeist amongst many professions, the methods laid out can be taken and developed further to adapt to the changes that will take place.

Regarding the methodology, the four approaches offer starting points for various individuals whether they have a background in design, physical sciences, social-sciences, and more. One doesn’t have to replicate the entirety of what this project has done. One can choose a specific approach such as Trends and look into uncovering new findings on a specific subject. This would be the ideal next step, to take the classification framework and the methods utilized in this report and uncover more granular findings on the Fracklands. Understanding the Fracklands leads to better understanding of how to address the dilemmas of fracking. While much research needs to be done into understanding the Fracklands as the are now, discussion also needs to be moved forward on the future of these landscapes. This is where Landscape Architecture can really step in. The broad and bold proposals laid out in this book can be taken and moved more towards becoming a reality.

Hydraulic fracturing quite possibly represents man’s last desperate attempt to extract oil and gas. It is a fascinating, highly technical process that allows us to access even the hardest to reach reserves.
The fracking process represents the extreme actions that are being taken to extraction fossil fuels before they become depleted. Despite fracking's rapid ascension to dominance over American energy, hydraulic fracturing will likely not last through the century.

Many challenges lay ahead in the coming decades in addressing hydraulic fracturing and the Fracklands. While this project is concluding there is much more work that can and needs to be done. New branches in research on this topic are open. The implementation fracking will continue and its infrastructure will increasingly grow in size. Therefore maximizing understanding before the weight of the issues are too much to handle adequately is essential.
REFERENCES


MEDIA STATEMENT

Title of Research: Revealing the Fracklands: A Framework for Addressing the Wicked Problems of Hydraulic Fracturing

Author: Evan Lanning

Institution or Professional Affiliation: Graduate Student, Kansas State University

I DO want to prepare a media statement for general release from the 2018 CELA Conference.

Media Statement:

Revealing the Fracklands investigates the complex landscapes of hydraulic fracturing – The Fracklands. It presents a classification framework for understanding the Fracklands as a landscape system and delineates methods that can support decision-makers when addressing dilemmas associated with frack. The Fracklands classification framework contributes to the dialogue over energy extraction landscapes by analyzing fracking as an interconnected system within the American landscape, that which affects its people, economy, and environment. By presenting this research through qualitative methods – photography, mapping, diagraming – I aspire that designers, planners, and decision-makers will have a clearer outline to better understand the nature of this wicked problem.

Graphic Abstract:
REVISITING SCHOLARLY PRODUCTION AMONG RECENTLY TENURED LANDSCAPE ARCHITECTURE FACULTY

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1. ABSTRACT
The career development and success of landscape architecture faculty hinges increasingly on their scholarship. Research performance is emphasized by academic institutions, whose assessments of faculty productivity are based on quantifiable research behaviors. Landscape architecture education, often emphasizing the preparation of practitioners, does not easily fit the traditional academic department model. As a result, it becomes necessary for landscape architecture faculty to describe the academic context in which they engage in scholarship and may place them at a disadvantage when evaluated. The purpose of this study was to revisit a study of landscape architecture faculty scholarly productivity by replicating a study conducted over the 2008 to 2012 academic years, assessing findings for faculty tenured since 2013 to establish a more longitudinal understanding of the trajectory of faculty scholarly productivity.

The study employed direct content analysis of the curriculum vitas of landscape architecture faculty members who were awarded tenure at public universities in the 2013-14 academic year or thereafter. Common scholarly outputs, such as refereed journal articles, juried competition participation, reports, etc., were operationalized by the research team. Two researchers independently analyzed each vita, thereafter comparing the individual results, and negotiating any discrepancies with a third researcher.

The results describe the mean scholarly productivity of landscape architecture faculty during the tenure evaluation period and after the awarding of tenure. The findings suggest landscape architecture faculty members’ scholarly productivity continues to be relatively low in comparison with other academic disciplines. An evolving, or new standard of scholarship, among landscape architecture faculty increasingly emphasizes traditional academic refereed products. Landscape architecture as an academic field is in need of greater training in conceptualizing, acquiring support for, conducting, and reporting research to be successful in an academic environment and provide a much needed foundation for current practice.

1.1 Keywords
Scholarship, Faculty, Tenure, Academia, Productivity
The career development and success of landscape architecture faculty continues to be based increasingly on their scholarship (Deming & Swaffield, 2011). Academic institutions often emphasize research performance, whose assessments of faculty productivity tend to be based on quantifiable research behaviors (Milburn & Brown, 2003). Faculty in the process of demonstrating their scholarly productivity and its value to secure academic promotion and tenure must often balance the demands of scholarship and the preparation of future practitioners. Landscape architecture does not easily fit the traditional academic department model (Milburn et al., 2003). Prior studies of landscape architecture scholarship indicate that faculty productivity is hindered by relatively high instructional loads and student contact time (Milburn, Brown, & Paine 2001; Chen et al., 2011; Christensen & Michael, 2014). As a result, it often becomes necessary for landscape architecture faculty to describe the academic context in which they engage in scholarship (Gobster, Nassauer & Nadenicek, 2010), and may place them at a disadvantage when evaluated with other faculty across their institutions.

There has been some recent investigation of the type, quality, and quantity of scholarship on which faculty may be appropriately evaluated in the diverse context of landscape architecture (Chenoweth, 1992; LaGro 1999; Milburn, Brown & Paine, 2001; Milburn & Brown, 2003; Milburn & Brown, 2016). In particular, Milburn and Brown (2016) followed up on their earlier study (2003) to identify whether research productivity of landscape architecture faculty in North America had changed over the past 15 years, providing a rare and valuable longitudinal assessment. The findings, which will be discussed further subsequently, indicate that both the research attitudes and behaviors of faculty have improved, with faculty producing research at a rate higher than ever before (Milburn & Brown, 2016). In 2014, Christensen and Michael published a study examining a smaller cohort of similar landscape architecture programs' faculty research productivity. This study’s purpose was to revisit that study conducted for the 2008 to 2012 academic years (Christensen & Michael, 2014) and assess findings for faculty tenured from 2013 to 2016 to add to a more longitudinal understanding of faculty scholarly productivity.

This study replicates Christensen and Michael’s (2014) earlier study employing direct content analysis, specifically systematic intuitive interpretive analyses to classify and quantify the curriculum vitae of landscape architecture faculty members who were awarded tenure in the 2013-14 academic year or thereafter. Participant selection was framed by the specific need to communicate expectations for landscape architecture faculty productivity within Utah State University. As a result, participant selection involved first identifying similar public land-grant university programs with accredited bachelors and masters degrees in landscape architecture. Twenty one of 66 accredited academic programs, all within the United States, were identified as peer institutions to Utah State University. These institutions are the same as those from Christensen and Michael’s 2014 study.

During September of 2016, the administrators for each of these 21 academic programs and Utah State University were contacted and asked to identify their faculty who had been awarded tenure in the 2013-14 academic year or thereafter. One program administrator was unresponsive after repeated requests and was excluded from the study. The remaining 21 administrators identified 19 faculty who were awarded tenure during the defined period. However, one of these faculty members was included in the prior study (Christensen & Michael, 2014) and were excluded from this study. According to the purpose of the study, faculty members who were not successful in garnering tenure were excluded from the study. Eight academic programs reported no faculty awarded tenure since the 2013-14 academic year.

Participation of the 18 identified individuals was solicited by an email request wherein they were asked to provide their current full curriculum vita. Participants were assured anonymity in the reported results. One faculty member was unresponsive after repeated requests. In total, 17 faculty members representing thirteen academic programs participated in the study, a 94% response rate.

Scholarship in landscape architecture may be defined as creative intellectual work that is validated by peers and communicated. Accordingly, scholarly productivity is primarily assessed by peer
review as a measure of the quality of a faculty member’s contribution, and the number of publications, presentations, and secured external funding as measures of communication productivity or quantity (Rudd, 1988 in Milburn et al., 2003). Although these generalities cannot fully elucidate the complexity of scholarship in landscape architecture, an important step toward a more coherent academy is the acceptance of increasingly precise terminology regarding scholarly outputs (LaGro, 1999). This is still the case. Accordingly, to establish a coherent metric for this study the authors identified categories of scholarly output felt to be generally recognized, as shown in Table 1, the definitions for which were taken from established definitions/specifications such as the 2012 Higher Education Research Data Collection (HERDC) specifications and Australia Research Council (HERDC, 2012; ERA, 2012; Deakin, 2012) and were those use in Christensen and Michael’s prior study (2014).

### 3.2 Procedures

Content analysis of the curriculum vita was conducted during January 2017. The textual content was individually coded and quantified for the year tenure was awarded and the prior five years. Post-tenure was the year following through the fall semester of the 2016-17 academic year. In consideration of publication lags, all works reported as accepted or in-press were counted as published in the year indicated. Single and multi-authored publications or creative works were not assessed differently.

Two researchers independently coded the textual content of each vita according to the pre-defined operational terms/categories and their subjective perspective, for both pre- and post-tenure. The categories under which individual faculty presented their scholarly output were not strictly adhered to, but rather the textual information was coded according to the previously agreed upon operational definitions for this study. The individual results were then compared to identify any discrepancies, whereupon consensus agreement concerning alternative interpretations was reached through dialogue with a third researcher (Graneheim & Lundman, 2004). The agreed upon findings were then interpreted to address the purpose of the study. For the 40 pre- and post-tenure categories assessed, initial agreement was over 80% with the exception of five categories where a consensus agreement had to be reached.

### 4 RESULTS

The study results are reported descriptively as the total mean productivity by category during the tenure evaluation period and after the awarding of tenure in Table 2. The information in Table 2 is not presented for comparison between the pre- and post-tenure award periods as the post-tenure period varies in length between participants. However, the total mean productivity from the prior study (Christensen & Michael, 2014) is included for comparison, with an asterisk where there appears to be a substantial increase. Three participants are outliers with significantly higher scholarly productivity in numerous categories, being at least one standard deviation greater than the mean. For example, of the 89 total pre-tenure peer reviewed journal articles published by the cohort, 40 were published by the three outliers. The total mean productivity is also reported with these three participants excluded from the sample for clarity.

Participants’ curriculum vita were very unclear regarding the distinction between grants and contracts. As the researchers were unable to code the information appropriately, it was necessary to aggregate all funding as external funding, although this category does include internal academic institution awards as well. The consensus agreement value is used for the remaining categories where initial agreement was below 80%; pre-tenure peer reviewed journal articles (65% initial agreement), peer reviewed conference proceedings (53% initial agreement), presentations (76% initial agreement). Across the participants it was difficult to assess the accuracy of journal articles and conference proceedings designated as peer-reviewed. These category required substantial careful investigation of the referenced journals and proceedings by the researchers to determine the review process and establish consensus agreement. While presentations and awards were rarely presented in a consistent or straightforward manner.

The mean yearly scholarly productivity is reported in Table 3. To calculate the yearly productivity for participants after the awarding of tenure, the overall scholarly productivity was divided by the mean post tenure period for participants. The data is presented with the total mean productivity from the prior study (Christensen & Michael, 2014) included for comparison, with an asterisk where there appears to be a substantial increase.
<table>
<thead>
<tr>
<th>Category</th>
<th>Review</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Journal Article</td>
<td>Peer</td>
<td>A written work published in an academic/professional journal. The journal is published by a recognized publisher and possesses an ISBN.</td>
</tr>
<tr>
<td>Conference Proceedings</td>
<td>Peer</td>
<td>A fully written work published in the collection of papers of an academic/professional conference.</td>
</tr>
<tr>
<td>Abstract</td>
<td>Peer</td>
<td>A written abstract, extract, extended abstract, or synopsis published in an academic/professional journal or conference proceedings.</td>
</tr>
<tr>
<td>Presentation – Invited</td>
<td>-</td>
<td>Presentation at an academic/professional conference where the organizers independently approach the author.</td>
</tr>
<tr>
<td>Presentation – Contributed</td>
<td>-</td>
<td>Presentation at an academic/professional conference where the author approaches the organizers.</td>
</tr>
<tr>
<td>Presentation – Poster</td>
<td>-</td>
<td>Presentation of a display at an academic/professional conference.</td>
</tr>
<tr>
<td>Book</td>
<td>-</td>
<td>A major written work bound and published. Preferably by a recognized commercial press or publisher, and possessing an ISBN.</td>
</tr>
<tr>
<td>Book Chapter</td>
<td>-</td>
<td>A written work contributing to a compilation subject to editorial scrutiny.</td>
</tr>
<tr>
<td>Article – Working Paper</td>
<td>-</td>
<td>A written work distributed independently or in an unrecognized journal.</td>
</tr>
<tr>
<td>Article – Popular Press</td>
<td>-</td>
<td>Newspaper or magazine articles, media interviews, internal newsletters and the like.</td>
</tr>
<tr>
<td>Report</td>
<td>-</td>
<td>A written work completed in behalf of an independent entity.</td>
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<tr>
<td>Website</td>
<td>-</td>
<td>An online work.</td>
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<tr>
<td>Illustration</td>
<td>-</td>
<td>A graphic work distributed independently or in a recognized outlet.</td>
</tr>
<tr>
<td>Exhibit</td>
<td>Refereed</td>
<td>Curated exhibition of original creative work in an independent public venue.</td>
</tr>
<tr>
<td>Design Competition</td>
<td>Refereed</td>
<td>A competition sponsored by an independent organization inviting the submission of proposals.</td>
</tr>
<tr>
<td>Creative Work, Design/Planning Project</td>
<td>-</td>
<td>Original work for which copyright law could conceivably apply.</td>
</tr>
<tr>
<td>Built Work</td>
<td>-</td>
<td>The manifestation of original work/design common to landscape architecture and its allied disciplines.</td>
</tr>
<tr>
<td>Award</td>
<td>-</td>
<td>An award offered by an independent organization according to a publicly understood process. The independent organization is at least an academic institution or equivalent.</td>
</tr>
<tr>
<td>Grant Award</td>
<td>Refereed</td>
<td>Funding allocated through competitive granting schemes.</td>
</tr>
<tr>
<td>Contract Award</td>
<td>Refereed</td>
<td>Funding allocated in response to an independent organization's request.</td>
</tr>
</tbody>
</table>

Peer – Peer reviewed work involved a formal, impartial, and independent assessment or review of the work in its entirety before publication/presentation, conducted by qualified experts independent of the author.

Refereed – Refereed exhibits involved a publicly understood refereeing process conducted by an independent review panel formed from qualified peers.

Table 2. Total mean productivity by scholarly output category (not for pre- post- comparison).

<table>
<thead>
<tr>
<th>Category</th>
<th>Tenure Timing</th>
<th>2013 Mean Productivity</th>
<th>2016 Mean Productivity</th>
<th>2013 Mean Productivity excluding Outliers</th>
<th>2016 Mean Productivity excluding Outliers</th>
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<td>Pre</td>
<td>3.6</td>
<td>5.2</td>
<td>2.4</td>
<td>3.5</td>
</tr>
<tr>
<td>Journal Article</td>
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<td></td>
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* Denotes at least a 25% increase.
** Denotes at least a 25% decrease.
### Table 3. Mean yearly productivity by scholarly output category.

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* Denotes at least a 25% increase.  
** Denotes at least a 25% decrease.
5 DISCUSSION

A major criticism of the academic field in supporting the profession (Milburn, Brown & Paine, 2001), scholarly productivity in landscape architecture is low relative to that of collegiate scholars, where yearly publication rates range between 0.74 in the fine arts, 1.46 in the physical sciences, 2.54 in health sciences, and 3.38 in engineering for example (Pripić, 2009; Fox, 2005; Fairweather, 2002; Dundar & Lewis, 1998). Prior study indicates landscape architecture faculty publish 0.93 refereed articles per year (Milburn & Brown, 2016) and give 2.25 conference presentations per year (Milburn & Brown, 2016). Further, Milburn and Brown (2016) suggest that 54% of refereed journal articles are produced by 20% of the landscape architecture faculty.

This study supports this finding, with 18% of the faculty participants produced 45% of the total refereed journal articles pre-tenure and 50% post-tenure. With such a disparity it is difficult to know how to best represent the scholarly productivity of landscape architecture faculty, hence this study presents the findings with these ‘outliers’ included and excluded. Given this, the study findings indicate that during the evaluation period for tenure landscape architecture faculty publish between 0.6 and 0.9 peer reviewed journal articles per year, 0.4 peer reviewed articles in conference proceedings per year, give 1 invited conference presentation, and delivered between 1.7 and 2 contributed conference presentations per year. The findings represent an increase in peer reviewed journal articles since that reported in 2014 of about a quarter of an article per year. Presentations and peer-reviewed conference proceeding rates are more similar to those reported in 2014 (Christensen and Michael, 2014) and by Milburn and Brown (2016), perhaps suggesting an increasing focus on peer reviewed journal articles as a recognized academic product in the tenure assessment process.

With regard to external funding, landscape architecture faculty secured between $29,269 and $20,085 per year of their pre-tenure evaluation period. This is a significant reduction, an over 65% decrease, than the external funding secured pre-tenure reported in 2014. It is unclear from the data available what may be contributing to this reduction in external funding.

After being awarded tenure, landscape architecture faculty publish between 0.50 and 0.81 peer reviewed journal articles per year, 0.17 to 0.21 articles in peer reviewed conference proceedings per year, give one invited presentation, and delivered 0.71 to 0.90 contributed conference presentations per year. Post tenure, landscape architecture faculty secure between $16,966 and $27,855 in external funding each year. These results suggest that publication rates do not appear to significantly decline post-tenure, although conference presentation rates appear to decline. At the same time, these rates appear to be substantially lower than those reported in 2014 and by Milburn and Brown (2016), particularly for presentations. However, Milburn and Brown (2016) did not differentiate between pre- and post-tenure faculty in reporting these results, and it may be that pre-tenure faculty in landscape architecture are contributing the majority of the peer reviewed scholarly outputs in the field.

While low overall, the results suggest that landscape architecture faculty are emphasizing traditional academic refereed products. Further, scholarly products historically associated with landscape architecture, but less so with other academic disciplines, such as exhibits, design competitions, and creative work, are being largely ignored likely in favor of the more institutionally accepted outlets needed to garner support in the academic environment. This emphasis is reflected in the way faculty scholarship is presented in vita, which can appear highly variable without widely understood and adhered to definitions of scholarly products. In lieu of establishing specifications for scholarly products in the field of landscape architecture, it would be beneficial if landscape architecture faculty adhered more closely to commonly accepted definitions of scholarly products, as suggested previously (Christensen & Michael, 2014).

Publication of faculty research is currently occurring primarily in recognized scholarly outlets, with no participants reported the independent distribution of working papers and very few articles in the popular press, a decline from 2014. This may portend a negative impact on the translation of research to practice, which is a major criticism of academia. The vast majority of the peer reviewed abstracts are associated with the annual conference of the Council of Educators in Landscape Architecture (CELA). There are very few other outlets which employ a similar dissemination strategy of peer reviewed abstracts. Landscape architecture faculty members are endeavoring to maximize this outlet during the tenure review period, and much less so post-tenure.

The results of this study are similar to those reported by Milburn and Brown (2016) in suggesting that a minority of landscape architecture faculty are responsible for a majority of the scholarly productivity.
A comparison of scholarly productivity between the three outlying participants and the remainder of the sample indicates that the three outlying participants are responsible for over 24% of the scholarly productivity during the tenure evaluation period and 23% post-tenure. When considering all of the participants and all of the identified scholarly products, the results suggest that faculty productivity decreases significantly (45%) post tenure. Most interestingly, external funding awards do not appear to change pre- to post-tenure (5% decrease), unless the three outlying participants are excluded and then external funding falls 16% post-tenure. It appears that in part, an experienced faculty member is better positioned to garner funding and will continue to do so, but this experience needs to be gained during tenure process. Otherwise, the trend in securing external funding does not continue. The findings thus suggest that faculty productivity decreases immediately post tenure, quite significantly, as well as reiterating that a minority of landscape architecture faculty members are responsible for a majority of the scholarly productivity, results similar to those found recently by Milburn and Brown (2016).

The reasons behind these findings should be examined in the future, but are likely due to a minority of landscape architecture faculty being academically trained for the scholarly demands of the academic environment. The proportion of faculty who hold doctoral degrees in this sample (9 of 17) is very similar to that reported in 2014 (8/18) (Christensen & Michael, 2014). A careful examination of the results supports this assertion in that productivity measured for scholarly categories that are often less valued in the academic environment, such as exhibits, popular press articles, and contributed presentations, actually rises when those faculty who do not possess doctoral degrees are excluded. While the scholarly categories typically most valued in the academic environment, such as peer reviewed publication, are lower.

However, some caution should be exercised as the data are reported for the six years of the tenure period, while productivity post tenure is reported for individual periods that together averaged just 1.7 years. Interestingly, very few participants (n=2) were awarded tenure in the last two years.

5.1 Limitations
This study has a number of limitations. We were unable to evaluate the level of responsibility individual participants had for externally funded research as few faculty members reported whether they were the principal or co-principal investigator. We were unable to assess the level of responsibility for multiple author publications as few respondents reported their role in the publication. Nor were we able to assess the role played in individual faculty member’s professional practice experience or whether their experience was academic or professional practice experience. Guest or invited jury participation was not measured in this study given the variability of reporting.

Most unfortunately, there are a host of well-studied factors which influence scholarly productivity, such as age, gender, subfield specialization, collaboration, etc., which the authors did not assess (see Helsi & Lee, 2011 for a more complete presentation of these factors), although Milburn and Brown (2016) suggest that age, gender do not influence scholarly productivity. It is very likely that instructional loads have a great deal of impact on scholarly productivity. Teaching in landscape architecture is time intensive. With studio-based curricula and faculty/student ratios being accreditation requirements, landscape architecture faculty typically have high student contact time overall as well as per credit hour, and labor intensive teaching loads (Milburn, Brown & Paine, 2001). The high instructional load is often offered as justification for the low scholarly productivity among landscape architecture faculty. However, we were unable to accurately assess instructional load as very few respondent’s curriculum vita indicated the number of credits or contact time for the listings of courses taught. In addition, the difference between academic institutions’ credit equivalents was not known.

6 IMPLICATIONS
The purpose of this study was to establish a current understanding of landscape architecture faculty scholarship. The findings indicate that scholarly productivity in landscape architecture is low overall and falls significantly after the awarding of tenure. The role of instructional loads needs to be examined. During the evaluation period for tenure faculty members focus on more commonly valued categories of academic scholarship. In addition to establishing the scholarly productivity rates of landscape architecture faculty, the most significant finding of this study suggests that a minority of landscape architecture faculty are responsible for a majority of the scholarly productivity. Considered together, the overall low scholarly productivity and a minority of faculty accounting for the majority of the scholarly productivity points toward a critical need for greater preparation of the landscape architecture
academy in conceptualizing, acquiring support for, conducting, and reporting meaningful scholarship. Doing so will lead to greater success in the academic environment, support for evidence-based professional practice, and provide a much needed theoretical foundation for the future of landscape architecture. At the same time, instruction in the field needs to be examined. The low overall scholarly productivity of faculty may be hindered by high instructional loads, which is likely. Evidence for this assumption should be sought to provide an evidence base for faculty’s case for promotion and tenure in the academic environment.

Despite national discussions regarding the future of the tenure model in higher education, the majority of new and emerging landscape architecture faculty positions employ this system. Consequently, success for the emerging faculty nationally will rely upon effective performance within the tenure track system. In a climate of increasing demands for transparency and accountability by the public and legislators, emerging academics can expect to face calls for performance at or above national standards. Doing so within the realm of scholarship requires clarity in benchmarks among peers at peer institutions. This study contributes to continuing efforts to establish an understanding of these benchmarks and their longitudinal trends. The current findings offer a foundation for understanding productivity among successful early career scholars in the discipline.

7 REFERENCES


DataScapes: A Landscape Architectural Workshop on Incorporating Environmental Data Capture into the Design Process

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Lindsay, Jacob
Aurecon

Burry, Jane
Swinburne University of Technology

1 ABSTRACT
Data capture and analysis through embedded sensors are becoming more prevalent in many industries. Increased amounts of available data are enabling designers to produce more customized solutions based on observations and numeric analyses of real-world phenomena. One such set of phenomena are microclimatic conditions. Microclimate data capture and analysis has the potential to influence design for human comfort and well-being in urban landscapes. This paper reports on a 7-week intensive university seminar on environmental data capture for landscape design. Beginning with a specific framing of a design hypothesis in the form of a “How might we...” statement, the student groups conducted data capture surveys by constructing sensor devices, then capturing, processing, visualizing and analyzing the data, in order to inform specific design decisions for proposed interventions in the Victoria Harbour precinct in Melbourne, Australia. These included structures to reduce wind tunnel effects, urban gardening initiatives that matched vegetation types to varying microclimates, and informing the positioning of artificial lighting to boost social interactions and perception of safety at night-time. Based on these student projects, this paper seeks to address the question of how data-driven design may be conducted in practice, and how to prepare design students for a data-driven future. This class focused on story-telling as the key method for achieving meaningful results efficiently. We mandated students to set up an aim and hypothesis before capturing any data, and to channel their efforts into short, narrated animations to learn how to engage audiences.

1.1 Keywords
Microclimate, data capture, story-telling, data-driven
2 INTRODUCTION

The increasing preponderance of publicly available data is causing a shift in the design disciplines towards data-driven methodologies. Examples of this include weather station data to inform sustainable building design and various city data platforms for downloading digital 3D models of city districts, as well as countless data sets with information on traffic, property prices and demography to name a few. While the emergence of Big Data and machine learning presents new potentials for the architectural design community, it generally remains an obscure concept that is unwieldy for applications in most practical design applications. Since architects usually design buildings for a specific context at a local scale, it is less the Big Data that is needed than the Right Data – information relating to a particular design question to build an understanding of site conditions and inform decision-making. This may require custom data capture tailored towards producing the precise types, volume, resolution and structure of data that would make a difference for the design process.

Various design practices have engaged in data capture. The WeWork research team documents space utilization of their co-working offices to optimize interior fitouts of future office spaces; Kieran Timberlake have set up climate sensors at their head office and created an app that monitors micro-climates and occupant comfort; Umbrellium’s WearAQ initiative combined people’s subjective perception of their environment with wearable technology to investigate personal agency and responsibility in air quality issues.

Data capture can aid the design process in a number of ways (for example, Prohasky et al. 2014; Williams et al. 2015). In order to introduce landscape architecture students from RMIT University to the concept of capturing data for applications in design, a 7-week intensive seminar was directed by []. This seminar was linked to a design project studio in partnership with Aurecon, aimed at proposing design solutions to activate the area around Victoria Harbour in Docklands, Melbourne, Australia. The results of the seminar were intended to feed into the studio project by evaluating and influencing design decisions. One key aspect of landscape architecture is to incorporate considerations of human comfort and well-being, which are affected by micro-climatic conditions. The goal of the seminar was to teach the students how to capture environmental data, visualize it in engaging ways, and act on it by using its analysis to develop design ideas. Many examples show that intensive university seminars can be helpful in engaging with diverse ideas and workflows by maximizing output in a limited amount of time (Melsom, Fraguada, and Hurkxkxens, 2017; Sarhan and Rutherford, 2014). Too often, data is captured without designers being able to make the connection between the data and design considerations. The seminar therefore emphasized storytelling to create narratives from data insights that help inform design.

3 METHODS

The seminar took place over the course of 7 weeks, with 2 supervised 3 hour sessions per week accompanied by homework assignments and independent project work by the students. Class activities included lectures by the course coordinators and invited industry professionals on data related topics, as well as practical workshops, design critiques and supervised group work activities. Since the seminar was tied into a studio project, the same student groups were formed for the seminar as in the studio. The structure of the seminar was conceptualized as an agile process to work through an end-to-end methodology involving formulating a research question, designing an experiment, constructing sensing hardware, conducting data capture, then post-processing, visualization and analyzing the data, before linking it to design considerations and developing a narrative to communicate the design ideas. The typical structure of the sessions proceeded in the order of a guest lecture, explanation of an assignment, group work on the assignment, presentation of results and critiques. The course had a strict schedule following logical methodological steps (Table 1).

From the beginning of the seminar, a special emphasis was placed on defining specific research questions to direct data capture towards maximizing insights instead of data volume. Research questions were therefore posed at the start of the seminar in the form of “How might we...” (HMW) statements, inspired by the online resources from Stanford’s Hasso Plattner Institute of Design. These statements are a method to phrase questions in a way that pinpoints design intents to structure an investigation that is most likely to lead to useful insights. This was done in the form of:

“How might we [insert action] for [insert person(s)] so that [insert desired outcome]?”

To enable a more directed teaching method and comparable results, we decided to narrow down the focus on environmental data. The students were introduced to practical considerations of data capture
methods, then taught how to wire up various environmental sensors to an Arduino microcontroller. Each student group was provided a package of components listed in Table 2.

The students designed a data capture experiment seeking to create the most conclusive outputs pertaining to their research questions, and conducted the data capture autonomously. We required their data sets to be well-structured, documented with meta-data and uploaded to an open data platform. We asked the students to visualize their initial data sets via the online data visualization tool Carto; later on, they chose individual methods tailored to visualizing aspects specific to their respective project.

The final output of the seminar was to create a 5min video with an engaging story-telling narrative, explaining the intent of the investigations, visualizing the data in understandable ways, and making a clear connection between the insights gleaned from the data analysis and proposed design solutions. To help structure this in an efficient way, we conducted several assignments geared at building a compelling story. This included filling out a Pixar Canvas, taken from the open source Startup Science Toolkit, in the form of:

“Once upon a time … One day … Because of that … Because of this … Until finally …”

The students created storyboards as the groundwork on which to base their data story videos, constituting the final assignment. The videos incorporated the Pixar-style narrative, problem description, HMW statement, data analysis and design proposals.

Table 1. Seminar structure.

<table>
<thead>
<tr>
<th>Week</th>
<th>Skill to learn</th>
<th>Lecture</th>
<th>Workshops/Assignments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Formulating a research question</td>
<td>How can data inform design?</td>
<td>HMW statements</td>
</tr>
<tr>
<td>2</td>
<td>Designing an experiment</td>
<td>Data capture methods</td>
<td>Research questions / Experiment design</td>
</tr>
<tr>
<td>3</td>
<td>Constructing sensing hardware</td>
<td>Open Data Platforms</td>
<td>Arduino building session / Capturing a data set</td>
</tr>
<tr>
<td>4</td>
<td>Post-processing &amp; Visualization</td>
<td>Data Visualization</td>
<td>Data visualization / additional data capture</td>
</tr>
<tr>
<td>5</td>
<td>Analysis</td>
<td>Biodiversity Databases</td>
<td>Developing data stories (Pixar canvas / storyboards)</td>
</tr>
<tr>
<td>6</td>
<td>Data story-telling</td>
<td>Human Well-Being</td>
<td>Create videos</td>
</tr>
<tr>
<td>7</td>
<td></td>
<td>Student presentations</td>
<td></td>
</tr>
</tbody>
</table>

Table 2: Arduino components.

<table>
<thead>
<tr>
<th>Type</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>DTH22</td>
<td>Measures temperature (C) and relative humidity (%)</td>
</tr>
<tr>
<td>TSL2561</td>
<td>Measures luminosity (lux)</td>
</tr>
<tr>
<td>Rev C</td>
<td>Measures wind speed (m/s)</td>
</tr>
<tr>
<td>BMP180</td>
<td>Measures atmospheric pressure (hPa)</td>
</tr>
<tr>
<td>Arduino Nano</td>
<td>Microcontroller</td>
</tr>
<tr>
<td>SD card logger</td>
<td>Enables saving measured values to an SD card</td>
</tr>
<tr>
<td>Real-time clock</td>
<td>Reads time and date</td>
</tr>
<tr>
<td>Breadboard</td>
<td>Used for fixating components and connecting them during prototyping</td>
</tr>
<tr>
<td>Jumper wires</td>
<td>Used to connect components</td>
</tr>
</tbody>
</table>

4 RESULTS

In this section, we summarize the seminar outputs of three of the student groups.

4.1 Wind Group

A commonly reported negative effect within Victoria Harbour are elevated wind speeds that make dwelling outdoors uncomfortable. This may be due to the area’s proximity to water bodies, leaving it
exposed to unobstructed winds. Another reason may be its high street canyons creating wind tunnel effects. This group therefore asked:

“How might we reduce wind speeds on Merchant St for people working in Victoria Harbour, so that they enjoy a better outdoor experience?”

The group measured wind speeds and relative humidity across a sample street and found prevailing north winds, consistent with weather data for the measured time of year. The detection of increased wind speeds was interpreted as evidence for a wind tunnel effect, whereby the highest wind speeds were measured in northern part of the road. These dissipated at the large crossing with Bourke St, then increased again in the southern part of the road where the street canyon becomes narrow again. The northern part of the road closer to the river had higher relative humidity levels. The group proposed modulating the terrain by creating an elevation at the northern end of the road to cast a wind shadow for the leeward side. The hill itself would be expected to have high speeds, therefore the design included wind shelters with wind harvesting devices at the hilltop. Further down the road, the students proposed an installation to diffuse water droplets at low relative humidity levels (figure 1).

4.2 Vegetation Group

The area around Victoria Harbour used to be a natural hunting ground and meeting place for aboriginal tribes; nowadays it is an urbanized commercial precinct with high-rise buildings and paved surfaces. As an initiative to increase greenery and induce a more organic lifestyle in the precinct, this group proposed distributing small urban gardens around the area. They asked themselves:

“How might we situate urban gardens for urban farmers in Victoria Harbour, so that crop yields are maximized?”

Based on the premise that different vegetation types thrive in different environmental conditions, the students measured micro-climate variations around the precinct to suggest ideal locations for various crops. They logged temperature, relative humidity, luminosity and UV levels across several city blocks. The students designed various urban gardening patches distributed throughout the area, with different plant types grown in different areas according to the spatially diverse micro-climatic conditions (figure 2).
4.3 Light Group

While Victoria Harbour is bustling during daytime, it is very quiet at night. The students hypothesized that one reason for this is a lack of night-time activities, as well as insufficient lighting, which together diminish the perception of safety in the area. This group was part of the Vegetation Group in the overarching studio project; their proposal to create activity therefore also involved urban gardens, but they focussed on lighting conditions to promote social interactions during night time:

“How might we optimize lighting conditions at night for residents in Victoria Harbour, to increase safety perception, community engagement and social interaction?”

The group monitored luminosity levels throughout the precinct at night, and conducted research on the light emittance of various light sources. Their research also found that lighting conditions below 40lux generally feels unsafe. The students proposed several locations for urban gardening interventions, and placed special emphasis on introducing lighting via lamps and interactive displays (figure 3).
5 CONCLUSION

The “How might we…” statements were instrumental in framing the work by first finding a problem and developing a hypothesis, then using data capture to find solutions, instead of vice-versa. This led to a goal-oriented workflow targeted at creating design outcomes. Relating the data capture seminar to a studio project facilitated this process; it gave the students a design context within which to direct the data analysis towards solving problems encountered in their project. Group work and distribution of various components of the workflow to team members maximized the seminar outputs and promoted knowledge transfer within the groups.

We consider such investigations an important part of current design courses. A benefit of the seminar was to demystify what data is, by showing the students the ease of creating data capture devices, and enabling them to use it to inform the materialization of design. Simultaneously, it fostered scepticism for the accuracy and validity of data sources. The seminar made apparent the importance of working with data to inform design decisions, and the lectures by industry professionals helped underline the importance of data within practical contexts. The seminar followed an intense end-to-end prototyping process, starting with a problem formulation, leading to an experiment for data-informed design outcomes. The final output of the seminar focused on visualizing data in novel and understandable ways and embedding analysis and design proposals into a compelling story-telling method.

6 ACKNOWLEDGEMENTS

We acknowledge that this research has received support from the Australian Research Council (ARC) through the Linkage Project Swarming: micro-flight data capture and analysis in architectural design CIs J Burry, S. Watkins, F. Salim, A. Mohammed.
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The Living Green Infrastructure Lab: Advancing Interdisciplinary Teaching and Experiential Learning in Landscape Architecture Pedagogy

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1. ABSTRACT
Demonstrating and experimenting interdisciplinary teaching and experiential learning, faculty and students across three colleges (Agriculture and Life Sciences, Architecture and Engineering), and 4 departments (Landscape Architecture and Urban Planning, Horticultural Sciences, and Civil, Biological and Agricultural Engineering) designed, implemented, and are monitoring effects of a rain garden. This collaboration presents a model for multi-scalar, interdisciplinary studio instruction involving a project conducted by over 200 undergraduate and graduate students across allied fields. Landscape Architecture students provided designs, construction details, and performance monitoring of the site as well as developed a large-scaled campus master plan. Horticultural Sciences students propagated and produced the plants. Civil engineers assisted with constructed infrastructure design and water quality/quantity assessment. Professional landscape architects, urban planners, horticulturalists, engineers and campus facilities maintenance personnel evaluated student work. Prior to installation of the project, runoff speed, volume, and water quality were monitored as base-line data. After installation, post-design water quality measures have been conducted and compared to base-line data. Collaboration between multidisciplinary professionals enabled students to experience the professional design process and have a deeper understanding of the positive impacts of green infrastructure through interdisciplinary experiential learning.

1.1 Keywords:  
green infrastructure, stormwater management, campus design, design pedagogy, low impact development, high impact experiences
2. INTRODUCTION
In recent decades, higher education has been emphasizing the importance of interdisciplinary experiences and high impact learning for students to be better prepared for immediate employment. According to Kuh (2008), “collaborative assignment and projects” is considered one of the high-impact educational practices in higher education because it deepens one’s own understanding by “listening seriously to the insights of others, especially those with different backgrounds and life experiences (p.10).” To facilitate more cross campus collaboration, Texas A&M University (TAMU) launched a series of initiatives with funding to support interdisciplinary teaching and experiential learning in 2015. Faculty from three colleges (Agriculture and Life Sciences, Architecture, and Engineering), and four departments (Landscape Architecture and Urban Planning, Horticultural Sciences, and Civil, Biological and Agricultural Engineering) formed the research team and collaborated to propose a project that addresses the importance of green infrastructure, and the project was selected to proceed with funding.

The project team focused on the green infrastructure topic because drought has had a statewide impact on Texas with current groundwater reservoirs at only 67% fill level (down from 81%) and reservoir storage rapidly declining with losses of up to 64,000 acre-feet per week from lack of rain, lack of stormwater infiltration, and over-consumption of water (Newman et al., 2018). Groundwater has declined in most aquifers while areas closer to the Gulf have subsided up to 8 ft. since 1940 due to groundwater consumption. Low Impact Development (LID) provides an alternative to traditional approaches that require costly maintenance and waste resources. As flood events become more frequent and impervious land cover increases, management of stormwater runoff becomes increasingly important (Thiagarajan et al., 2018). Planning strategies emphasizing stormwater management, such as Low Impact Development (LID), are increasingly utilized in sustainable design/development, minimizing impacts of impervious land cover. LID is an innovative approach treating stormwater at the source, using uniformly distributed facilities such as stormwater collection devices, filtering systems, and water reuse mechanisms. However, the interaction of different scales (from master plan to site-scaled facilities) and disciplines within the design process are rarely conducted in academic settings. Current design studios have both limited funding and limited interdisciplinary cooperation. In most cases, products created within a landscape architecture studio conclude at the conceptual level and are never installed, nor does post occupancy evaluation occur (Newman et al., 2017). If installed, the performance of the project is seldom calculated and physical inspection of the built out product does not occur.

Using a site on the TAMU campus, the project team and participating students designed and implemented a rain garden, which serves as a living green infrastructure (GI) lab. In this living GI lab, different courses under the landscape department were connected from the design studio to construction courses, and interaction between multi-disciplinary departments was promoted. In this way, a comprehensive masterplan, a detailed rain garden design, a feasible construction layout, a planting plan, an irrigation plan, a maintained plan, and substantial performance monitoring involved the students across all four departments, which provided the
opportunity for interdisciplinary cooperation, design application, and landscape performance assessment. Landscape architecture students have been experiencing the real time project design and implementation process, allowing for a better understanding of the utilization of LID, as well as providing a hands on experience for conceptual design to detail and implementation.

This paper presents lessons learned from a framework for interdisciplinary site design studio teaching integrating landscape development, stormwater management, professional feedback, landscape performance, and the integration of site scaled design into existing larger-scaled masterplans. General benefits of this project were to raise awareness of hydrological issues and to demonstrate the feasibility of widespread implementation and to educate a new generation of practitioners in LID applications. Several objectives were sought to achieve this focus:

1. Strategically implement a set of structural and non-structural LID facilities on each test site and link their core functions through education, research, and demonstration provided by outdoor classrooms.
2. Operationalize the construction, performance measurement and long term monitoring of each site assessing the impact of LID treatment versus non-treatment as an educational mechanism for students.
3. Assess the learning outcomes of the interdisciplinary teaching and experiential learning outcomes.

2.1 Disciplinary Roles
Like professional landscape architecture projects, the design and implementation of a project usually requires interdisciplinary cooperation (Meyer et al., 2018). For designs involving planting plans, an expertise in regional horticultural knowledge is an essential facet to bringing a landscape design into reality as well as its long-term success. To demonstrate this process and expand the border of the traditional landscape courses, the instructors from different departments interacted in this project to provide feedback and instructions on the design and strengthen its feasibility.

In this project, the landscape architecture department played a leading role with the design, revision, implementation, and performance monitoring, the horticulture department played an important role of plant propagation and planting design, and civil engineering department took charge of construction plan feasibility as well as assisted in the monitorization processes. During this process of design and implementation, multiple courses were involved: In the Department of Landscape Architecture and Urban Planning, 5 Construction and Site Engineering Courses (LAND 329/330/331/612/614), 6 Design Studio Courses (LAND 318/319/320/321/601/602), and 1 Practice Diversity Course (LAND 645) were utilized. In the Horticultural Sciences Department, 6 courses were utilized (HORT 306/308/425/485/608/609), and in the in the Civil, Biological and Agricultural Engineering, 4 courses were utilized (CVEN 301/413/627/665). In total, the students involved in the design and implementation phases totaled more than 200 across all departments.

2.2 Site Description
The site of this project was located on the western portion of the TAMU campus, on a site adjacent to White Creek. This portion of campus was recently designed in part by White Oak Studio, a professional landscape architecture firm, as a component of the Leach Teaching Gardens. It is also a part of the 2020 vision of the TAMU masterplan to become a campus greenway. The implemented rain garden portion is adjacent to the Borlaugh Institute, which was an open grass swale which transported runoff from an adjacent parking lot. The mission of this living lab was to design a comprehensive masterplan and a detailed rain garden design. After a planting plan consultation with horticulture department and a construction plan consultation with civil engineering, the SSC Campus Facilities Service helped install and currently maintains the student and faculty led raingarden design. Funding for construction of this project was provided by both the Aggie Green Fund ($61,500.00) an organization for sustainable built projects at TAMU as well as a TAMU Tier one Grant ($300,00.00), a three year interdisciplinary research and teaching opportunity. Both offer major funding to empower students, faculty, and staff to take action and bring creative environmental improvements to the TAMU campus.

3. FRAMEWORK DESCRIPTION
3.1. Learning Objectives and Outcomes
The primary intent of this project is for students to learn what hydrological and ecosystem services are and the important role that LID facilities can play in mitigating urban flood issues. Students were exposed to multi-disciplinary approaches and learned how to analyze, interpret and present data from complex projects. The program addressed six learning outcomes of each department: 1) mastering the depth of knowledge required in design, construction and plant biology and landscape function; 2) demonstrating critical thinking in problem solving for the design and evaluating effectiveness from the collected data; 3) communicating results effectively to a variety of audiences; 4) learning socially responsible uses of water management; 5) preparing the students for lifelong living by stimulating curiosity and learning to acquire knowledge from multiple sources and assembling it into a coherent purpose; 6) working in many collaborative groups and teams to accomplish the various stages of the project. It also directly linked to 5 of the university’s student learning outcomes: 1) developing a coherent understanding of the subject matter through synthesis across courses and experiences; 2) application of subject knowledge in a range of contexts to solve problems; 3) using a variety of sources to analyze and integrate information; 4) using appropriate technologies to communicate, collaborate, conduct research, and solve problems; 5) conducting valid and data supported appropriate research. Table 1 describes these learning outcomes and the assessment methods which accompanied them.

<table>
<thead>
<tr>
<th>Learning Outcomes</th>
<th>Assessment Tools</th>
</tr>
</thead>
<tbody>
<tr>
<td>University Nurture critical thinking and life-long learning skills needed for deep and continuing engagement within the built and natural environments</td>
<td>Determine the degree of self-motivation increase and understanding of the causal linkages of developmental decisions</td>
</tr>
</tbody>
</table>
### Landscape Architecture and Urban Planning

| Demonstrate leadership and informed decision-making skills in professional practice and in the community | Monitor and analyze the roles of each student and their devotion to the program’s development |
| Build a broad knowledge base of natural and cultural systems | Identify the multiple components which comprise the composite of the natural and cultural environments |
| Develop and apply knowledge of landscape architectural materials, methods, and performance, from source through extraction, design use, and place | Construction detailing examinations and professional critique |
| Demonstrate a deep knowledge of and ability to apply the processes of design, planning, preservation and construction of exterior spaces | Juried review by faculty and visiting professionals |
| Develop and apply knowledge of landscape architectural materials, methods, and performance, from source through extraction, design use, and place based characteristics | Portfolio, technical report, and design package development |

### Horticultural Sciences, & Civil, Biological and Agricultural Engineering

| Identify horticultural plant characteristics and their uses | Measure students’ understanding of the importance of matching the correct plants with the desired functions in the design. |
| Integrate knowledge of the movement of water, nutrients and energy through the biosphere and the resulting impacts on plant growth and physiology | Identify the extent to which students understand the bio-filtration and water collection systems modification of hydrology and nutrient movement in the test systems. |
| Critically evaluate options for sustainable plant management, including natural, urban and engineered horticultural systems | Determine the extent to which students have gained an understanding of the alternative water saving technologies into urban landscape designs. |
| Collect, manage, analyze and interpret data | Measure the extent of involvement of student in analysis and presentation of data generated. |

#### 3.2. Project Phases

As noted, this program sought to educate and train students in LID alternatives to traditional stormwater management through hands-on outdoor classroom activities involving development, installation, monitoring, management, and evaluation within interactive test plots.
on the site.
The first phase of this project was the conceptual master planning for west campus. Students were introduced to LID, instructed to investigate existing drainage problems, and applied LID strategies and design elements to solve said problems.

The second phase of the project was to link the conceptual design to the goals of the Texas A&M Gardens and Greenway at White Creek, a public greenway for conducting teaching, research, and extension/outreach activities. In this phase, landscape architecture students were required to integrate the LID facilities and apply GI as a means of assisting in stormwater management while connecting to the current greenway system. Since the masterplan is part of the 2020 TAMU vision masterplan and adjacent to the landscape design site of horticulture buildings under construction, the studio had the consultation with the university planning faculty and landscape architecture professionals from the White Oak Studio. Students in this masterplan phase received feedback from professionals as well as planning faculty about large-scale design, and gained practice-wise feedback from practicing professionals. The studio was divided into four groups based on different themes. Their final masterplan was modified throughout the self-reflection and a series of feedback sessions with professionals, faculty, and maintenance associates.

The third phase was the conceptual design of the rain garden, located near a series of Borlaugh Institute greenhouses. Horticulture faculty members cooperated with landscape faculty on plant selection and evaluation/feedback for the planting plan. Plant selection process for LID was conducted under their instruction and utilized mostly native, low maintenance species. Students gained a deeper understanding of plant characteristics for LID and suitability under certain conditions. Later the designs were illustrated and presented to the horticulture faculty members and professionals. The best design was selected to move forward for revisions and an eventual construction plan for implementation.

After the conceptual design phase, the project was integrated with civil engineering students and faculty. In consideration of performance and feasibility, an overflow detention structure was put into the design to divide the first flush and better handle the peak runoff during rainfall. The structure of the overflow structure was designed under by both landscape architecture and civil engineering faculty/students. After the design with the civil engineering group, instructors in the horticulture department cooperated in a review and revision of the planting plan according to the current nursery inventory within the horticulture department and what was available to grow. During this phase, the students collaborated with more disciplines and professionals, and gained better understanding of the practical landscape implementation such as budget control, material selection, sourcing, and plant combinations for maintenance considerations.

To compare the pre-construction condition and post-construction condition, a program to monitor the water quality and quantity of runoff into and out of the site was installed. Landscape architecture students used ISCO water samplers to collect rainwater, and H-flumes to test runoff speed. After retrieving data and water sample from the samplers, the water
samples were sent to the TAMU AgriLife Extension Service Soil, Water and Forage Testing Laboratory to compare the water quality before and after entering our pre-construction site. When the construction is completed, and the plants are fully established, students will use the same method to test the water quality and runoff velocity in and out the rain garden again, to compare pre and post conditions. The research will provide a powerful longitudinal case study for future education for LID from the perspectives of site design, construction design, and design practice.

Figure 1. Selected plants and their associated characteristics.  
Image credits: Zhihan Tao

Figure 2. Installation of monitoring facilities and H-flumes for testing the pre-construction runoff condition and collecting rainwater into and out of the site.
4. RESULTS
During this three-year period, over 200 undergraduate and graduate students across four different departments collaborated with one another and working professionals within their related fields. From the perspective of landscape architecture education, this course was well received. There are students interested in construction design who worked with the civil engineering faculty to develop the final construction documents of the on-site overflow device. Meanwhile, the students with special interest in planting design cooperated with the horticulture faculty and students to finalize the feasible planting plan. In addition, among the four student design teams, three teams won the state chapter ASLA student awards; two of which won awards of Excellence in the General Design, and Planning and Analysis Categories. During the three-year duration of the lab, the participating department earned experience with multi-discipline cooperation across different colleges, and has poised itself to develop a solid scientific case study for future education of the impacts of GI on stormwater mitigation.

Figure 3. Texas Chapter ASLA Student Award for Excellence in Planning and Analysis.

Image credit: Zhihan Tao, Bingjie Zhao, and Kaidi Ye
The traditional landscape architecture studio course usually consists of a process entailing site analysis, case studies, conceptual design, and design schematics. There are few opportunities for students to explore multiple scales of design and implementation of these projects is quite rare. The isolated environment of landscape architecture students from other disciplines in traditional design studios can be different from most of the multi-disciplinary working environments in professional practice. Furthermore, traditional studios can limit opportunities for students to be involved in real projects and have a more comprehensive understanding of construction materials, the construction process, and planting materials.

In the living GI lab, because the project is both multi-scalar and interdisciplinary, students have the opportunity to have different experiences with both large-scale master planning and small-scale site design while providing an in-depth multi-disciplinary learning experience. With the feedback loop with planning and maintenance crews and well as professionals, students were able to be intimately involved with the many revisions and sacrifices required to actually get a project installed. Furthermore, the landscape performance measurement provides great opportunity to examine the research associated with GI and LID benefits.

![Figure 4. Revised planting plan after consultation with horticulture faculty.](Image by authors)

As noted, prior to the installation of the project, the runoff speed, volume, and water quality were monitored and recorded using water samplers produced by ISCO and consultation with the TAMU AgriLife Extension Service Soil, Water and Forage Testing Laboratory. The entire construction process was recorded by time-lapse cameras to produce videos for further inspection and to educate students about the different phases: site preparation, grading, paving installation, metal structure installation, and planting. After the installation, post-design water quality measures were conducted and compared to pre-installation data. The results of
the performance monitoring are more than study material for this lab, but also a case study for future course materials of construction, theory application, and practice diversity classes to demonstrate the outcomes of LID and future interpretation of this rain garden to improve its performance.

5. CHALLENGES
Despite the positive outcomes of this project, there are a few challenges for future process of this lab and usage of this lab model. The first challenge of this model is its time consuming process. Since the different phases of this project are dependent on different groups of faculty and professionals, the timeline often changes according to the changes of human resources, curriculum, weather conditions, and other emergencies. In this case, the construction of the rain garden can be influenced by the surrounding construction (which delayed the installation of the rain garden for more than three months) or other outside circumstances. The delay of installation forced the timetable to change, which made this project exceed the duration of planned 3 years. The excessive amount of time causes challenge of costs of the project. A majority of the costs of the project were construction costs, since the plants were grown by students. However, the equipment of the monitoring devices was also a significant financial burden. Since the devices will be implemented in the outdoor environment under raining weather, they are very easily influenced by wind and rainstorm events. The devices for conducting pre-development condition tests were actually broken by the storm during Hurricane Harvey. The substantial cost of repair also ate into the budget. The shipment of replacement parts for the devices required extended time as well. Relatedly, since the designed device for the overflow structure on site was custom, the work for the metal flume was extremely costly and required an excessive amount of communication work with the custom metal workshops and fabricators. Having said these, these challenge are real in the industry and therefore, allow true learning for the students and faculty.

Figure 5. Monitoring devices influenced by hurricane event and the final installed design. Photos by authors.

6. CONCLUSION
This project is an experimental approach to integrating different disciplines into a single living lab which covered site analysis, campus masterplan, site design, LID application, planting design, construction documents, construction process, and landscape performance testing. It allowed landscape architecture students to go through the full process from sketch of design to
actual installation. Further, it provided opportunities for students to find their own interest area and expertise, which is very helpful for their career planning and development. Since this project also provided a glimpse of the research process involved with landscape performance, students interested in landscape research were able to explore its potential. Despite the cost and time spent on this project, the students gained opportunities for their future, and better understanding of systematic green infrastructure and application of low impact development. In addition, the nature of this project, course organization, multi-disciplinary network, and performance monitoring methods were helpful for the future educational opportunities in the future.

7. REFERENCES
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1 ABSTRACT

Ever accelerating technological changes had the unfortunate effect of disconnecting us from the outdoors. In multiple studies, researchers have shown that people spend more time indoors looking at screens than they do outside and that our mental and physical health is suffering as a result (Louv, 2011; Williams, 2018). UC Davis is one of a number of universities attempting to address this nature deficit disorder through programs that fall under the umbrella of “Nature Rx.”

This paper focuses on specific aspects of those programs and their attempts to embolden participants to push competing priorities aside and head outdoors. Goals included: 1) exposing students, staff, and faculty to the gardens, green spaces, and natural areas of UC Davis; 2) introducing them to community members that interact with nature through research or vocation; 3) identifying organizations that connect people to nature at UC Davis; and 4) providing information about the therapeutic benefits associated with spending time in nature.

A mixture of quantitative and qualitative methods was used to determine the programs’ effectiveness. Data were compiled through pre and post class survey instruments, final evaluations, and written personal reflections. Survey data taken from a similar Nature Rx class at Cornell University were also integrated into the findings. Results indicate participants gained greater levels of comfort and familiarity with the campus and its community and developed a deeper awareness of the value of time spent in nature. These findings suggest that directed classes in nature therapy can positively impact the health of university communities.

1.1 Keywords
Nature Rx, Nature Deficit Disorder, Nature Prescription, Biophilia, Landscape Architecture Pedagogy
2 INTRODUCTION

In March of 1994, the Departments of Environmental Design and Environmental Horticulture at the University of California, Davis, along with the San Francisco Sheriff's Department, organized a research symposium to explore the relationship between plants and human well-being. The symposium, entitled Healing Dimensions of People-Plant Relations, attracted researchers from disciplines spanning landscape architecture, horticulture, psychology, and sociology. Through presentations focusing on community gardens, urban forests, horticultural therapy, environmental education, healing gardens, and more, researchers outlined the health and well-being case for encouraging people to interact more deliberately with nature. In his keynote address to the symposium, founding member of the People-Plant Council Charles Lewis applauded research accomplishments within the nascent cross-disciplinary field and speculated on the future of people-plant relations. He predicted that a) technological innovations would help further refine research results on the psycho-physiological benefits of nature interaction, b) the health benefits of people-plant relationships would be recognized as necessary for the nation’s well-being, c) plants and plant-centered activities would be more integrated into our culture, and d) a priority for healthy humanity would be the reestablishment of the people-plant connection (Lewis, 1994).

Strikingly, twenty-five years later, attitudes towards human health and nature contact have changed very little. While Lewis was correct in forecasting the rise of evidence-based research to scientifically support the positive health effects of nature interaction (e.g. Frumkin et al., 2017), he was unable to account for the deleterious effect increased technology use would have on society and our resulting inability to embrace the healing value of people-plant relationships. Technology now dominates our daily lives, with recent studies highlighting alarming trends of American teens spending close to eight hours a day using entertainment media and adults checking email obsessively while on vacation and insisting on sleeping with their smart phones within reach (Rideout, 2010; Perlow, 2012). A 2017 study reported that of 12,000 adults interviewed, more than half reported spending five hours or less in nature per week and that their children spend three times as many hours indoors on computers and telephones as they do playing outside (Kellert, 2017).

This is not to say that social and cultural progress hasn’t been made in the interim towards the integration of plant contact into our daily lives, as evidenced by the popularity of nature programming such as biophilic design, the rise of physicians writing park prescriptions requiring patients to spend time outside, and the creation of forest therapy trails to promote the practice of shinrin-yoku (forest bathing), among others. The terms may have evolved and our scientific knowledge base may have expanded, but, unfortunately, our methods for disseminating the benefits of nature interaction have remained static. Charles Lewis charged symposium attendees in 1994 to “shout from the rooftops of the miracles we have witnessed” and encouraged them to “mount campaigns to spread the word that plants play an essential role in human well-being.” In the current age of information inundation through internet, social media, and smart phones, Lewis’s traditional methods of sharing information have failed to bring about the large-scale cultural changes he predicted, largely because messages about well-being are crowded out by competing priorities and technologies.

A growing body of research indicates that the most effective and durable way to create meaningful learning experiences is through experiential education. As posited by David Kolb in his theory of experiential learning, knowledge is gained through concrete experience (hands-on learning) and abstract conceptualization, and then solidified through reflective observation and active experimentation (Kolb, 1984). The UC Davis Nature Rx Program was founded on the belief that while people are engaged in immersive outdoor activities, they are also reaping the health and wellness benefits of being in nature and experiencing the value of people-plant interactions. Cultural attitudes change not from lectures, social media posts, or scientific articles, but from ongoing direct experiences and the reflections that come from participating in them. Nature Rx is now one of the foundational elements of a broader, campus-wide effort to create programs and landscapes that support a more holistic vision of sustainability that encompasses human health and well-being at its core.

3 METHODS

The Nature Rx program was piloted in the fall of 2016 with a not-for-credit student seminar (“Aggie Connection”) and then officially launched in the fall of 2017 to specifically target two campus
populations (staff/faculty and students) with separate interventions. Freshman and incoming transfer students could register for a weekly, two-hour, two-unit seminar that met on Friday afternoons, while faculty and staff were invited to sign up for one of three or four four-hour-long lunchtime sessions. Although the specifics of the programs varied, the goal for each was the same: to teach participants the therapeutic value of nature through immersive, experiential programs. The Nature Rx first-year student seminar was offered for a 10-week quarter in fall of 2017 and again in fall of 2018. Three staff and faculty Nature Rx health and well-being sessions were offered in fall of 2017. A fourth session was added for fall of 2018.

A mixture of quantitative and qualitative methods was used to determine the effectiveness of the two Nature Rx programs. For the first-year student seminar, data were compiled through the use of pre- and post-class survey instruments (from 2018 only) and written personal reflections (2017 and 2018). For the faculty/staff series, data were collected from online evaluation forms distributed at the end of each program (2017 and 2018).

A total of 23 students from two universities, the University of California, Davis (UC Davis) and Cornell University, participated in the pre- and post-class survey. The study’s sample size was drawn from 18 students in the first-year Nature Rx student seminar at UC Davis and 7 students from a similar Nature Rx class at Cornell University also offered in the fall of 2018. The two courses varied in scope, length, and format, but shared similar learning objectives, including: how time spent in natural settings contributes to holistic self-care and can improve overall well-being; how nature is accessible and all around us, both on campus and at nearby sites; and how to identify campus organizations and activities to stay regularly connected to nature. The study utilized identical pre-and post-class surveys at both campuses. One was distributed in the beginning of the course to assess a baseline of information and the second was distributed at the end of the course to gauge changes in attitudes and learning outcomes. Quantitative and qualitative response analysis was conducted upon course completion. Responses for both surveys were collected anonymously and voluntarily. Additionally, students in the UC Davis Nature Rx first-year student seminar were required to write personal reflections at the end of the course. In 2017, 13 of 15 students submitted reflections. In 2018, 16 of 18 total students submitted reflections.

The Staff and Faculty Health and Wellbeing Nature Rx program utilized evaluation forms distributed electronically to participants in each of the hour-long Nature Rx sessions that made up the series. In 2017, there were 54 registrants for the program, and an average of 16 people attended each session. In 2018, the sample size was drawn from a total of 56 participants with 16 respondents from the Watercolors in the Arboretum session, 16 from the Mini Succulent Gardens session, 14 from the Terrarium Building session, and 10 from the Fall Harvest session. Responses for the evaluations were collected anonymously and voluntarily.

3.1 **First-Year Student Seminar - Nature Rx: Exploring the Power of the Natural World**

UC Davis launched the First-Year Seminars program to ensure that “every incoming student to UC Davis will have the opportunity to take a transformative small enrollment course that fosters intellectual curiosity, active discussion, critical thinking, a sense of community and engagement with faculty and peers.” With class sizes limited to 19, the first-year seminar format presented a unique opportunity to introduce nature therapy to incoming students new to UC Davis and its campus. Inspired by a similar program launched by Dr. Don Rakow at Cornell University, the first-year student seminar, entitled Nature Rx: Exploring the Power of the Natural World, launched in the fall of 2017. The seminar served the dual purpose of orienting incoming freshman and transfer students to the natural communities of UC Davis (instructors, places, resources, one another) while simultaneously introducing them to the concepts and research supporting the healing power of nature. Through experiential outdoor experiences such as walks, bike rides, and guided tours, students explored the natural components of UC Davis and learned about activities, internships, and scientific research occurring all over campus. Assigned readings and discussions focused on literature exploring the health benefits associated with such activities.

A not-for-credit pilot version of the seminar (First-Year Aggie Connection) was held in the fall of 2016 with an enrollment of 25 students (maximum enrollment). 19 students (maximum enrollment) enrolled in the first-year student seminar of 2017 and 19 students enrolled in the first-year student seminar of 2018. There was a waitlist to get into the seminar both years it was offered, but ultimately 15 students matriculated in 2017 and 18 students in 2018. Students came from a variety of majors, including landscape architecture, environmental studies, chemistry, and math. The class was worth two units and could only be taken on a pass/fail basis. Lasting 10 weeks, the seminar format was simple: students received a weekly email telling them where on campus they would be meeting. There they would be
introduced to the nature activity for the day and the campus expert that would be leading them. Examples of activities included water coloring in the Arboretum with a professor of landscape architecture, practicing yoga and harvesting fruit at the Student Farm, discovering the favorite trees of the campus arborist, wading through the local creek with a professor of fish biology, and exploring the principles of Kundalini meditation with a professor of medicine. At the end of the activity, students were required to write reflections (or draw pictures, write poems, etc.) about what they had experienced. In addition, students were given weekly assignments to discover outdoor spots on campus (“Great place to take a date,” “Cool tree on campus,” “Best spot for daydreaming”), and then photograph and post them on Instagram.

3.1.1 Survey Structure – First-Year Student Seminar
The purpose of the survey was to assess changes in attitudes and behavior over the course of the seminar and to give students the opportunity for self-reflection. Of the fourteen total questions asked, seven were multiple choice and seven were open-ended to allow students to explain their answers (see Table 1). The same questions were used for both the pre- and post-survey, with the exception of the final question, which asked “What do you hope to get out of this class?” in the pre-survey and “What one or more things do you feel you got out of this class?” in the post-survey. Students in the UC Davis Nature Rx first-year student seminar and students in Cornell University’s Nature Rx class participated in the survey.

Table 1. Survey Questions

<table>
<thead>
<tr>
<th>Changes in Behavior</th>
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</thead>
<tbody>
<tr>
<td>1. When you are in school, how frequently do you engage with nature?</td>
</tr>
<tr>
<td>o Less than once/week</td>
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<tr>
<td>o Usually once a week</td>
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<tr>
<td>o 2-3 times/week</td>
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<tr>
<td>o Almost daily</td>
</tr>
<tr>
<td>2. Why do you intentionally engage with nature?</td>
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<tr>
<td>3. In what ways do you intentionally engage with nature? (check all that apply)</td>
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<tr>
<td>o Take walks/hikes</td>
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<tr>
<td>o Bike ride</td>
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<tr>
<td>o Canoe/kayak</td>
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<tr>
<td>o Ski downhill or cross-country</td>
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<tr>
<td>o Camping</td>
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<tr>
<td>o Quiet contemplation in natural settings</td>
</tr>
<tr>
<td>o Rock/mountain climbing</td>
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<tr>
<td>o Tree climbing</td>
</tr>
<tr>
<td>o Other_____</td>
</tr>
<tr>
<td>4. How many natural or landscaped area on campus have you discovered?</td>
</tr>
<tr>
<td>o 0-2</td>
</tr>
<tr>
<td>o 3-5</td>
</tr>
<tr>
<td>o 6-8</td>
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<tr>
<td>o More than 8</td>
</tr>
<tr>
<td>5. What has helped or hindered that?</td>
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</tbody>
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<thead>
<tr>
<th>Changes in Attitude</th>
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</thead>
<tbody>
<tr>
<td>6. How frequently do you think about your role in the complex web of nature?</td>
</tr>
<tr>
<td>o Never</td>
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<tr>
<td>o Occasionally</td>
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<tr>
<td>o Frequently</td>
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<tr>
<td>o All the time</td>
</tr>
<tr>
<td>7. How would you describe your role?</td>
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<tr>
<td>8. How would you rank your degree of comfort for hiking in deep forests?</td>
</tr>
<tr>
<td>o Not at all comfortable</td>
</tr>
<tr>
<td>o A little uncomfortable</td>
</tr>
<tr>
<td>o Fairly comfortable</td>
</tr>
</tbody>
</table>
9. Why do you feel that way?

10. To what degree do you feel that UC Davis (Cornell) students care about protecting the environment? (1 = not at all; 10 = care very deeply)

11. How would you rank your concern for the environment relative to the majority of your fellow students on campus?
   - Less than majority
   - Equal to majority
   - Greater than majority
   - Much greater than majority

12. Why do you report that?

Self-Reflection

13. What one or more things do you feel you got out of this class?

General Information

14. What is your class year?

3.1.2 Personal Reflections – First-Year Student Seminar

All students enrolled in the UC Davis Nature Rx first-year student seminar (2017 and 2018) were required to submit a personal reflection at the end of the class. Students were asked to reflect on how the seminar had impacted them by selecting two questions from a list of four to answer thoroughly (see Table 2). Responses varied from one or two paragraphs to several written pages.

Table 2. Reflection Questions

Class Impact

1. How did your experience in this class transform or impact you personally?
2. What strengths did you develop or what insights did you gain about yourself, nature, and/or your health and well-being?
3. How was your experience with Nature Rx distinctive or unique from other classes you’ve had?
4. Did the Nature Rx seminar inspire you? If so, in what way and how do you plan to channel or build upon this inspiration in the future?

3.2 Staff and Faculty Health and Well-Being Program – Nature Rx

The second component of UC Davis’ Nature Rx program falls under the umbrella of the campus Staff and Faculty Health and Well-being Program (SFHWB). Launched in the summer of 2016, SFHWB’s stated mission is to “develop, promote and support a thriving culture of health and well-being throughout the UC Davis community so that staff and faculty can learn, teach, innovate and contribute.” SFHWB health and wellbeing programs include physical activities such as tai chi, yoga, biking, and walking, mental and emotional activities such as meditation, mindfulness, happiness, and self-care, and food activities with nutrition workshops and farmers’ market events. In fiscal year 2018, 3,298 unique individuals participated in SFHWB programs. (SFHWB Annual Report, 2018)

The Nature Rx component was first offered in the fall of 2017 in collaboration with the Arboretum and Public Garden as part of SFHWB’s health and well-being series. The goal of the lunch time one-hour sessions was to provide staff and faculty an opportunity to interact with nature as a means of decreasing stress levels. Three sessions were offered in 2017: Propagation, Planting, and Mini Succulent Gardens. In 2018, participants could choose from four different activities: Watercolors in the Arboretum, Mini Succulent Gardens, Terrarium Building, and Fall Harvest. Led by a campus staff member, the sessions provided hands-on opportunities for staff and faculty to take a break from their work and immerse themselves in the outdoors.
3.2.1 Program Evaluations – Staff and Faculty Health and Well-Being

Participants in the Staff and Faculty Health and Well-Being program - Nature Rx were asked to complete an on-line evaluation of the session in which they participated (see Table 3). The evaluation questions for each of the three sessions in 2017 (Plant Propagation, Planting in the Arboretum, Mini Succulent Gardens) and four sessions in 2018 (Watercolors in the Arboretum, Terrarium Building, Fall Harvest, Mini Succulent Gardens) were identical.

Table 3. Evaluation Questions

<table>
<thead>
<tr>
<th>Class Organization and Structure</th>
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<tbody>
<tr>
<td>1. Please rate the class based on the following statements. (Strongly Agree; Agree; Neither Agree or Disagree; Disagree; Strongly Disagree)</td>
</tr>
<tr>
<td>o The class had a positive impact on my health</td>
</tr>
<tr>
<td>o The class had a positive impact on my well-being</td>
</tr>
<tr>
<td>o The class had a positive impact on my work performance</td>
</tr>
<tr>
<td>2. Would you recommend this class to a colleague?</td>
</tr>
<tr>
<td>3. Would you attend similar class offerings in the future?</td>
</tr>
<tr>
<td>4. Please add any comments and/or suggestions for improvement to the class.</td>
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</tbody>
</table>

4 RESULTS

4.1 Survey Results – First-Year Student Seminar

Table 4. Survey Results

| When you are in school, how frequently do you intentionally engage in nature? |
|-------------------------|-------------------------|-------------------------|
| UC Davis                | Initial                 | Final                   |
| 2 – 3x/week: 36.8%; daily:15.8% | 2 – 3x/week: 40%; daily: 20% |
| Cornell University     | Initial                 | Final                   |
| 2 – 3x/week: 18%; daily :45%  | 2 – 3x/week: 57%; daily: 43%  |

| How frequently do you think about your role in the complex web of nature? |
|-------------------------|-------------------------|
| UC Davis                | Initial                 | Final                   |
| Frequently: 26.3%; all the time: 5% | Frequently: 20%; all the time: 33.3% |
| Cornell University     | Initial                 | Final                   |
| Frequently: 9%; all the time: 36%  | Frequently: 28%; all the time: 14%  |

| How would you rank your concern for the environment relative to the majority of fellow students? |
|-------------------------|-------------------------|-------------------------|
| UC Davis                | Initial                 | Final                   |
| Greater than the majority: 26.3% | Greater than the majority: 60% |
| Cornell University     | Initial                 | Final                   |
| Greater/much greater than majority: 84% | Greater/much greater than majority: 85% |

| How many natural or landscaped areas on the campus have you discovered? |
|-------------------------|-------------------------|
| UC Davis                |                         |                         |
|                         |                         |                         |
| Cornell University     |                         |                         |
4.2 Personal Reflection Results – First-Year Student Seminar

While the pre- and post-survey results helped to quantify the effectiveness of introducing students to nature on campus and any resulting changes in their behavior towards it, the personal reflections truly shed light on the learning outcomes of the students. We ranked the reflections on a scale of positive, neutral, and negative. Of the 29 personal reflections received (representing 13 students from the 2017 seminar and 16 students from the 2018 seminar), we found that 28 were quantified as positive (96%) and one was quantified as neutral (4%). Reading through the reflections, it became clear that the first-year student seminar was unlike any of the students’ other classes and that it had made a strong impact on them. Reactions tended to fall across four broad categories: 1) anticipation for the seminar’s unique activities and adventures; 2) the refreshing/relaxing/destressing effect of the weekly nature activities; 3) a broader understanding of the social aspects of nature and the community it cultivated; 4) increased self-awareness and demonstrated behavioral changes towards nature.

Students reacted positively to the diversity of the seminar’s content and structure, citing the “variety of meaningful interactions,” “something completely new and adventurous,” “a surprise where and what we would be doing next,” and “refreshing, especially after a long week of 'normal' classes.” Wrote one, “it didn’t even feel like an actual class because of all the different things we would do every week.” Many reflections opened with how the student regularly looked forward to the weekly Nature Rx seminar. One student commented, “I learned how much it affected me to have a fun nature activity/class to look forward to every Friday. When things felt overwhelming, I would just think ‘I have my fun class Friday/tomorrow/soon’ and it always helped my perspective.” Another wrote, “Every time I would have a rough day, whether it was because I was missing home or stressed about a class, I would remind myself of the fun and calm two hours in Nature Rx that I had waiting for me at the end of the week.” Frustration with typical lecture-format classes ran through a number of responses, with students commenting on how “it becomes more about the grade and passing the class than it is about learning the material,” “everything can get quite impersonal repetitive and stressful: go to lecture, take notes, learn the material, take a test, repeat,” and, “my experience with my classes were all exactly what I expected, boring and long.” With Nature Rx, however, students wrote about the low-pressure atmosphere, learning for the sake of learning, and of being able to enjoy the activities more and better absorb the information because of the structure of the course. “It’s literally a breath of fresh air to have an outside classroom.”

The seminar’s weekly contact with nature also had the intended effect of relaxing students and helping them reduce their levels of stress. “It gave me a sense of relaxation that no other class has ever given me,” wrote one student. “I find that being outside stabilizes my mood and comforts me in distress,” noted another. “Nature has the magical quality of destressing, bringing happiness, and creating new definitions to life, and this seminar is so sincerely aimed toward that.” One student, who described himself as originally skeptical about the seminar, admitted that “I had never really paid attention to nature before, and, within a few weeks, I was stopping on my way home to examine the leaves on a tree. It was good. I felt refreshed.” Several students commented on how the yoga, meditation, and mindfulness activities had helped reduce their anxiety, stabilized their mood, and comforted them in distress. “This process was intriguing to me, someone with anxiety,” wrote one, “and I started meditating in my daily life at short intervals to calm my mind and achieve a sense of well-being. I plan to meditate more frequently in the future, preferably in a natural setting, and I never would have discovered this coping mechanism if it wasn’t for Nature Rx.” The biggest impact, however, was a newfound appreciation of the power in taking even a short break outside, with students mentioning setting daily goals to spend time outside, taking time out of their day to reflect, and practicing “more indirect learning, where I soak in what’s around me.” In summary, “I’m now aware of how I choose to go about my day. I know that if I isolate myself behind walls all day, I get frustrated and anxious, but if I take a moment to go outside, I instantly feel better.”
A third effect of the seminar, as recorded in the personal reflections, was the role it played in establishing community by connecting students to each other, the campus, and the natural world. Participants stated that the class made them feel connected to the Davis community, that they enjoyed being with “like-minded people,” and that “it was fun to find people with similar interests outside of our specified major courses.” Other students wrote about the diversity of each week’s experts. As one wrote, “Bringing in professionals and people from all different walks of life involved in nature was truly inspiring and fun to watch and get involved in.” Another summed it up by saying, “Not having the regular classroom setting was pretty amazing because we got hands on experience observing different plant species, fishing like a professional fish biologist, and practicing meditation outside. I have never had a class that was so interactive and full of experts in their own field.” For one student, the connection to community went even beyond the campus. “I gained a sense of how special this relationship we have with Earth is, and we can connect with the community through it.” Interestingly, students reflected on the desire to share nature with others, writing, “now I want to show everyone nature. I tell all my friends to go out in nature and de-stress yourself from school,” or “I will also definitely go back to all the places we explored with my friends so I can show them the extent of how beautiful the campus is, which is right under our noses!”

Students reflected on the lasting impact of the seminar and how it modified their everyday behaviors. They reported taking greater risks, being more outgoing, and feeling better grounded than they had when the quarter began. “I was reminded of how important and necessary it is for me to try new things on a regular basis in order to maintain a curious, open-minded, and adventurous attitude,” wrote one. “This class revealed to me that I am perfectly capable of conquering my fears, no matter how irrational they are” stated a student who had previously been afraid of fish. “This is a transformative idea to me because I can apply it to other fears and new experiences.” Almost all reported a greater sense of self-awareness, resulting from taking time to pause, observe, and reflect. Referring to the weekly required journal entries, a student explained, “At first it seemed like a chore because it was a homework assignment, but I found myself either reminiscing of fond moments or realizing how much I admire our sessions and nature in general” Another added, “I didn’t think of them as assignments; they were more like a fun escape from reality.” Students wrote about taking time out of the day to take care of themselves, setting regular times to practice meditation, inviting friends to go for walks with them, and trying new experiences outside of their comfort zone.

Most profoundly, the seminar seemed to change students’ overall attitude towards nature. “I usually picture nature as being something I have to go to, some sort of destination, like a National Park or a lake, but Nature Rx showed me that nature is all around me at all times.” In talking about the insights gleaned from the class, one student explained “I’ve learned that nature is so non-judgmental about who we are as individuals. It is way too easy to judge myself harshly sometimes – what I haven’t done or haven’t accomplished… and yet nature is simply here for us to enjoy even if we do or do not deserve it.” By the end of the class, there was a greater sense of environmental stewardship and responsibility. “Nature Rx has inspired me to be more alert with my surroundings, to focus more on nature, for where I am from nature is not of an importance.” And finally, “It all culminated in me realizing that I have some work to do if I truly want to be a part of nature the way I assumed I was.”

### 4.3 Program Evaluation Results – Faculty/Staff Health and Well-being

Post-class evaluation data revealed that in 2017, a total of 30 faculty/staff participants in the Nature Rx program completed evaluations. Of those, 80% of participants strongly agreed or agreed that the classes contributed positively to their health, 93% of participants strongly agreed or agreed that they contributed positively to their well-being, and 73% of participants strongly agreed or agreed that they contributed positively to their work performance.

In 2018, the response to the class was overwhelming. All of the available spots for the four sessions filled up within five minutes of registration opening, and the watercolor and succulent sessions had waitlists of 20+ people in each. Overall results from the evaluations changed very little from the previous. A total of 57 staff/faculty filled out an evaluation for one of the four Nature Rx sessions, with 85% strongly agreeing or agreeing that the classes contributed positively to their health, 93% strongly agreeing or agreeing that they contributed positively to their well-being, and 73% of participants strongly agreeing or agreeing that they contributed positively to their work performance.

Unexpectedly, seventeen participants in the faculty/staff Nature Rx series have since made independent inquiries asking for a version of the Nature Rx program tailored specifically to their departments.
5 DISCUSSION

When Charles Lewis presented his keynote speech at the Healing Dimensions of People-Plant Relations symposium, he did so armed with overwhelming evidence correlating human physical, psychological, and social well-being with nature contact. In the twenty-five years since his presentation, the relationship between people and nature has, in fact, changed, but not in the direction he anticipated. Lewis got it right when he forecasted great strides in nature therapy research and a preponderance of scientific data to support the central thesis that spending time outdoors is good for you (Louv, 2011; Williams, 2017). What Lewis failed to understand is that “spreading the word” about the benefits hasn’t been working, and the message to spend time outside simply hasn’t sunk in. Our findings suggest that, in an era where teens spend an average of six hours a day in front of screen media (Common Sense, 2015), creating experiential programs that require participants to deliberately engage with nature may be the best way to try and reverse this worrisome trend.

Data from the pre- and post-student surveys and faculty/staff evaluations confirm that participants enjoyed the Nature Rx programs, believed that they improved their overall health and well-being, and would recommend similar Nature Rx activities to friends. The survey results from Cornell University and UC Davis highlight that students interacted more with nature and reported a greater sense of responsibility towards the environment as a direct result of their Nature Rx seminar. It’s the qualitative data, however, that tell the true effects of the Nature Rx Program.

Results from the student reflections corroborate previous research that place-based education, which utilizes field trips to teach about the local community and environment (Sobel, 2005), increases student engagement with learning (Emekauwa, 2004). Students praised the format of the class, lauding the fact that it was held outside, in a new location each time, and that they never knew what to expect. The variety of program and location, combined with a lack of pressure to excel academically, revived weary students and led them to look forward to the weekly meetings. “There was meaning hidden, or not so hidden, in the variety of things we did. It kept us interested, yes, but the real beauty behind it all was the fact that it showed us the vast expanse of how nature intertwines with UC Davis,” explained one student. By immersing students directly in nature, engaging them in hands-on activities, and utilizing campus experts to introduce them to nature-themed concepts and practices, we were able to remove academic constructs and transform the experience into one that promoted learning for the sake of learning. As one student noted, “In this class, I was able to enjoy the activities more and better absorb what I learned each week.”

Students wrote that dedicating a weekly two-hour block to Nature Rx “helped wind down my mind” and “decompress,” supporting the growing body of research demonstrating reduced stress levels and decreased feelings of depression after spending time in nature (e.g. Astell-Burt et al., 2014; Bratman et al., 2015; Ward Thompson et al., 2016). One participant admitted feeling “rejuvenated and happier” after each class, another said the class helped ground her, and a third described the class as “filling a void in myself that I will be forever grateful for.” They reflected that that they were deliberately setting aside time to incorporate nature into their daily lives through walks, recreation, meditation, or observation.

Interestingly, a number of students commented on the social and community aspects of the seminar. Beyond exploring the connections they made with each other and nature-related campus organizations, students reflected on the desire to share their experiences in nature with other people. This corroborates research demonstrating that experiences in nature are deeply social and that they connect people to one another (Groenewegen et al., 2012; Kellert et al. 2017). Human connection lies at the heart of well-being, and so, in speaking to the importance of nature to humans, we cannot forget the nature of humans, that we are social creatures and thrive when we are part of a community. In an era of increased suicide rates on college campuses (ACHA, 2015) and a rise in loneliness across all age brackets (CIGNA, 2018), any intervention that can pull people away from the solitude of their screens to share the wonders of nature in the company of others is bound to be a good thing.

The most striking aspect of our study, however, are the resulting self-described changes reported by students. We expected participants would enjoy the class and ultimately take away some new insights about the healing powers of nature, but we had no idea of the extent to which they would internalize the message. Their reflections demonstrate the true power of experiential education. When provided with the opportunity to participate in concrete experiences and reflect on the outcomes, these students ultimately modified not only their attitudes towards themselves and their personal well-being, but also their behavior towards nature. “Everywhere I look now, I see nature in a new light. It may seem like I’m exaggerating,
but I’m really not. When I look at the trees in front of me, I notice them. Actually, I search for them and explore them. I want to find that one tree that makes me feel at peace, or inspired, just by looking at it.”

5.1 Future Directions for Teaching

For students of landscape architecture in particular, inclusion of a Nature Rx-type seminar within the curriculum requirements makes sense. The role of a landscape architect is to create outdoor spaces that evoke emotion and hold meaning for people, spaces to find peace and take refuge. Before students can design this type of space, they need to experience it first-hand. Google maps, AutoCad files, PowerPoints or even site visits won’t elicit the “child-like giddiness” or “curious, open-minded attitude” that comes as a direct result of full immersion into nature. It is only by taking the time to stop, observe, soak everything in, and reflect that students will gain a true appreciation for nature and be able to authentically re-create it for others. Requiring a Nature Rx seminar will not only produce better designers, it will also have the added benefit of producing healthier and happier designers, who understand the benefit of taking a nature break in the face of a looming deadline and recognize the value of nature as a form of stress management and self-renewal.

6 CONCLUSION

The healing dimensions of people/plant relations have not, and never will be, successfully disseminated through typical channels of communication. Media campaigns, scientific articles, and lectures outlining the benefits of spending times outdoors have had little practical effect on people’s mindsets. Until there are more experiential classes and immersive interventions like Nature Rx, people will continue to stay indoors, staring at screens. Our hope is that this study inspires others to take steps to create their own version of a Nature Rx program.

7 REFERENCES


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FROM SLAVERY TO FREEDOM HILL AND BEYOND

enviroKIDs use Virtual Reality as a Landscape Design Tool 2018

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1 ABSTRACT
The purpose of this study From Slavery to Freedom Hill and Beyond was to increase the awareness of the enviroKIDs Summer Campers to the ideas and activities designers use while working with historical and cultural landscape revitalization. The enviroKIDs are high risk and disadvantaged youth between the ages of 13-18 years. The primary goal of this study is to bring about an understanding of how different cultural and ethnic groups value and use their urban spaces as a part of their social reality. The social reality of cultures can be affected and altered by design activism which can also be linked to the past as well as the present.

At the close of the Civil War, former slaves sought refuge at a Union Troop encampment located in Edgecombe County, Eastern North Carolina. Following the departure of Union soldiers, in 1865 many of the now freed slaves remained behind in the encampment and affectionately named their settlement of huts and shanties along the Tar River floodplain Freedom Hill. Within twenty years, Freedom Hill was renamed Princeville and in 1885 became the first African American town incorporated in the United States. The history and the establishment of Princeville is an example of design activism by freed slaves.

Over time Princeville has experienced many defeating efforts in its struggle to survive, including the Jim Crow Era, annexation efforts of Tarboro and several devastating hurricanes. The enviroKIDs used a Virtual Reality device call an HTC Vive to walk through two Sketch-Up study models in the digital Princeville’s Heritage Walk and gave feedback on different ways of making the Heritage Walk experience better. The final outcome of the study resulted in enhancing the proposed Heritage Walk by highlighting the Town’s historic identity as participatory art in an effort to save the Historic Town of Princeville.

1.1 Keywords
Design Activism, Social Reality, Jim Crow Era, Virtual Reality

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INTRODUCTION

From sunrise to sunset, enslaved Black people were forced by their slave masters to relentlessly work in cotton, tobacco, and peanut fields. These fields where the enslaved people worked were labor-intensive cash crops for Southern plantation owners, making slave labor a vital asset for accruing white wealth in the south and the whole of the United States. Then in 1860 Abraham Lincoln's election as president of the United States was of grave concern to the Southern plantation owners. What concerned Southerners most about Lincoln's election was his opposition to the expansion of slavery into the territories; Southern politicians were clear about that. If new states could not be slave states, then it was only a matter of time before the South's clout in Congress would fade, abolitionists would be ascendant, and the South's “peculiar institution” – the right to own human beings as property – would be in peril.

The Civil War started because of uncompromising differences between the free and slave states over the power of the national government to prohibit slavery in the territories that had not yet become states. When Abraham Lincoln won election as the first Republican president on a platform pledging to keep slavery out of the territories, seven slave states in the Deep South seceded and formed a new nation, the Confederate States of America. The incoming Lincoln administration and most of the Northern people refused to recognize the legitimacy of secession.

Up until September 1862, the main focus of the Civil War had been to preserve the Union. With the issuance of the Emancipation Proclamation freedom for slaves now became a legitimate war aim. With the Emancipation Proclamation, the aim of the war changed to include the freeing of slaves in addition to preserving the Union. Although the Proclamation initially freed only the slaves in the rebellious states, by the end of the war the Proclamation had influenced and prepared citizens to advocate and accept abolition for all slaves in both the North and South. The 13th Amendment, abolished slavery in the United States, was passed on December 6th, 1865.

The Emancipation Proclamation paved the way for African-Americans to fight for their freedom. Five months after the Proclamation took effect; the War Department of the United States issued General Orders No.143, establishing the United States Colored Troops (USCT).
200,000 African-Americans would serve in the Union army and navy. During the Civil War, thousands of slaves escaped to U.S. army were enlisted in the 35th, 36th and 37th U.S. Colored Troops.

At the close of the Civil War, former slaves sought refuge at a Union Troop encampment located in Edgecombe County, Eastern North Carolina. The defeat of the Confederate soldiers in the Civil War gave approximately 4 million slaves their freedom. These men and women with newfound freedom needed somewhere to go, somewhere to live, and somewhere to call home. Union officials encouraged former slaves to return to the plantations and work for their old masters, but freedom offered more than that. The refugees sought the chance to control their own fortunes. Following the departure of Union soldiers, in 1865 many of the now freed slaves remained behind in the encampment and affectionately named their settlement of huts and shanties along the Tar River floodplain Freedom Hill. The Freedom Hill location symbolized that opportunity: from the citadel overlooking the Tar, the Union army had announced its victory and the former slaves’ newly-recognized freedom. Here was the opportunity for black men and women to define their own independent future. Most newly emancipated slaves were extremely poor and without food or clothing. However, the freed people realized that freedom was an opportunity for them to reconnect with family members from whom they had been separated during slavery. Freedom also meant controlling one’s own labor. And for black men, freedom would eventually mean the right to vote and hold political office. Within twenty years, Freedom Hill was renamed Princeville and in1885 became the first African American town incorporated in the United States. The separate black community of Freedom Hill, located at the core of one of the state’s largest slaveholding regions, also made social sense in the early stages of segregation and Jim Crow Era. The Jim Crow laws were state and local laws that enforced racial segregation in the Southern United States. Because Princeville was an established all African American Town separate from the larger Town of Tarboro, North Carolina it was left alone and No white mob ever attacked or razed Princeville. Few whites wanted free black men and women to live among them, yet Freedom Hill supplied Tarboro and surrounding areas with a removed but dependable supply of laborers, sharecroppers, servants, and artisans. The history and the establishment of Princeville is an example of design activism by slaves and newly freed slaves of the past who also participated in their community social reality.

The story of Princeville, the slave trading industry in this county is about more than just the past, present and the future of a small town in Edgecombe County, North Carolina. It is about making powerful connections and about bring understanding and healing to people from different walks of life around the country and the world. The global slave trade was a fundamental chapter of history that continues to shape our world. The enviroKIDs Summer Camp Program decided to work on the Heritage Trail of Princeville was a historically significance to the young African American teenagers and the Community. The historic Town of Princeville has the ability to build important bridges based on a shared history between communities, cultures, nations, past and present, ancestors and descendants of African People around the world.

In a series of activities, the enviroKIDs Summer Camp Program 2018 started their community revitalization design approach for Princeville, North Carolina. The enviroKIDs started by learning about the challenges that faced newly freed slaves as they built lives on an unwanted piece of swamp land along the Tar River called Freedom Hill. Through reading and discussion, the enviroKIDs were explored to how African Americans in Princeville, North Carolina have faced overwhelming adversity for nearly 150 years. The Town of Princeville continuously exhibiting self-determination and survival in the face of slavery, prejudice, and numerous floods (the most devastating of which occurred with Hurricane Floyd in 1999 and Hurricane Matthew in 2016).
3 PURPOSE

The main purpose of this study was to introduce and expose the enviroKIDS Summer Campers too many of the ideas and activities designers use while working with historic and cultural landscape revitalization. This summer the enviroKIDS Campers summer project was intended to help with the proposed Heritage Trail for the Town of Princeville. The Princeville Heritage Trail was developed during The Princeville Design Workshop by Yasmin M. Fozard, August 2017. The Design Workshop was organized by HMDRRI (Hurricane Matthew Disaster Recovery and Resilience Initiative). The purpose of the Princeville Community Development Workshop was to develop multiple land use scenarios regarding a 53 acre site and its connectivity to the existing Town of Princeville. The workshop involved creating three visual representations of community development options, spanning infrastructure, housing, public facilities, businesses, and community open space on a roughly 53 acre parcel of land slated to be annexed by the Town of Princeville. The goal of the workshop was to also include how this parcel could be physically, socially, environmentally and economically connected to the existing Town of Princeville, as well as other parcels of land adjacent to the Town that have yet to be acquired. The intent of the proposed heritage trail was to physically connect The Town of Princeville to all of the surrounding resources. The workshop process did follow commonly accepted practices associated with intensive community development meetings for five-days. The design process included involving a team of architects, land use planners, landscape architects, civil engineers, historians, economic development experts, community experts and other professionals.
3.1 The enviroKIDs Summer Camp 2018

The enviroKIDs Summer Camp is an eight week long urban forest / environmental design camp. The Camp works with local underserved youth in socio-economically disadvantaged neighborhoods between the ages of 13-18 years. The Summer Camp uses (STEM), Science, Technology, Engineering and Mathematics to study the urban forestry and study a special selected urban design project each summer. This past summer the special selected urban design project was the evaluation of the proposed Town of Princeville Heritage Trail. This summer the enviroKIDs was assigned the task of coming up with alternative recommendations to improve the Heritage Trail. The Heritage Trail is a revitalization method to physically, socially, environmentally, economically and historically connect to the existing Town of Princeville and to resources that would assist in keeping the Town alive. The enviroKIDs did used virtual reality techniques, a computer-generated simulation of a three-dimensional image to show the outcome of the enviroKIDs summer efforts. The enviroKIDs worked closely with North Carolina State University Professor Kofi Boone and Princeville natives, Fighters for Freedom Hill and The Institute of Landscape, Art and Sustainable Spaces (ILASS) to carry out the study over the summer. The type of environmental project the enviroKIDs Summer Camp Program explorer are: They exhibited in the 2018 North Carolina State Fair Home and Garden Competition a Garden of Concern. Their Garden of Concern stated Global Warning is Real and showed what they and the earth’s environment would look like if nothing is done to correct our mistakes surrounding global warming in the near future. Their Garden of Concern exhibit won 3rd place in the garden competition. They studied and carried out a clean-up Goose Creek campaign with Keep Durham Beautiful in Durham, North Carolina. Create an Urban Forest Management Plan (UFMP) for ILASS 4 acre forest. The enviroKIDs goal is to work on projects that will help revitalize and empower local communities.

3.2 Empowering At-Risk Teenagers to become Environmental Design Superheroes

It is important in this study to empower at-risk teenagers through design activism to help them try and save the Town of Princeville. The enviroKIDs program teaches disadvantaged neighborhoods kids to become Environmental Superheroes by addressing local community needs. In this study the enviroKIDs saving the planet means working to help revitalize the Town of Princeville by using Virtual Reality as a Landscape Design Tool to improve a proposed Heritage Trail experience. By improving the experience of the Princeville Heritage Trail the enviroKIDs is helping the Town of Princeville reach their goal of keeping a strong sense of town pride and keeping their heritage alive.

A goal of this study is to bring about an understanding of how different cultural and ethnic groups use their urban spaces as a part of their social reality. The social reality of an ethnic group can be affected and altered by design activism, which is linked to the past as well as the present and future in Princeville’s case. This study covers three important major concerns: (1) It introduced and exposed the enviroKIDs Summer Campers too many of the ideas and activities designers use while working with historic and cultural landscapes revitalization. (2) It helps the Town of Princeville continue to stands as a symbol of African-American determination and endurance by use design activism to bring about environmental enhancement and economic development. (3) It allows the superhero enviroKIDs the opportunity to work and engage with the local community groups and organizations in Princeville around a common design activity and social reality as part of their learning experience.
4 THE DESIGN PROCESS

eenviroKIDs go through a Five Step Design Process. The enviroKIDs learned to think creatively when solving a problem and strengthen their critical-thinking abilities. To solve the problem the enviroKIDs follow a series of steps through the “Design Process.” Because this design project serves children and young designers, a simple Design Process to guide enviroKIDs through our design challenges has been created. This design process has just five steps and uses terms children and young designers can understand. The Design Process Chart is as follows:
Figure 4: The Design Process

4.1 Step 1 - Identify the Problem

Understanding the problem paves the way for the solution. It is important to define the challenge(s) clearly before getting started. The Inventory of Princeville and how others approached a solution for Princeville was part of identifying the problem and the constraints of the problem. The enviroKIDs explored the proposed Heritage Trail for The Town of Princeville by walking and recording their experience.

Problem Statement: How can the proposed Heritage Trail for the Town of Princeville developed during The Princeville Design Workshop be improved?

The Historic of Freedom Hill, North Carolina:

At the close of the Civil War in 1865 the Union soldiers declared victory over the South. The defeat of the Confederate soldiers in the Civil War gave approximately 4 million slaves their freedom. The separate black community of Freedom Hill, located at the core of one of the state's largest slaveholding regions, also made social sense in the early stages of segregation and Jim Crow. Few whites wanted free black men and women to live among them, yet Freedom Hill supplied Tarboro and surrounding areas with a removed but dependable supply of laborers, sharecroppers, servants, and artisans. The community's 1880 population totaled 379 people. The largest numbers of residents were day laborers, laundresses and washerwomen. The community was also home to eight carpenters, seven blacksmiths, four grocers, three seamstresses and three brick masons. One of the carpenters, ex-slave Turner Prince, had lived in Freedom Hill since its founding; residents renamed the community in honor of him when it was incorporated in 1885. Princeville workers also capitalized on Tarboro's growth at the turn of the century. Many found laboring jobs in the new fertilizer plant, textile mills and lumber industries across the Tar.

It was, however, a bitter, violent time. Waves of white supremacy and economic depression threatened to swallow black communities throughout the south. White mobs drove black political and economic leaders and their allies from Wilmington, North Carolina in 1898. A mob of 10,000 whites torched entire black districts in Tulsa, Oklahoma in 1921. Such acts of racist terrorism were not unique during this period. Government actions — or inaction — seemed to condone this reign of terror. Laws banished African Americans to "colored-only" sections in railroad cars, restaurants, theaters and other public places. In 1896 the United States Supreme Court legalized the "separate but equal" doctrine with its decision in the case, Plessy v. Ferguson. But in several eastern counties of North Carolina, black residents were a majority, and in many of these locations, blacks exercised their political strength by electing black men to office. Princeville and Edgecombe County voters had elected eleven black men to the state legislature to serve fifteen terms from 1877 to 1890. Edgecombe County was part of the Second Congressional District, the famous "Black Second," which sent to Congress two black representatives: James E. O'Hara of New Bern, from 1883 to 1887; and Henry Plummer Cheatham of Vance County, from 1889 to 1893.

However, with the emergence of the white supremacist movement in the state, black voters and office holders were gradually excluded from the political process by legal or illegal methods. Literacy tests and poll taxes excluded poor and illiterate blacks from voting. Black voters were attacked or threatened by opposing whites; black ballots were altered or discarded altogether. George H. White, North Carolina's last black representative in the U.S. Congress during this period, was removed from office in 1901 by a white electorate. No white mob ever attacked or razed Princeville, but the town successfully battled a racist campaign to have its charter revoked in 1903. Some white Tarboro residents must have considered what a black town meant — a place where blacks governed themselves, owned businesses, and operated schools — to the idea of white supremacy. The Tarboro Southerner, the local newspaper controlled by white supremacists, urged Tarboro to annex Princeville because blacks were deemed unruly, beyond white "law and order."

Princeville, indeed, was a unique community. Although white supremacists had effectively ended black political participation at the federal and state level, black men continued to vote in municipal elections. Princeville established a public primary school in 1883 with black principals educated at northern institutions like Oberlin and Yale. By 1910 Princeville's population had increased to 636, half of its adult residents could read and write, and the town contained a growing number of black merchants.
and artisans. In 1912 the primary school added a high school curriculum. Several Baptist and Methodist
congregations also built churches in the first two decades of the twentieth century.

The Water This Time: Flooding, like the threat of white supremacy, has plagued Princeville since
its settlement. Major floods occurred two years after the community’s founding and again in 1919, 1924,
1928, 1940 and 1958. Time after time, residents evacuated, came back and rebuilt. But some apparently
tired of this periodic disruption of their lives. Between 1910 and 1923, the town’s population dwindled from
636 to 300. This coincided with a nationwide exodus of blacks out of the South; spurred by southern
racism and perceived northern opportunities, many left for places like New York, Philadelphia and
Baltimore. That trend continued until the 1950s. After a major flood in 1958, town officials approached the
Army Corps of Engineers with a proposal to build a dam. A three-mile long, four million dollar earthen
levee along the south bank of the Tar River was finally completed in 1967. The dike could accommodate
thirty-seven feet of water; since flood waters had never exceeded thirty-three feet, people felt safe at last
from the Tar.

4.2 Step 2 - Brainstorm
The enviroKIDs broke into groups and each group came up with as many possible solutions to
the problems of Princeville as possible by brainstorming. Brainstorming is a powerful method designers
use to begin a problem solving project. In a group discussion to produce ideas or solve problem
brainstorming can generate some wonderful ideas. Some essential historic questions the enviroKIDs
responded to as they brainstormed about the Heritage Trail Design:

• Why is Princeville such a unique community?
• What were circumstances like for freed slaves as the Civil War ended?
• Why did many freed slaves make their way to Freedom Hill?
• Why did some newly freed slaves choose to migrate north, while others chose to stay at
  Freedom Hill?
• What challenges did the black settlers face at Freedom Hill and as they worked to
  incorporate Princeville?
• What character traits and skills did Princeville founders possess in order to create a lasting
  settlement and town?
• Who was Turner Prince and in what ways did he affect Princeville? And why was the town
  named after him?
• What would it be like for your home to flood and what would you do?

4.3 Step 3 – Design Alternatives
Now it’s time to choose the best solution and plan from your brainstorming and decide how to
implement or how to build the ideas. The two design elements that needed to be included in the design of
the Heritage Trail for the Town of Princeville was Design Activism and Social Reality Design

Design Activism involves taking action that makes a claim for change on behalf of a wronged,
excluded or neglected group. It is driven by the identification of a wrongdoing or problem that needs
changing. Tim Jordan describes activism as a moral undertaking because it seeks to put forward a vision
for a better society in his book Activism! Direct Action, Hacktivism and the Future of Society (London:
Reaktion Books Ltd, 2002). At the close of the Civil War, former slaves sought refuge at a Union Troop
encampment located in Edgecombe County, Eastern North Carolina on the plantations of John Lloyd and
Lafayette Dancy. Following the departure of Union soldiers, many of the now freed slaves remained
behind in the encampment called their settlement of huts and shanties on the Tar River floodplain
Freedom Hill. This ability of freed slaves to establish a settlement in 1865 and in 1885 become the first
African American town incorporated in the United States renamed the town of Princeville was an example
of design activism in the past.

Social Reality Design refers to something that is a product of the ideas of a collection of minds.
If you have an imagination that can be explained through logic and reason go share it with your family
and friends and other individuals from a community, make it social because social reality cannot be
explained through lonesome individual thoughts. It is the product of human dialogue. Social reality may
be considered the accepted social belief of a community, involving relatively stable laws and social
dependencies. The collective decision for free slaves to establish Freedom Hill was a Social Reality
Design move in 1865.

**Design Recommendation 2:** The enviroKIDS recommend that as part of their Social Reality
Design along the Heritage Trail several designated locations be sited to reveal, unveil and or
frames sculptures of men, women and children in chains and shackles be displayed showing the
injustice or wrong doing of the institution of slavery.

The enviroKIDs recommend that as part of their Social Reality that along the Heritage Trail several
designated locations where theater as participatory art along the Heritage Trail be conducted. At
the theater location along the heritage trail a theatrical performance of what it would be like if you
were a runaway slave caught and returned to an angry slave master. The enviroKIDs Campers
also recommended used the art of rap and spoken word to express the slavery experience while
walking along the Town of Princeville Heritage Trail singing to show the injustice or wrongdoing
of the institution of slavery.

**4.4 Step 4 - Build, Test, Evaluate, Redesign**

Professor Kofi Boone from The North Carolina State University School of Design worked with the
enviroKIDs on their urban design project for 8 weeks with the Town of Princeville Project. The project
study outline was:

1. Field trip to Princeville, North Carolina. The enviroKIDs conduct a reconnaissance of the proposed
Town of Princeville Heritage Trail. The mission of the enviroKIDs was to obtain information by visual
observation or other detection methods, about the activities and resources along the proposed heritage
trail. During their documentation of the proposed trail the enviroKIDs took images of the site with a regular
camera to complete a survey of the area.

2. Professor Kofi Boone has the enviroKIDs send him all of their images and he downloaded the images
into a special file on the NCSU computer server.

3. During the next few sessions the enviroKIDs meet with Professor Kofi Boone in the computer lab on
Campus at the School of Design and learned to use the sketch-up computer program. The enviroKIDs
and Professor Boone using the sketch-up computer program to create digital study models of the
Princeville Heritage Trail. They walk through their digital study models and generated individual and
group ideas.

4. The enviroKIDs used a Virtual Reality device called an HTC Vive to walk through two Sketch-Up
study models in digital space and gave feedback on each study model.

**4.5 Step 5 - Share Solutions**

The enviroKIDs produced two (2) recommendations to make the proposed Princeville Heritage
Trail experience better for its visitors. The enviroKIDs recommendations to making the Town of
Princeville is shared with the community at the enviroKIDs Summer Camp end of summer Workshop. The
two main solutions recommended by the enviroKIDs were:

1. **Participatory Art:**
   
   The enviroKIDs recommends as part of their social reality experience along the Heritage
   Trail several designated locations where theater as participatory art can take place or be
   conducted. At each theater / participatory art locations along the heritage trail a theatrical
   performance of different themes related to the institution of slavery in Edgecombe County is
   performed. During the performances the public is encouraged to participate and share their
   experiences. An example of the participatory art would be a play about what it would be like if
   you were a runaway slave caught and returned to an angry slave master. The audience may want
   to play the part of the runaway slave for the experience or simply voice their feelings.

2. **Heritage Sculpture:**

   The enviroKIDS recommend that as part of their Design Activism along the Heritage Trail
   several designated locations be sited to reveal, unveil and or frames sculptures of men, women
   and children in chains and shackles be displayed showing the injustice or wrongdoing of the
   institution of slavery.
Figure 5. Princeville Heritage Trail  
Developed August 2017 – Designer Yasmin M. Fozard 

a. Freedom Hill 

b. Shiloh Landing 

c. Mount Zion Primitive Baptist Church 

d. African American History Museum 

e. Other historic landmarks in Princeville
5 PRESENT DAY PRINCEVILLE

Historically, the Town of Princeville has been populated primarily by African-Americans and struggled early-on with social and economic difficulties relating to racism. Over time, the citizens of Princeville have developed a strong sense of pride in their history and in their community and the Town stands as a symbol of African-American determination and endurance. Today the town of Princeville is characterized by a high degree of vulnerability across a broad spectrum of potential risk factors. Many Princeville residents are at risk to experience job loss, housing instability, poverty, and poor health, and are less likely to have the resources needed to cover expenses related to flooding hazards, compared to state and national averages.

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<th></th>
<th>Town of Princeville</th>
<th>Edgecombe County</th>
<th>North Carolina</th>
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<tbody>
<tr>
<td>Unemployment Rate</td>
<td>23.5%</td>
<td>15.4%</td>
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<td>Median Household Income</td>
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<td>Per Capita Income</td>
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<td>Percent Below Poverty</td>
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<td>26.3%</td>
<td>17.4%</td>
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Source: ACS 5-year estimates (2015)

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<th>Town of Princeville</th>
<th>Edgecombe County</th>
<th>North Carolina</th>
</tr>
</thead>
<tbody>
<tr>
<td>Housing Cost Burdened (&gt;1/3 of income)</td>
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<td>31.6%</td>
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<td>Percent Renters</td>
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<td>Rental Vacancy Rate</td>
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<td>Homeowners Vacancy Rate</td>
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<td>Vacant Housing Units</td>
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<td>Average Cost of Homes (2015)</td>
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<td>$82,200</td>
<td>$154,900</td>
</tr>
</tbody>
</table>

Source: ACS 5-year estimates (2015)

Figure 6. Princeville, NC Age Distribution by Gender
Halligey, Alex. (2016) How Theatre Helps To Explore a City’s Identity


Introducing The Design Process – Design Squad Global is produced by WGBH Boston, 2018 WGBH Educational Foundation


Organized By HMDRRI (2017) Princeville Design Workshop


Thorpe, Ann. (2011). Defining Design As Activism

**enviroKIDs Funders**

ILASS – Institute of Landscape, Art and Sustainable Spaces

North Carolina Forest Service

United State Department of Agriculture – USDA

Triangle Community Foundation – Send A Kid To Camp

Campbell Global, Forest & Natural Resource Investments

Rehabilitated Support Services

NC SFI Grant Program – North Carolina Sustainable Forestry Initiative Grant Program

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THE NEXUS STUDIO: A SYNERGISTIC PEDAGOGICAL APPROACH FOR INTEGRATING RESEARCH AND EVALUATING LEARNING IN A LANDSCAPE ARCHITECTURE STUDIO

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1 ABSTRACT
Evaluating a student’s development is key to understanding effective techniques for teaching and learning, applying relevant research, and developing competencies for practice. The purpose of this project is to integrate landscape architecture and planning education with a research project addressing socio-ecological issues for a landscape. This project focuses on landscape architecture and planning education, using a studio course framework, surveys, and a geospatial evaluation model as vehicles for experimentation. This planning and design studio uses relevant research, an alternative futures research methodology, geospatial design and evaluation as vehicles for building key competencies in sustainability for landscape architecture students (Wiek et al, 2011). It systematically evaluates student learning within a studio course by analyzing self-reported and spatially explicit evidence of learning concerning Food, Energy, and Water Systems (FEWS) at the landscape scale. The method gathers, assesses, and evaluates evidence of student learning. It uses measurement and mapping combined with student surveys to evaluate these two forms of evidence. The results of this study present and interpret the evaluation of the self-reported and spatially explicit evidence of learning. This paper concludes both spatially explicit and self-reported evidence together best indicate learning for design and planning students, with the evidence in this project most compelling regarding student-driven evaluations and revision. The results are intended to equip educators in Landscape Architecture and Planning with effective tools and methods for evaluation and course revision.

1.1 Keywords
Alternative Futures, GeoDesign, Planning, Evaluation
2 INTRODUCTION

Evaluating student learning reflects the program goals of a higher education institution. Our current education system asks educators to maintain standards for skills learned or conveyed throughout a curriculum, and students are required to exit academic programs with a specific set of competencies pertinent to their field. These competencies have the potential to be viewed as indicators of student strengths and weaknesses. They can be measured to understand if, and if so, how knowledge is acquired.

The aim of this project is to develop and apply an evaluation framework, relevant to the field of Landscape Architecture, to determine learning within design instructional courses by measuring, evaluating, and comparing student skills and competencies using two forms of evidence. The project also intends to utilize studio outputs with a concurrent research project, thus creating a synergy between research, pedagogy, and service. As a contribution to landscape architecture and planning pedagogy, this project is intended to enhance professional skills for efficient and effective educators as well as others within the field of Landscape Architecture.

2.1 Landscape Planning and Design Education

The field of Landscape Planning and Design can be defined as “a particular form of planning at a regional scale which integrates land use, physical planning, and environmental issues” (Frank, 2006). Within the past three decades, Landscape Planning and Design education has undergone significant advances to develop student learning within formal course instruction. Studios and workshop course types focus on current and relevant issues, and they are effective in initiating student interest and preparing students for practice with the field (Lusk & Kantrowitz, 1990).

Landscape Planning and Design studios and courses ask students to provide solutions to current problems for a specific geographical location using tools and guidance. Studios typically last for an entire academic semester or term, and focus on a wide range of topics, theories, and specific circumstances relevant to a given study area. Workshops or modules are often briefer, and are generally designed to “foster learning how to learn” (Frank, 2006). These modules can potentially be used to comprise a complex structure for a studio. This project evaluated evidence of student learning in a 16-week Studio through four modules or workshops. This evaluation led to guidance for revising particular components of a Landscape Planning and Design Studio.

The purpose of this project is to provide and demonstrate a systematic approach for evaluating student learning within a Landscape Planning and Design Studio using two forms of evidence: self-reported and spatially explicit. This approach will provide educators with guidance for developing instructional courses to aid student learning. The project evaluates student knowledge, skills, and competencies throughout courses related to current stormwater issues for a particular geography. The results indicate students’ self-understanding of key concepts from self-assessment and provide a faculty-produced spatial evaluation of student designs.

This project intends to contribute to Landscape Architecture and Planning education. This paper also intends to contribute to Landscape Planning education by creating, delivering, and revising Landscape Planning and Design modules to site and evaluate suitable locations for landscape interventions. This project aims to address the need for initial and final self-reported and spatially explicit student evaluations as guides of how to improve instruction to revise learning about this topic. Reporting the relationship of learning to this evidence will indicate what revisions need to be made to course materials and instruction.

By proposing the use of a combination of mixed evidence, this project seeks to answer the following research question: What types of evidence best indicate student learning in semester-long and module instruction in landscape planning and landscape design studios?

2.2 The GeoDesign Framework

Carl Steinitz’ GeoDesign Framework is centered on the question, “How do we get from the present state of this geographical study area to the best possible future?” (Steinitz, 2012). This process occurs across scales, temporal and geographical, to produce “constructed physical change” in site-scale projects and to “influence the way society values and changes its geography” in landscape-scale projects (Steinitz, 2012). GeoDesign relies on an interconnected, representative matrix of experts including
regional stakeholders that Steinitz describes as “the people of the place,” geographic scientists, design professionals, and information technologists (Steinitz, 2012).

The framework includes six inquiries: “How should the study area be described? How does the study area operate? Is the current study area working well? How might the study area be altered? What differences might the changes cause? How should the study area be changed?” (Steinitz, 2012). Multiple iterations through these questions are employed to calibrate the models and refine stakeholder and researcher assumptions. Results of this iterative process demonstrate plausible futures for a given landscape or site.

2.3 INFEWS Project

The INFEWS (Innovations at the Nexus of Food, Energy, and Water Systems) Research Project uses an integrated approach to investigate effective means of stakeholder engagement for a National Science Foundation-funded (NSF) waste solutions project in the Magic Valley, Idaho, USA. These key issues in stakeholder engagement require a framework to represent anticipatory trajectories of change driven by the stakeholder’s understandings of the system. For this process, we used the GeoDesign Framework (Steinitz, 2012), described in the previous section. The following diagram illustrates the INFEWS process for incorporating researcher assumptions with stakeholder input (Figure 1).

![Figure 1. INFEWS Project Process Diagram](image)

Complex adaptive system management is key to biological and socio-economic integrity within landscapes. Drivers of landscape ecology, population growth, climate change, and economic pressures necessitate a profound understanding of both the processes and future conditions of the landscape (Kliskey et al., 2017). The determination and interconnection of these assumptions for change demand organization through an integrated approach to model existing conditions, future processes, and solutions to address issues within Food, Energy and Water Systems (FEWS). Stakeholder input requires various tools and strategies to develop effective and useful results; however, specific challenges and limitations of participatory research arise throughout the process. An alignment of stakeholder and researcher assumptions considering plausible futures of a landscape can require a large amount of time. Probabilistic model simulations take the form of land-use and land-cover representations, which are outputs of the project, also require calibration, parameterization, and revisions from stakeholders and researchers. 'Key
Uncertainties were developed from the stakeholder group. Various scenario narratives were scripted from researcher and stakeholders assumptions and the ‘Key Uncertainties’ about the future for the region (Figure 2).

The NEXUS Studio project uses student designs as the first iteration of land-use and land-cover representations from each scenario narrative using the GeoDesign Framework (Steinitz, 2012). The outputs of the studio used in a stakeholder meeting to illustrate each scenario and to validate researchers models with stakeholder assumptions.

2.4 The NEXUS Studio

The NEXUS Studio was divided into four modules for instruction: Module 1, Inventory & Analysis; Module 2, Initial Designs; Module 3, Evaluations; Module 4, Design Revisions (Table 1). Within the modules, instructional sessions were focused on delivery of content relevant to the INFEWS project, the project site, and deliverables noted in Table 1. INFEWS researchers gave presentations to students concerning their areas of expertise. “Key competencies in sustainability,” at varying degrees, were used to compile instructional materials. Survey instruments were distributed to student prior and post instruction. Spatially explicit evaluations were used to assess student design within Module 3 and upon completion of the final landscape scale and site scale designs in Module 4.

During Module 1, Students were presented with the Scenario Narratives compiled by the INFEWS research team. Each student was given a narrative to depict a plausible future dictated by the stakeholder group. Students were asked to explore design decisions at the landscape and site scale for the scenario distributed to them. For ‘Module 1, Inventory & Analysis’ students were asked to form groups to develop presentations about their understandings of the site and inherent processes under each
scenario. The students were, again, asked to divide into teams during ‘Module 3, Evaluations’ to assess initial scenario designs created by each student for their assigned Scenario Narrative.

### Table 1. The NEXUS Studio Modules, Expectations and Deliverables

<table>
<thead>
<tr>
<th>NEXUS STUDIO MODULES</th>
<th>KEY COMPETENCIES IN SUSTAINABILITY</th>
<th>GEO DESIGN QUESTIONS</th>
<th>DELIVERABLES</th>
</tr>
</thead>
</table>
| **MODULE 1: Inventory & Analysis**  
- (3 weeks)  
- INITIAL SURVEY - Beginning of Studio Course | Systems Thinking Competence  
Anticipatory Competence  
Normative Competence  
Strategic Competence  
Interpersonal Competence | How should the study area be described?  
How does the study area operate?  
Is the current study area working well? | Digital presentation  
- site conditions through graphics, tables, maps and photos  
- identify opportunities and constraints |
| **MODULE 2: Initial Designs**  
- (3 weeks) | Systems Thinking Competence  
Anticipatory Competence  
Normative Competence  
Strategic Competence  
Interpersonal Competence | How might the study area be altered? | Digital presentation  
- a process diagram  
- initial landscape scale design  
- initial site scale design |
| **MODULE 3: Evaluations**  
- (2 weeks)  
- INITIAL DESIGN EVALUATION | Systems Thinking Competence  
Anticipatory Competence  
Normative Competence  
Strategic Competence  
Interpersonal Competence | What differences might the changes cause? | Evaluation Diagrams and Tables  
- Landscape Scale Evaluation  
- Site Scale Evaluation |
| **MODULE 4: Design Revisions**  
- (3 weeks)  
- FINAL SURVEY - END of Studio Course  
- FINAL DESIGN EVALUATION | Systems Thinking Competence  
Anticipatory Competence  
Normative Competence  
Strategic Competence  
Interpersonal Competence | How should the study area be changed? | Digital presentation  
- revised landscape scale design  
- revised site scale design |

### 3 METHODS

This study seeks to evaluate student learning within courses regarding land use planning, with a focus on improving teaching and coupling pedagogy with a concurrent research project. The Methods section explains the process by which evidence of student learning was gathered and the methods used to evaluate whether or not learning occurred. It offers an approach for evaluating two forms of evidence: self-reported and spatially explicit. Within this project, the term 'STEPS' is used to describe the process.

The following approach was used for course instruction and student learning evaluation: STEP 1: INSTRUCT; In the studio modules, material concerning the siting of land use interventions was conveyed to students. A method for designing such at the landscape scale and site was explained through individual formal workshops and desk critiques. STEP 2: COLLECT; The self-reported evidence on which assessment of learning is partly based, takes the form of responses to a survey administered both before and after a formal course of instruction. Student designs from the Studio were also collected for the spatially explicit evaluation. STEP 3: EVALUATE; The evaluations of this evidence consist of a comparison of the initial survey responses with the second, and a comparison of the first spatially explicit designs of landscape scale and site scale designs with the second. Both stages of evaluation seek to identify specific evidence of learning. The spatially explicit evidence takes the form of student designs for land use planning related interventions in the form and pattern of a landscape. One such design was produced midway through the course of instruction, and the other at its conclusion. STEP 4: PRESENT RESULTS; The evidence of student learning was used to determine instructional context or means of delivery in need of revision for subsequent courses of instruction concerning planning and design using suitability criteria for landscape planning. STEP 5: REVISE; Revisions based on the overall process were made to the studio and course curriculum.

This paper will focus on STEPS 3 and 4 to demonstrate the evaluation process of student learning for the studio course. The objective of this evaluation strategy is to merge these two forms of evidence to demonstrate student learning quantitatively (spatially explicit evidence) and qualitatively (self-reported evidence). This project also uses deductive strategies to evaluate learning and diagnose needed changes in course content and delivery to improve learning. Evaluation and diagnosis is a strategy to develop explanations and interpretations through specific processes (Deming and Swaffield, 2011). Detecting learning
by applying specific indicators and tools to both self-reported and spatially-explicit evidence of learning, this method may become a more generally transferable approach for educators within planning and design.

3.1 Self-reported evidence: Surveys

Surveys were given to students at two intervals during the studio to assess learning. Based on the ‘Key competencies in sustainability’ criterion (Wiek et al, 2011), an interpretation of relevant landscape planning factor was developed for the survey. By conducting an investigation of relevant landscape planning criteria and competencies for sustainable planning and design, the following factors were addressed in the surveys: Systems Thinking Competence, Anticipatory Competence, Normative Competence, Strategic Competence, and Interpersonal Competence. The initial and final survey questions reflected aspects of each competence as noted in Table 2.

3.2 Spatially explicit evidence: Design Evaluations

As a method of inquiry, spatial analysis was used to indicate evidence for the NEXUS Studio at the landscape and site scale. After completion of the studio, student designs were evaluated using student-driven evaluation metrics. In Module 3: Evaluations, students were asked to develop evaluation models to measure the success of landscape scale and site scale scenarios. At the landscape scale, students were asked to develop evaluation models using ESRI’s ‘Modelbuilder’ (Figure 3) to measure and rank scenarios answering the questions: What differences might the changes cause? How should the study area be changed?” (Steinitz, 2012). Each model for landscape evaluation was developed in relation to the INFEWS ‘Key uncertainties’ driven by INFEWS stakeholder assumptions. Site scale evaluations were conducted by using a rubric (Table 3) developed by student teams also during Module 3: Evaluations.

Table 2. Key Competencies in Sustainability applied to the NEXUS Studio survey questions

<table>
<thead>
<tr>
<th>SURVEY QUESTIONS</th>
<th>KEY COMPETENCIES IN SUSTAINABILITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Which role would you identity with for solving the planning and design components of the project?</td>
<td>Interpersonal Competence&lt;br&gt;- Functions, types, and dynamics of collaboration&lt;br&gt;- Concepts of solidarity&lt;br&gt;- Concepts of leadership and team dynamics</td>
</tr>
<tr>
<td>2) How reasonably professional of a knowledge base do you think you have for integrating terrain-related patterns of land-use type, planning systems related solutions, and land-use suitability for available and potential spaces?</td>
<td>Systems Thinking Competence&lt;br&gt;- Complex cause-effect chains&lt;br&gt;- Across/multiple/coupled domains: Environment, Equity, Economy&lt;br&gt;- People and social systems: values, preferences, needs, perceptions, (collective) actions, decisions</td>
</tr>
<tr>
<td>3) Please describe how well you think you understand how to integrate systems-related factors of land-use interventions at the site and landscape scale.</td>
<td>Anticipatory Competence&lt;br&gt;- Concepts of time including temporal phases&lt;br&gt;- Concept of uncertainty, possibility, probability, desirability of future&lt;br&gt;- Concepts of consistency and plausibility of future developments</td>
</tr>
<tr>
<td>4) With your current understanding, what are some viable and probable solutions that you expect to plan and design?</td>
<td>Strategic Competence&lt;br&gt;- Obstacles and synergies&lt;br&gt;- Success factors&lt;br&gt;- Intentionality, Success factors, feasibility, effectiveness, efficiency</td>
</tr>
<tr>
<td>5) What are the key uncertainties to address in landscape planning for the given site? 6) Please list some land-use conflicts that you expect to model for Magic Valley, Idaho.</td>
<td>Normative Competence&lt;br&gt;- Sustainability principles&lt;br&gt;(Un-)sustainability of current states and future states&lt;br&gt;- Concept of risk, harm, damage</td>
</tr>
</tbody>
</table>
Figure 3. Spatially explicit evaluation instrument

<table>
<thead>
<tr>
<th>Environment</th>
<th>Requirement</th>
<th>Availability (Y/N)</th>
<th>Present</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Does not develop on previously undeveloped floodplain</td>
<td>Y</td>
<td>Y</td>
<td>N</td>
<td>3.0</td>
</tr>
<tr>
<td>Re-establishes previously developed wetland</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>3.0</td>
</tr>
<tr>
<td>Conserves aquatic ecosystems</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>5.0</td>
</tr>
<tr>
<td>Manages precipitation on site</td>
<td>Y</td>
<td>Y</td>
<td>N</td>
<td>4.0</td>
</tr>
<tr>
<td>Reduces outdoor water use</td>
<td>N</td>
<td>Y</td>
<td>N</td>
<td>2.0</td>
</tr>
<tr>
<td>Restores aquatic ecosystems</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>4.0</td>
</tr>
<tr>
<td>Conserves and restores native plant communities</td>
<td>N</td>
<td>Y</td>
<td>Y</td>
<td>2.0</td>
</tr>
<tr>
<td>Reduces the risk of catastrophic wildfires</td>
<td>Y</td>
<td>N</td>
<td>N</td>
<td>3.0</td>
</tr>
<tr>
<td>Uses renewable sources of energy</td>
<td>Y</td>
<td>N</td>
<td>N</td>
<td>4.0</td>
</tr>
<tr>
<td>Aquatic buffer system present</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>5.0</td>
</tr>
<tr>
<td>Conserves habitats for threatened species</td>
<td>N</td>
<td>Y</td>
<td>Y</td>
<td>3.0</td>
</tr>
</tbody>
</table>

| Equity                                                                      |             |                    |         |        |
| Creates or connects to multi-modal transit networks                        | N           | N                  | N       | 2.0    |
| Protects and maintains cultural and historic places                        | N           | N                  | N       | 3.0    |
| Provides optimum site accessibility, safety, and wayfinding                | N           | Y                  | Y       | 3.0    |
| Promotes equitable site use                                                | N           | Y                  | Y       | 3.0    |
| Supports social connections and mental restoration                         | N           | Y                  | Y       | 2.0    |
| Promotes sustainability awareness and education                            | Y           | Y                  | N       | 4.0    |

| Economy                                                                     |             |                    |         |        |
| Mitigates development on farmland                                          | Y           | Y                  | Y       | 5.0    |
| Locates new development within existing developed areas                   | Y           | Y                  | Y       | 5.0    |
| Designates vegetation and soil protection zones                            | Y           | Y                  | Y       | 5.0    |
| Reduces water use for landscape irrigation                                 | N           | Y                  | N       | 3.0    |
| Optimizes biomass                                                          | N           | Y                  | N       | 4.0    |
| Provides on site food production                                            | N           | Y                  | N       | 2.0    |
| Supports the local economy                                                 | N           | N                  | N       | 2.0    |

| Aesthetic                                                                  |             |                    |         |        |
| Redevelops degraded sites                                                  | N           | N                  | N       | 4.0    |
| Designs functional stormwater features as amenities                        | N           | N                  | N       | 4.0    |
| Reduces urban heat island effect                                           | N           | Y                  | Y       | 2.0    |
4 RESULTS

The results section presents and interprets results regarding learning in the Nexus Studio. It provides overall results for the entirety of the studio. This section summarizes the connection between the evidence of learning and the possible approach future research-driven GeoDesign studios in Landscape Architecture and Landscape Planning.

Self-reported evidence was combined with spatially explicit evidence by using percent increase from both initial and final instruments for evaluation. The initial and final survey results were analyzed to understand if specific information and concepts presented by course instruction were learned by the student. Also, when offered by the student, relevant and specific responses were marked as learning for each of the key competencies of sustainability (Wiek et al., 2011) related to landscape planning. For example, in the initial survey a student may have used general and non-specific language to describe system factors, whereas in the final survey responses the same student may have specifically mentioned suitability criteria siting for these system factors and solutions. Questions were weighted equally. Spatially explicit evidence of learning was also evaluated by comparing percent increase from the initial and final design for an average of the site scale and landscape scale designs. Increase from the existing conditions aligned with assumptions from each scenario narrative dictated an increase for each scenario.

Results from both forms of evidence were combined by creating an average of the spatially explicit percent increase with the self-reported percent increase using a scale to understand the degree of learning from low to high. The following scale was used to understand degree of student learning from low to high: LOW (0% – 33%), MEDIUM (34% - 66%), HIGH (67% - 100%). A simple equation was used for replicability in future studios.

\[ i = x - y + a - bb2100 \]  

4.1 Combination of Results

The project results indicate various levels of learning per scenario and student. The combination of the surveys and design evaluations disclosed four of the six student-driven design scenarios reported as being a “high increase” in learning. The results are interpreted as mixed due to the combination of qualitative and quantitative data creating inconsistencies. The results of this study indicated a low correlation \((r^2 = .0718)\) between percent increase in the self-reported evidence of learning and spatially explicit evidence noted in Table 4 and Figure 4. However, all students demonstrated an “increase” in learning based on the survey responses and backed by student designs.

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Initial Survey Results</th>
<th>Final Survey Results</th>
<th>% Increase (Survey)</th>
<th>Initial Design</th>
<th>Final Design</th>
<th>% Increase (Design)</th>
<th>AVERAGE % Increase</th>
<th>Learning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scenario 1</td>
<td>35%</td>
<td>75%</td>
<td>114%</td>
<td>30%</td>
<td>65%</td>
<td>117%</td>
<td>115%</td>
<td>HIGH Increase</td>
</tr>
<tr>
<td>Scenario 2</td>
<td>25%</td>
<td>60%</td>
<td>40%</td>
<td>35%</td>
<td>75%</td>
<td>114%</td>
<td>80%</td>
<td>HIGH Increase</td>
</tr>
<tr>
<td>Scenario 3</td>
<td>75%</td>
<td>85%</td>
<td>13%</td>
<td>25%</td>
<td>45%</td>
<td>80%</td>
<td>47%</td>
<td>MEDIUM Increase</td>
</tr>
<tr>
<td>Scenario 4</td>
<td>55%</td>
<td>65%</td>
<td>18%</td>
<td>30%</td>
<td>70%</td>
<td>133%</td>
<td>76%</td>
<td>HIGH Increase</td>
</tr>
<tr>
<td>Scenario 5</td>
<td>60%</td>
<td>90%</td>
<td>50%</td>
<td>50%</td>
<td>70%</td>
<td>40%</td>
<td>45%</td>
<td>MEDIUM Increase</td>
</tr>
<tr>
<td>Scenario 6</td>
<td>40%</td>
<td>75%</td>
<td>88%</td>
<td>30%</td>
<td>65%</td>
<td>117%</td>
<td>102%</td>
<td>HIGH Increase</td>
</tr>
</tbody>
</table>

Table 4. NEXUS Studio Survey, Design Results, and Averaged Percent Increase in Learning
5 CONCLUSION

Upon completion of this study, I have concluded that spatially explicit and self-reported evidence together best indicate learning for design and planning students. Student self-awareness of land use factors, methods for siting and modeling, and design reasoning is a crucial component to warrant the validity of planning and design decisions. However, further investigation for combining qualitative and quantitative evidence of student learning is needed. Within the following section, the rationale supporting this conclusion is presented.

This project illustrates the utility of a course framework, which couples a research project a landscape architecture and planning studio. Course objectives and competencies for both research and the studio were successful from indications of learning outcomes and the production of multi-scalar representations used in an INFEWS stakeholder meeting. There are many advantages to employing this framework including the following: a) pairing studio outputs with an active research project, b) utilizing geodesign framework for organization, and c) developing an understanding of multi-scalar dynamics expressed in landscape and site scale design.

A union between landscape architecture studio objectives and deliverables of the INFEWS research project provided an effective learning experience for students and researchers alike. This contribution to research motivated and gave enthusiasm to students. The project exposed students to research in landscape planning aligning.

The research project and modules within the studio were initially complex for student understanding, however upon conducting the methods and running tools, students found an understanding through a guide: the GeoDesign Framework (Steinitz, 2012). As a tool, it gave students a roadmap to follow throughout each course module. The students in the NEXUS studio demonstrated a high level of systems-thinking competence (Wiek et al., 2011). “Systems-thinking competence means that graduates have the ability to understand the immediate and root causes of complex sustainability problems including the actions, needs, motives, intentions, and mandates of key players in the problem constellation (Wiek et al., 2011).”
The crosswalk between research, education, and service was accomplished by giving a multi-
scalar component to a problem statement within instructional modules. Students modelled and revised
landscape scale designs and understood the impacts at the site scale. Production of site scale designs
and evaluation led to direct outreach for particular sites within Magic Valley, Idaho currently in the process
of conceptual design. Students were able to propose designs for a community park with a focal area study
within Magic Valley based on assumptions from designs and evaluations at the landscape scale. The
designs have been used by the city for future consideration for management, planning, and possible
implementation.

Evaluation metrics have become a crucial component for Landscape Architecture and Landscape
Architecture Education. This research project has provided a systematic evaluation framework which acts
as a foundation for future research. A continuation of this framework will be needed in other courses of
instruction in various settings, course materials, and content. However, this coalescence of research,
education, and service gave a demonstration of a transferable process, which can be used for landscape
architecture educators and researchers alike.
Figure 5. NEXUS Studio Student work & INFEWS Models used for a Stakeholder Meeting
6 REFERENCES


Appraoching Landscapes: Structuring Disciplinary Dichotomies for Rhizomatic Learning

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1.0 ABSTRACT

‘Landscape’ / ‘Architecture’ | ‘Seeing’ / ‘Acting’
Structuring disciplinary dichotomies for rhizomatic learning

‘the rhizome pertains to a map that must be produced, constructed, a map that is always detachable, connectible, reversible, modifiable, and has multiple entryways and exits and its own lines of flight’. (Deleuze and Guattari 1987)

Historically landscape architecture has drawn from practices of ‘seeing’ for example, landscape painting, mapping and GIS. At the same time forms of action have been modified from gardening, architecture, painting and other fields. Taking this idea of multiple lineages as a starting point, a teaching practice was developed that actively used the tension between processes of seeing and acting in landscape architecture to establish a dynamic frame of reference for analysis and positioning, in which the act of positioning is always in motion and capable of producing multiple threads of connection. This oscillating framing of seeing and acting became a way for students to explore ideas using multiple intelligences and establish a suite of tools for students to position their own work and the work of others.

The articulation of these processes of positioning within modes of practice were developed to equip students with the ability to engage in a ‘practice-based’ learning process and develop an awareness in creative intelligence, in which students are empowered through a process of creative critical thinking and connecting the ‘act of seeing to the act of thinking and doing’. The aspiration is to develop a pedagogy of practice-based learning that has the ability to empower students to think and act critically and demonstrate that holding multiple articulated positions creates a productive discourse which contributes to disciplinary understandings.

This paper discusses how three dynamic ‘design research-based teaching’ models; ‘the conference’, ‘the design laboratory’ and ‘the expedition’ were developed for the purpose of engaging multiple intelligences in order to develop both lateral and linear thinking. This is an expansion of what is commonly understood as the ‘studio learning model’, into a ‘collaborative and cooperative’ learning model which suggests a pedagogical structure customised to various types of disciplinary learning and doing.

Keywords
Design Research, Landscape Architecture, Creative Thinking, Multiple intelligences

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2. INTRODUCTION

This paper discusses how three dynamic ‘design research-based teaching’ models; ‘the conference’, ‘the design laboratory’ and ‘the expedition’ were developed for the purpose of engaging multiple intelligences in order to develop both lateral and linear thinking. An expansion of what is commonly understood as the ‘studio learning model’, into a ‘collaborative and cooperative’ learning model which suggests a pedagogical structure customised to various types of disciplinary learning and doing.

The framing of landscape architecture as an ‘art and a science’ is commonly found in descriptions of the discipline. Describing it in this way claims the approaches found within art, gardening, architecture and the sciences within a territory of disciplinary knowledge. Offering the potential for landscape architects and landscape architectural students to draw from a rich set of lineages.

An appreciation of these multiple lineages formed the jumping off point for a teaching practice that explicitly explored and created a dynamic relation between diverse approaches, tools and techniques. With the understanding that, broadly, these approaches are also multiple in that they allow for - both ways of seeing (conceptual/analytical approaches) and ways of acting (approaches to forming the landscape).

Dynamic relations between these aspects occurs in an oscillating manner in the practice of design. An approach to practice - based design teaching was to structure a sets of tasks that encouraged students to explore and generate multiple positions. Through this activity of position building they developed a suite of tools to evaluate, produce and position landscape architectural works. This set of oscillating relations is understood in the broader educational context of multiple intelligences.

In the Discipline of Landscape Architecture creative forms of intelligence are discussed in teaching and learning environments, however rather than arguing for an either-or-model, in this paper we suggest that multiple forms of intelligence may be engaged, which we title as a ‘practice-based model’ for teaching and learning. This is explored as a model to enable multiple forms of engagement and learning capacity which is inherent in the process of learning for the discipline.

The articulation of these processes of positioning within modes of practice were developed to equip students with the ability to engage in a ‘practice-based’ learning process and develop an awareness in creative intelligence, in which students are empowered through a process of creative critical thinking and connecting the ‘act of seeing to the act of thinking and doing’. The aspiration is to develop a pedagogy of practice-based learning that has the ability to empower students to think and act critically and demonstrate that holding multiple articulated positions creates a productive discourse which contributes to disciplinary understandings.

2.1 Multiple Intelligences

Howard Gardner identified eight intelligences (linguistic, logical-mathematical, spatial, bodily-kinesthetic, musical, interpersonal, intrapersonal, naturalist) in the book Multiple Intelligences. These intelligences were presented by Gardner in the context of a model that assumed the pre-existing tendency towards a type of intelligence within the students themselves. As a result, the focus was on the use of curriculum to draw out the various intelligences by modifying the the mode of delivery to enable efficient learning of the same core material for different learning types.

The model is useful in identifying various frameworks that operate in relation to knowledge and learning. However, the processes of design do not necessarily fall within the category of a singular intelligence. Vaughan (2007) highlights the notion that design may be regarded as a way of working that demonstrates
not a singular capability but clarifies the ‘nature of design ability and offers a framework for understanding and developing the culture of design’. If we then add the complexity of practice-based teaching and learning from a disciplinary context of multiplicity then, different modes of teaching and learning are required, which can vary according to areas of disciplinary contribution, techniques, approaches and projects.

In order to make use of the multiple intelligence model within Landscape Architectural pedagogy, Gardner’s approach to multiple intelligences was re-read. Shifting the ideas from a categorical definition to a process of active forming of multiple modes of understanding and action. These intelligences are then understood as frameworks that allow for a deep relational learning.

The emphasis on relational is important as it is moving between perspectives and knowledges that is crucial to landscape architectural design. This ‘moving between’ is articulated further by Klein (2003)

“In a widely cited study, Kulhavy et al. (1985) found that students learned more about a map if they created a narrative text about it than if they wrote a geographical description of it. Apparently, writing a description merely required students to produce a new representation analogous to the original one, whereas the narrative task required students to reorganize this information into a more novel form, possibly providing additional retrieval cues.” (Klein, 2003)

Practice based design research mode of learning can then be considered not simply as deploying multiple intelligences in sequence or using as ways to model content delivery, but indicate a move towards pedagogy that structures tasks to enable continuous translations from one to the other. With the deliberate structuring of translation between as the intelligences become meaningful through the translation from one to another

‘the rhizome pertains to a map that must be produced, constructed, a map that is always detachable, connectible, reversible, modifiable, and has multiple entryways and exits and its own lines of flight’. (Deleuze and Guattari 1987)

3. Case Studies

A series of courses explored various types of knowledges and their translations. The courses spanned a number of content areas from the final year of a Bachelor program to the final year of a Master of Landscape Architecture program.

Digital as a translation between site / algorithmic /.
Translation of visual data (contours) into other models.

**Case Study 01: The Conference: (linguistic, spatial)**
Course name: Theoretical Frameworks III, Program: Bachelor of Landscape Architectural Design

An undergraduate course was developed as part of a suite of three covering theoretical frameworks of Landscape Architecture. It was designed around the practice-based model of a conference. The ambition
was for each student to come to a key question or position on a contemporary project through examination of related projects, approaches and techniques of production.

The conference as model generates an intersection that allows for the translation between text and image. There were a number of recursive translations embedded into the course. Rather than respond to a discrete questions, students were asked to investigate landscape architectural projects through a series of provocations that deliberately cut across the modes of ‘seeing’ and ‘acting’. In this way the students could not simply respond in a rote manner to the question. But had to define the key terms, meanings and lineages that they would work with. The first translation, was from the raw material found in books, online, interrogating pictures, accounts, marketing material and other readings of projects through the key terms they had defined. First the question had to be decoded, the terms analysed, second the oscillating points could be argued through the work.

To construct the argument for the conference paper, the task shifted to a spatial / visual task – to redraw the site in such a way that elucidated a understanding (relational to the framework). The abstract was then re-composited based on the reading of the drawing. A further process of association was used to construct a field of influences that informed the writing and drawing of the project.

The outcomes from the conference were a series of unique readings of projects that highlighted the perspective, relationships and possibilities of projections through the translation across text, image, drawing and mapping, this oscillation is described in fig x. A richness of ground for students to develop further concepts and position ideas. Within this framework students were enabled to hold multiple positions and developed agility in taking on roles and perspectives - taking on processes of combining and translating between multiple modes of intelligence.

*Fig: 1 The interplay between the terms unfolded as a methodology of enquiry that expanded critical questioning within a non-binary approach that gave agency to thinking and making within a spectrum of actions, connections and possible solutions.*
Case Study 02: The Design Laboratory (linguistic, spatial, interpersonal)  
Course Name: Project A & B, Program: Master of Landscape Architecture

The design laboratory describes a final year, independent project course within a coursework masters. The course was designed to focus on the development of individual techniques, approaches, modes of representation, and modes of positioning to enable each student to explore their design research practice and situate in a broader landscape architectural context.

The course was designed to cross pollinate and move between sets of intelligence. Across the course there were four phases designed to scaffold the building of a critical project brief and set of responses. Phase 1: positioning, Phase 2: techniques of analysis, Phase 3: techniques of forming and Phase 4: techniques of connection.

Phase 1: Positioning. To build a collective environment, a series of design research ‘laboratories’ formed around different approaches to the act of design in landscape architecture. The laboratories were organised through three phases over the course of the semester and were structured for students to position their independent research in a context (the collective) that allowed framing and connection of a project lineage.

Phase 2: techniques of analysis. The initial investigations of the project required the translation of site information into visual material as is usual for projects of this type. The difference for this exercise was that all information was to be translated into 2d or 3d line and hatch drawings. No aerial images were allowed (or for reference only) in this way the information could not be simply traced / inscribed from as singular the picture - but needed to be coordinated and developed from a range of sources including historical mappings, government reports and site visits. The resultant drawings were in themselves translations. And began to unfold other potentialities. The scale, scope and selection of linework needed to reflect the overall argument being developed through these translations.

Phase 3: Techniques of connection. For the completion of the project there were three deliverables for the course - Exhibition, presentation and document. Each had a distinct mode of delivery - visual, verbal and written. These modes are usual in the delivery of projects in professional practice.

The diversity of deliverables were assessed together as as a holistic representation of the project. The types of deliverables enabled the translation, re-articulation and development of the project through a range of intelligences and perspectives. The exhibition - visual, association, drawing. The presentation - a voice to discuss the work. The document focussed on the written and visual association to construct a particular conceptual argument for the project, and argue its value in relation to a particular audience. Each student developed the work in relation to a client, stakeholder and users group as a means to further explore multiple perspectives.

A number of projects used each deliverable as a means to addressing a particular audience (community group, client). As models for the document students put together various types of outputs ranging from reports, atlases

Case Study 03: The Expedition (linguistic, spatial, bodily, kinesthetic, naturalist)
In this postgraduate seminar course, students adopted the role of an ‘explorer’ in order to develop and question the role of mapping. In this way the person of the explorer acknowledges the construction of the map as a critical and creative act. The perspective of the explorer as a narrative device reveals and connects techniques, assumptions, ideas and realities.

Through the expedition students engaged with fictional notions of fieldwork as a post factual condition that is constructed, positioned and curated through a suite of drawings and a written narrative that are in dialogue with each other.

Across the course there were three phases in which each was simultaneously both analytical as well as creative; Phase 1: constructing the brief and site, Phase 2: constructing a suite of maps, Phase 3: constructing narratives

The role of the explorer was structured to simulate a practice model that is stakeholder oriented in its critical positioning and view of the world. It is to enable students to develop discursive methods between multiple subject matter and intelligences.

X Conclusion

Translation between intelligences are mapped in various ways across the three teaching models. We propose that understanding of intelligences as part of the design process is key to considering their applicability to design. Further that explicitly structuring activities that require translation as a creative activity could allow for diversity of ideas and outputs. The value of this approach can be seen by the breath and diversity of approaches developed in the work of the students.

“Competence is required in operating recursively with representations, coordinating representations, and translating them from one form into another” (Schnotz et al. 1993, Siegel 1995, Smagorinsky, 1995, Klein 2000)” KLEIN

“Rather, the traditional educational practice of pursuing facility in sign systems within subject-area courses provides a starting point. Also promising are several contemporary projects that include some overlapping features: introducing students to sign systems traditional to a given discipline, engaging students in authentic activities, relying on a combination of explicit instruction and learning by doing, supporting students in using these representations for thinking and learning rather than simply for communicating knowledge, and expanding the use of sign systems to include those not traditional to a given discipline (Siegel 1995, Vidal and Gilabert 1995, Lowrie 1996, Roth and Bowen 1999).” KLEIN

Inversion of models and processes.

That critical enquiry within the framework of ‘practice-based research’ requires mechanisms that allow for the production of ideas through the various modes of learning that cut across site analysis, design activities and related actions. The ambition of these modes is to prioritise difference, multiplicity and variation as desirable outcomes for students, and the broader profession.
This work explores a range of models that develop a pedagogy that seek to structure mechanisms into courses such that these inversions and translations are embedded to deepen learning.

X. REFERENCES


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HOW VIRTUAL REALITY IMPACTS THE LANDSCAPE ARCHITECTURE DESIGN PROCESS AT THE SITE-SCALE DURING THE PHASES OF ANALYSIS AND CONCEPT DEVELOPMENT

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1 ABSTRACT
Virtual reality (VR) offers many benefits for spatial awareness. In the field of landscape architecture, the technology is primarily being used as a tool for design review in the late stages of the design process. Many of the benefits that make VR valuable in the later stages of the design process suggest that VR may be equally valuable when used in earlier stages such as analysis and concept development. However, the present body of research does not provide a detailed study of truly immersive design within VR in the early stages of the process. This research tested incorporating VR in the design process phases of analysis and concept development and integrated its use with traditional landscape architecture methods to measure the impacts on a small-scale site design project. This research suggests a positive outlook for VR as a creation tool for small scale design and explores its affordances and limitations.

1.1 Keywords
Virtual reality, design process, immersive design
2 INTRODUCTION
Virtual reality (VR) is an important emergent technology that offers the promise of significant benefits to landscape architects through improving a designer's ability to understand the spatial nature of design decisions. Unlike traditional design tools, which invariably include forcing the designer to work through a series of perception filters such as dimension and scale, VR has the ability to situate the designer in a virtual re-creation of a site that closely imitates physical reality. While research has been conducted on the power of VR in late-stage evaluation of design concepts, research exploring the use of VR as a design generation tool is limited. This study presents a case study analyzing the use of VR in a collaborative design project, where the tool was used from the earliest stages of the design process in order to assess the value of VR in supporting design creation. The design team relied on VR as the primary design mechanism in developing their concepts and supplemented their work with other traditional design tools. It is theorized that VR will enhance students' design thinking and enable them to produce a more thoughtful and rational design.

3 LITERATURE REVIEW
Noted data visualization expert Edward Tufte describes the value of visualization as bringing clarity to complex data through graphical means. The visual representation of data has several advantages over non-visual representations, such as written text or verbal description (Tufte, Goeler, and Benson, 1990). This is because the human mind is wired to prioritize the visual sense, and the brain has evolved to be able to rapidly and intuitively process complex visual information (Bruce et al. 1996; Rose, 2012). Research has demonstrated that visualization is effective for conveying information regardless of field or discipline (Hansen & Machin, 2013; Valiela, 2009; Ware, 2013). In addition to having dominant visual senses, the human brain is adept at processing spatial information and tasks, and the awareness of space is an integral component of the awareness of self (Gersmehl and Gersmehl, 2007). Logically, the understanding and expression of spatial concepts is a critical skill for landscape planners and architects, both for designing and for communicating ideas with clients. Because of this, tools which provide landscape architects and planners with improved spatial awareness should expand the capacity of designers to more effectively engage with clients and stakeholders to develop appropriate design solutions (Chamberlain, 2015). For these reasons, VR should benefit designers in their work by enabling the designer to natively work in a highly spatial and visual environment.

The visual and spatial power of VR stems from its use of multiple sensory inputs to convince the user that they are present in an artificial world (Castronovo, Nikolic, Liu & Messner, 2013). VR can be divided into two categories: semi-immersive and immersive. A semi-immersive VR environment is when the user is only partially immersed in the virtual world or where the user is unable to interact with the digital environment. In a semi-immersive VR environment the user is aware that they are participating in a visualization. A common example of a semi-immersive environment is a VR theater, where imagery is projected onto surfaces surrounding the viewer on multiple sides (commonly referred to as CAVE system). In contrast, immersive VR is a digital environment that fully surrounds the user in a multi-sensory experience to convince the user that they are in a virtual world (Slater & Usoh, 1993). To be truly immersive, the virtual environment must be interactive and respond to the user’s actions (Grau, 2003).

Having the ability to craft and enter a digital world that is an accurate representation of the real world empowers designers and researchers to explore complex spatial issues in a more realistic manner (Horne & Thompson, 2008). This type of visualization technology is valuable to researchers and designers by providing a mechanism to more closely represent and understand the complexities of the landscape (Horne And Thompson, 2008). Despite these benefits, most use of VR in landscape architecture has been limited to visualizing design concepts prepared outside of VR as a form of design review and presentation. This has led to VR being used as a passive tool that provides powerful visual feedback, but is not informing the design as much as may be possible. Several studies documenting the use of VR in design and construction fields reveals the large majority of research has evaluated using VR to passively view design (Portman, Natapov, & Fisher-Gewirtzman, 2015; Wang, et al., 2018; de Freitas and Ruschel, 2013).

This research has demonstrated the clear value of VR in this role and has also strengthened the case to experiment with the use of VR in earlier design phases. Identified benefits of VR that would
support conceptual design activities include immersions and increased spatial awareness. Immersive VR has been attractive as a late-stage evaluation tool because the wide field of view creates a realistic viewing experience for the user (Castronovo, et al., 2013). Beyond visual immersion, VR also provides the user the opportunity to interact with design elements, which further heightens the sense of immersion and provides the user with a more realistic experience (Dunston, Arn, and McGlothlin, 2011). This high level of immersion has also produced some concerns in the research, as it has been suggested that the user may draw flawed conclusions because they accept at face value the environment that they are immersed in (Lange, 2011).

An ancillary benefit of immersion is that the user also has improved spatial awareness while in VR (Castronovo, et al., 2013; Rahimian & Ibrahimi, 2011; Portman, et al., 2015). This increased spatial awareness allows users to intuitively respond to a site and design. George (2016) had students utilize VR to conduct a site analysis of a residential site, and found that students were able to successfully conduct an analysis that accurately responded to the site conditions. However, caution should be exercised to not rely exclusively on VR when making design decisions, as the current level of detail supported by VR may constrict the ability to make some decisions (Bullinger, et al., 2010; Gill, et al., 2013).

There have been mixed results on the effects that VR has on collaboration. In their review of VR research, de Freitas and Ruschel (2015) conclude that VR has been demonstrated to improve communication and comprehension. In example, Gu, Kim, and Maher (2011) used semi-immersive VR to enable students collaborate on simple design exercises. However, when George, Sleipness, and Quebbeman (2017) tasked students with collaborating on designing a micro park in immersive VR, students found it difficult to work together to collaboratively create a design concept because the experience between those in and out of VR was markedly different.

Despite some limitations, VR is being steadily adopted in the design fields and a recent ASLA survey found that 82% of firms in the United States either have or intend to adopt VR into their workflow (George and Summerlin, 2018). This follows the broader trend of practitioners quickly adopting new digital simulation and visualization technologies over the preceding decade (Lange, 2011). As technology continues to improve, it is expected that VR will be integrated into more and more aspects of the design process.

Despite the increased adoption of VR, there has been relatively little research into expanding the use of VR beyond visualization applications, but what research has been done has been encouraging for the use of VR to facilitate design creation (George, Sleipness, and Quebbeman, 2017; George, Blauer, Hill, Quebbeman, 2018; Lombardo, 2018). Chamberlain’s (2015) work combining video game engines and VR has shown that VR can be used to teach design principles. George, et al. (2017) found that students could successfully use VR to design and that the students responded to the affordances provided by VR to adapt their design concepts. Rapid prototyping of loose conceptual designs has also been found to be successful in VR (Sleipness and George, 2017). These successful precedents warrant continued experimentation with VR in the design process using sites and projects that have a greater degree of complexity.

4 METHODS

This research is a case study of a project worked on by a six-student team consisting of four females and two males, and a class distribution of three juniors and three sophomores. The project was part of the Community Design Team (CDT) program, which is a program of the student ASLA chapter wherein students volunteer to work on real world extracurricular design projects in the community. This project focuses on the site design of an inclusive play environment at an innovative charter school in Providence, Utah. The team used a combination of VR and traditional methods to analyze the site and develop design concepts to test the impacts of integrating virtual reality into the landscape architecture design process.

4.1 Preparing VR materials
Several preparatory steps were taken to facilitate the virtual reality analysis and design in this study. A three-dimensional site model was needed to serve as a basemap in VR. This enables students to understand the surrounding context in 3D, and virtually visit, interact with, and design on the site as if they were there. A DJI Mavic Pro drone and Pix4D photogrammetry software were used to create the model. The drone was used to fly a single 20-minute drone mission, during which the drone flew 100 feet above the site in a pre-determined grid pattern controlled by the Pix4D mobile application. During the flight, the drone took pictures of the ground below, with each image overlapping by seventy five percent. Approximately 300 images were collected from the flight, which were then put into the Pix4D photogrammetry software and processed to create a point cloud and 3D model. This resulted in a detailed 3D terrain and vegetation model of the 15-acre site and the additional surrounding landscape. The photogrammetry model included the school building, but this was replaced with a model of the building created in Rhinoceros to increase detail and render quality. The building model was then inserted onto the terrain generated from the photogrammetry process in Rhinoceros. The preparation process took several hours to complete, including computer processing, but yielded a detailed site survey with contour data optimized for use in VR.

4.2 Carrying out the design

Apart from those previously listed, the hardware and software used for this project consisted of a Puget Systems PC with a high-performance CPU and GPU, HTC Vive VR platform, and Google Tilt Brush software. The 3D terrain model with the new building was exported out of Rhinoceros and imported into Tilt Brush in VR, where it was ready to be used by the design team. The project was conducted in a studio space with a projector and large screen (180°), on which a feed of what the designer was seeing inside VR was projected. A mixed reality capture system was used that digitally composited the student into the VR scene so that students outside of VR would be able to have improved contextual understanding of what the designer in VR was seeing and doing, with the limitation of it being seen on a 2D screen. In addition to VR, the students also utilized traditional design process methods such as 2D basemaps and trace paper to assist in conducting site analysis and developing design concepts. Students worked...
interchangeably between the two methods for three sessions, each one week apart, and data was collected after each session.

Four data collection rounds were used. Rounds 1 and 2 consisted of surveys distributed directly after the design session concluded to collect preliminary data. These surveys consisted of five questions and covered topics such as how much time was spent inside VR, what were the benefits they experienced using VR, and what were the challenges they experienced using VR. Round 3 data collection was a survey that was distributed after the third design session. This was a more comprehensive survey that consisted of seven open response questions and nine questions to be rated on Likert-scales. Round 4 data collection was a focus group held several days after the last design session and consisted of nine open response questions. Examples of questions that were asked in the focus group are, how long did it take you to feel comfortable using VR, how effective was communicating designs ideas in VR, and what about collaboration worked and did not work in VR.

In Round 1, 5 participants responded to the survey and in Round 2, 4 participants responded. In Round 3, which was the longest and most comprehensive survey, all 6 participants responded. Finally, in Round 4, all 6 participants were present for the focus group. The data collection resulted in 148 open answer responses and 66 Likert-scale rankings. The open response questions were then coded and produced 13 different codes (see Figure 2). This resulted in 198 combined coded comments, considering that some responses include multiple codes. For example, in response to the question “What part of analyzing the site was easier in VR?” a participant responded that “You could get an understanding of the site and design quickly”. This comment was then coded as improved understanding of a design through immersion, and improved site orientation and navigation. The mean of the Likert-scale responses was then calculated, and these results are represented in Tables 1 and 2.

5 RESULTS

Several important findings resulted from this study. Over the course of all four rounds the code most mentioned by participants was improved understanding of a design through immersion in VR. This code was talked about 42 times over the four rounds and is more than double the number of the next highest code. Other codes with significant mentions included site orientation and navigation (22), improved communication of ideas (19), limited technology capabilities (19), learning curve (18), improved process (18), and improved self-expression (14). A complete representation of the codes illustrating the changing nature of the conversation about VR is show in Figure 2. Students reported that VR presented several new challenges, such as always thinking and designing in three dimensions and a software learning curve. This is further illustrated by a student’s comment which states, “Developing concepts in 3D was challenging because it is new. It made me think about how to design in 3D.” However, once they got over the learning curve and became accustomed to thinking in 3D, they reported that they had a better understanding of the spaces that they were creating.

Another important finding is that verbal team collaboration was found to be less efficient than the traditional design process with the current limitation of only one designer in virtual reality at a time, while the rest of the team observes. However, visual communication and sharing of spatial ideas with a team was found to be very effective.

Working in VR affected and improved the students’ design process in multiple ways. Students responded that they were more aware of the three-dimensional character of their designs. They also commented that they experienced an improved ability to express their design ideas and get their points across to other students quickly. Students also stated that using VR improved the quality of design critiques from other students because of their improved ability to understand designs and communicate ideas visually. Overall, students were very positive in their assessment of VR as a design tool and would want to use it on future projects.

The quantitative data revealed that, overall, students had a positive experience using VR to design. Student ratings were high for issues related to visualization, immersion, value, and desire to use again. However, students disagreed that VR was a valuable collaboration tool (see Table 1). When asked to rate which tasks are easier in or out of VR, students preferred using VR to develop, visualize, and interact with a concept, but preferred to be outside of VR to refine the design and collaborate (see Table 2).
Figure 2: Coded comments of student responses

<table>
<thead>
<tr>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Somewhat Agree</th>
<th>Neutral</th>
<th>Somewhat Disagree</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Using VR made me more aware of the 3-dimensional character of my design</td>
<td></td>
<td></td>
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<tr>
<td>Using VR improved my ability to visualize my design</td>
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<tr>
<td>Using VR altered my approach to design</td>
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<tr>
<td>My team could collaborate effectively using VR</td>
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<tr>
<td>I would be interested in designing using VR in the future</td>
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<tr>
<td>VR was a useful tool in my design process</td>
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</table>

Table 1: Likert-scale results.
6 DISCUSSION

The results of the codes from Figure 1 suggest a positive outlook for VR as a tool for analysis and design in landscape architecture. However, limitations were also documented. Codes that suggest affordances of VR include positive technology capabilities, positive team collaboration, improved site orientation and navigation, improved understanding of a design through immersion, improved self-expression, increased process efficiency, improved sensory experience, and improved communication of design ideas. Codes that suggest limitations consist of physical effects, limited technology capabilities, limited team collaboration, learning curve, and decreased process efficiency.

The largest, and perhaps most significant, cluster of codes was related to spatial experiences, and included improved understanding of a design through immersion, improved site orientation and navigation, improved self-expression, and improved sensory experiences. Improved site orientation and navigation and improved understanding of a design through immersion were the two highest codes in the project, these two correspond with 64 of the 198 coded comments, or roughly one third of the total. Improved self-expression also scored relatively highly with 14 coded instances, and an improved sensory experience received the lowest of this cluster with 5 instances. These codes suggest important affordances that VR brings to the design process. The Likert-scales in Table 1 show that VR made students more aware of the three-dimensional character of their designs, improved their ability to visualize their designs, and altered their approach to design. Students understood spatial components of their designs and were able to interact with their designs much better in VR than via traditional methods, and they showed a slight preference for using VR to design a concept. However, students slightly favored traditional methods for collaborating and refining a design.

The spatial benefits of VR are especially beneficial to landscape architects, who benefit from the ability to visually and spatially communicate their ideas. This benefit is clearly visible in several student comments, such as "seeing 3D is quicker to understand," "understanding spatial relationships of the site and architecture was made easier in VR," and "I was able to make better informed decisions." Viewing the site in VR made it easier for students to understand and respond to complex concepts such as landform, as one student describes "understanding topography was easier in VR, and was helpful for laying out paths and trails." Just as digital drafting and modeling software accelerated and made possible more complexity in design, it is possible that VR will eventually lead to similar leaps forward as the tool.

<table>
<thead>
<tr>
<th></th>
<th>Outside VR</th>
<th>Neutral</th>
<th>Inside VR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collaborating on a design</td>
<td></td>
<td>4.7</td>
<td></td>
</tr>
<tr>
<td>Developing a concept</td>
<td></td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Understanding the spatial components of the design</td>
<td>8.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Refining the design</td>
<td>4.9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interacting with your design</td>
<td></td>
<td>8.5</td>
<td></td>
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</tbody>
</table>

Table 2: Rating-scale results.
becomes more refined. Ultimately, VR appears to improve the ability of the designer to understand and interact with their design by immersing them in it, and this provides the designer with the opportunity to engage in a reflective conversation with their own design decisions (Schön, 1984).

Physical effects was mentioned frequently during the start of the project and decreased in the subsequent rounds. A couple students experienced dizziness or felt disorientated in the first round, but that seemed to not be present as the project progressed and they became accustomed to working in VR. One of the six students reported nausea in Round 1 and did not use VR for the remainder of the project, but continued collaborating with those inside VR and suggested design ideas. In the later rounds, the physical effects that were most reported were annoyance factors from using the headset such as hat hair. Learning curve also showed decreasing frequency between rounds 1 and 3. During the focus group in Round 4, students reinforced that there was a learning curve present that they had to overcome, and some expressed that they still were not fully comfortable with it. This suggests that the basics of the technology are intuitive, but advanced usage, as with other skills, can take time and effort to become highly proficient. This might be best illustrated by a student’s comment who stated in the focus group, "I understood the basics quickly, it was just challenging to get comfortable with the controls for designing detailed and precise ideas”.

Decreased process efficiency was mentioned by several students throughout the project. Comments in this category included, “Drawing in 3D took me a little longer,” and “It was hard to get a lot done.” A majority of the comments received that fit this code seemed to be referencing negative impacts of the learning curve to proficiently use the software, and these comments were also coded under learning curve. While there were several comments in this category, there were substantially more comments that gave feedback about how their design process was improved. In total, 4 comments were about decreased process efficiency and 18 talk about an increase in process efficiency. Many of the student’s comments about improved process efficiency expressed thoughts about fast and efficient communication of ideas, and one student commented, “I was quickly able to mock up my ideas and show them to the team”. This suggests an overall increase in the efficiency of the design process through integrating VR once a designer is comfortable with the software.

The positive and limited technology capabilities of VR showed clear results and the limited capabilities outscored the positive capabilities by a score of 19 to 8. Regarding limited capabilities, many students expressed that they wanted the ability to use more precise measurement and design tools. This is a constraint of Tilt Brush which, while useful for basic gestures, left students feeling limited in further refining their concepts because they wanted specific tools regularly found in design software that have not yet been developed for Tilt Brush. Tilt Brush is primarily designed for artists and, while other programs exist that offer more technical tools, they also come with a steeper learning curve and larger price tag, and none of these support the scale of site needed for landscape architectural design. This contributed to why Tilt Brush was chosen for this research. Unfortunately, there is not a VR design program available at this time that provides an interface, toolset, and scaling capacity equivalent to what is commonly available in landscape architecture design software. Such programs may be available in the future.

However, it is possible that students’ comments about being limited by software may be more closely associated with a lack of experience with the software and not knowing the capabilities of what is possible to create. There are many different tools in Tilt Brush that can be used in a variety of ways to closely imitate features of common design software such as SketchUp. There are also many examples built into Tilt Brush that showcase the capabilities of the software, many of which show intricately detailed scenes. However, this requires a greater amount of experience and comfort with both VR and Tilt Brush than the students were able to achieve during this project. Overall this data suggests that there are both positive and limited capabilities of the technology depending on the tasks being performed. In this project the limitations outweighed the capabilities, and more research is needed in order to better understand how these limitations might be overcome and how they affect design outcomes.
Collaboration is another set of codes that had both positive and negative responses, and like the technology capabilities, this set of codes revealed substantially negative results. Limited team collaboration was mentioned much more that positive team collaboration, and students’ responses show that it was a challenge working as a group to make modifications to a design. Student comments described how there were times when they experienced confusion or frustration because those outside VR could not completely understand what the person inside was verbally describing or vice versa. This proved to be a limitation throughout the project and confirms the findings of George, Sleipness, and Quebbeman (2017). The Likert scale responses to the question “My team could collaborate effectively using VR” also showed limitations in this category and the mean response was 3.6 out of 7 (7 being ‘strongly agree’ and 1 being ‘strongly disagree’). Although collaboration was identified as being limited in several ways, the majority of the time that students reference collaboration they are referring to verbal communication, and it is important to note that collaboration can happen in more than one way. This is further highlighted in the related code improved communication of ideas. Responses in this category specifically reference visually sharing ideas and concepts. This code was especially high during the final round and many of the students mentioned that they were able to easily mock-up ideas to share with their peers, and that their teammates were able to quickly see and understand their design intent, which in turn enabled them to get their points across quickly and improved the design conversation. One student commented, “When one of us had a good idea but had a hard time telling others about it or showing it in 2D, they just drew it in VR and the group was able to understand. This seemed like it reduced team compromises because we understood everyone’s ideas and were able to make decisions quicker.”

The word ‘visual’ was brought up many times in this category. This highlights the difference between verbal and visual communication in collaboration. These results suggest that while verbal communication and collaboration is hindered in VR, visual collaboration and communication is greatly improved. The hinderance is likely due to the designer being visually separated from the team and as virtual team environments become more accessible, more research is needed to assess team collaboration in the same VR space. Because of this, a recommended workflow for collaborating in VR would need to include frequent sharing of the VR design space so that the entire team is tapping into the visual communication benefits of VR, which in turn should help to alleviate some of the difficulties with verbal communication.

**Fig. 3:** A student creates a design concept and receives feedback from the team
Overall, considering the identified affordances and limitations, this research suggests that there is a positive outlook for the use of VR as a tool for design creation in small-scale site design applications.

**Fig. 4:** A mixed reality view into what a student is seeing while designing in VR
and the benefits observed validate the efforts used to collect additional materials to facilitate VR design that is not required in traditional methods. While VR is still an emerging technology, the expansion of available software and capabilities has expanded substantially over the last two years, and ongoing investment in the technology will further drive technical innovation. While some software already exists that is tailored towards design professionals, such as IrisVR, it can be expected that in the near future more programs will be developed for specialized fields such as landscape architecture. This will create many opportunities for future research and exploration into improvements that are expected to be, made such as team collaboration.

7 CONCLUSIONS
This study examined the use of VR during the analysis and concept development phases of the design process on a small-scale site design project. Instead of using VR in the late stages of the design process as a tool for design-review, students successfully integrated VR into a workflow that utilized both traditional and VR methods to analyze a site and develop and design a series of concepts. The results yielded that using VR for analysis and concept development on a small-scale project improved students’ understanding of their designs, allowed them to better express their ideas, and make better informed design decisions. However, limitations were also observed, such as difficulties with verbal team collaboration, technology issues, the possibility of adverse physical effects, and a learning curve to proficiently use the software. However, with virtual reality technology rapidly improving and adoption expanding, future research will be needed to quantify the impacts of VR on design decisions and monitor how technological advances impact current limitations, such as team collaboration and the effect of VR on the design process. Overall, this research suggests that VR can be fineffectively incorporated into the analysis and concept development phases of the design process, and while it offers both benefits and limitations, this study concludes that the benefits outweigh the limitations.
8 REFERENCES


George, B. H. (2016). Distributed Site Analysis Utilizing Drones And 360-Degree Video. Digital Landscape Architecture, 1, 92-96.


CELA MEDIA STATEMENT

Title of Paper or Research: HOW VIRTUAL REALITY IMPACTS THE LANDSCAPE ARCHITECTURE DESIGN PROCESS AT THE SITE-SCALE DURING THE PHASES OF ANALYSIS AND CONCEPT DEVELOPMENT.

Authors: Drew Hill, Benjamin George, David Evans

Institution or Professional Affiliation: Utah State University

Authors please select one of the following: I DO X DO NOT want to prepare a media statement for general release from the 2018 CELA Conference.

Media Statement: This research examines the benefits and challenges of incorporating virtual reality into the landscape architecture design process. Virtual reality and traditional design process methods were used together in the analysis and concept development phases of the design process to create an inclusive play environment around a charter school. Data was collected from the six member design team throughout the process, and the results suggest many benefits and a positive outlook for the use of virtual reality as a tool for analysis and design creation in the landscape architecture design process.

Graphic Abstract:
NOTES ON COMMUNITY DESIGN-LED COLLABORATION:
WAIPAHU TRANSIT-ORIENTED DEVELOPMENT

Ho Schar, Cathi
University of Hawai‘i at Manoa School of Architecture. E-mail: cathi@hawaii.edu

1 ABSTRACT
This paper examines a multi-departmental, multi-curricular, and extramural collaboration on the Waipahu Transit-Oriented Development (TOD) Collaboration Proof of Concept (PoC) Study for the State of Hawai‘i Office of Planning (OP). This project mobilized eight faculty members representing intersecting academic units: the Department of Urban and Regional Planning (in the College of Social Sciences); the Center for Public Policy; School of Architecture; and Sea Grant Colleges, through the newly established University of Hawai‘i Community Design Center (UHCDC). The project aims at a new interagency planning and design framework for state-owned lands surrounding Honolulu’s controversial billion dollar rail line. To accomplish this, the UHCDC team sequenced and aligned coursework and contract work to provide community engagement, an ecological hazards assessment, an ecological asset study, a tree canopy study, infrastructure and transportation studies and recommendations, strategic planning sessions, flood mitigation measures, a design futures digital optimization model, block typologies, site development options, and costing studies for the state parcels. This paper assesses the internal and external collaborations involved in this project through metrics that describe costs, benefits, and outcomes to faculty members, students, the state, and community. These metrics provide a basis to reflect on UHCDC’s unique model as a driver for academic, institutional, and community collaboration.

1.1 Keywords
Community design, transit-oriented development, transdisciplinary action research, collaboration
2 INTRODUCTION

A university-based community design center is typically a hybrid practice constituted of academic and professional methodologies applied in service to diverse communities at all scales of built environments. In this respect, CDCs are necessarily cross-disciplinary: they both create and inhabit unique academic space within which its agents—faculty, researchers, students, and consultants—move freely across disciplinary boundaries ordinarily constricted by university departmentalization. Community design centers therefore offer unique space for cross-disciplinary collaboration. The impact of this collaborative model on communities is widely documented, however we tend to pay less attention to the impact of this model on university collaboration. For example, one well-recognized but under-examined consequence of the university tenure system is its concentration of disciplinary identity and resources within units that reward individual specialization. Universities are working to develop criteria for tenure and promotion that recognize cross-disciplinary, collaborative scholarship. This paper offers the University of Hawai’i Community Design Center (UHCDC) as a case study that demonstrates ways CDCs can provide interdisciplinary opportunities that circumnavigate traditional obstacles to collaboration both within and between traditional departments. This case study features a specific project, the Waipahu Transit Oriented Development (TOD) Collaboration for the State of Hawai’i Office of Planning (OP), as it provides opportunities to assess the collaborative model at work in a project aimed at supporting large-scale state collaboration surrounding TOD.

2.1 Honolulu Rail Transit Project

The state created the Honolulu Rail Transit Project in 2005 to provide a transit route connecting the south side of the island of Oahu, comprised of 21 key transit stations accessing significant destinations from Central Oahu’s “second city” to the urban core, shown in Figure 1. The controversial $8.3 billion estimate for the entire 20-mile system, makes the rail the largest public works project in Hawai’i’s history (HART, 2016). Originally financed by the City and County of Honolulu and the Federal Transit Administration, recent overruns led to the state legislature providing $2.4 billion in state funding, bringing all three tiers of governance into the project.

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1 Faculty members on the Waipahu TOD team include: Simon Bussiere, Assistant Professor, School of Architecture (SoA), Priyam Das, Associate Professor, Department of Urban and Regional Planning (DURP), Wendy Meguro, Assistant Professor, SoA, Sea Grant College, Colin Moore, Associate Professor, Center for Public Policy, Hyoung-June Park, Associate Professor, SoA, Cathi Ho Schar, Adjunct Assistant Professor and Director UHCDC, SoA, Daniele Spirandelli, DURP, Sea Grant College.
2.2 Hawai‘i Interagency Council for Transit Oriented Development (TOD Council)

Pursuant to Act 130 Session Laws of Hawai‘i (SLH) in 2016, the Hawai‘i state legislature established the Hawai‘i Interagency Council for Transit Oriented Development (TOD Council), to coordinate statewide TOD planning. As the largest landowner along the 20-mile corridor of the Honolulu Rail Transit Project on Oahu, the state has the potential to capitalize on its properties along the rail, and to work toward revitalizing adjacent neighborhoods, in particular through new affordable housing and improved access to public facilities and services. As part of its role leading the state’s interest in all TOD areas, the council also identifies annual priority Capital Improvement Project (CIP) funding requests for each legislative session.

2.3 State of Hawai‘i Office of Planning

The Office of Planning (OP) heads the TOD Council, which is nested within their purview to provide the state with “central direction and cohesion in the allocation of resources and effectuation of state activities and programs, and to effectively address current and emerging issues and opportunities.” (OP, 2019). To assist in this process, the state legislature appropriated $250,000 in capital improvement project funding to OP, to work with the University of Hawai‘i Community Design Center to produce a proof of concept (PoC) research, planning, and design study aimed at developing a framework for subsequent state-led TOD projects.

2.4 University of Hawai‘i Community Design Center (UHCDC)

The University of Hawai‘i Community Design Center was established in 2016 as a hybrid teaching practice and outreach initiative led by the School of Architecture, to provide a new platform for students, staff, faculty, and partnering professionals to collaborate on interdisciplinary applied research, planning,
and design projects that serve the public interest. The center’s projects offer research-based design and service-learning opportunities for students through academic instruction, internship, and post-graduate employment. This practice model was developed in close collaboration with a state senator, who was chairing the Capital Improvement Project (CIP) committee, which oversees the state’s $500 million CIP budget. This partnership positioned the UH CDC to serve at the intersection of government, university, and community, introducing a novel, top-down model to a conventionally bottom-up model of practice.

2.5 Waipahu

OP selected Waipahu as a pilot site for the study, a town of 40,000, that was originally a plantation town, home to the many ethnic groups that immigrated to the islands for agricultural employment (Waipahu Town Action Plan 17). Approximately 10 acres of state lands are within the ½ mile radius from the Waipahu rail station and bus transit center. These lands are owned by Hawai‘i Public Housing Authority, Department of Accounting and General Services, and Hawai‘i Housing Finance and Development Corporation, with current uses including elderly housing, the Waipahu Library, Waipahu Civic Center, and surface parking. The site was selected because of the manageable area and smaller number of state landowners included within the TOD area, providing a context with less challenges to interagency collaboration.

2.6 Collaboration

Kurt Lewand and his colleagues at the Center for Group Dynamics at MIT coined the term "action research" to describe the process of convening government officials, scholars, and community leaders to translate psychological research principles and findings into practical solutions for wicked problems, like prejudice and conflict nearly 60 years ago. (Stokols, 2006). This integration of academic and applied research gained widespread interest in 1960s and 70s in response to social issues, prompting a critical look at the impact of these collaborations. As Stokols notes, “effective practice of action research—especially the development of evidence based sustainable community interventions—depends heavily on the adoption of community partnering strategies in which researchers, lay citizens, and community leaders work together, often over extended periods, in a highly collaborative and equitable fashion.” (Stokols, 2006)

In 2006, Stokols identified a need for what he called “a science of transdisciplinary action research,” to provide an integrative analysis of cross disciplinary efforts to resolve existing gaps in our understanding of these types of collaboration (Stokols, 2006). In his discussion, he defines distinctions for cross-disciplinary research, describing three different types: multi-, inter-, and transdisciplinarity. Multi-disciplinarity is defined as a process in which researchers from different disciplines work independently or sequentially, within their disciplines to address a shared topic; interdisciplinarity, in contrast, entails increased exchange of information between the researchers across disciplines; transdisciplinarity involves research across disciplines integrating multiple perspectives within a shared framework. The metric for measuring success in transdisciplinary work is the extent to which they promote novel conceptual models and investigations that integrate the concepts, theories, and methods of particular fields (Fuqua, Stokols, Gress, Phillips, & Harvey, 2004; Stokols et al., 2005). Stokols also defines three separate facets of transdisciplinary action research—scientific (academic); community coalitions between researchers and practitioners; and intersectoral collaboration, spanning organizations and agencies. The Waipahu TOD Collaboration project offers experience with all three of these facets in its engagement between academics, community members, and public agencies.

This reflection is positioned at a transitional time in the center’s development. The first generation of collaboration projects near completion, providing lessons learned for the center as it starts its sophomore phase. The Waipahu PoC project offers insights on its multiple forms of curricular and extramural faculty and student collaboration and interagency effectiveness. In this aim, the paper aligns the science or scholarship of transdisciplinary action research, which entails studying the processes and outcomes of team research projects for the purpose of identifying circumstances that facilitate or constrain effective collaboration (Stokols, 2006)
3 METHODS

3.1 Proof of Concept

In partnership with the chair of the State Senate Capital Improvement Project (CIP) Committee, which controls the state’s $500 million CIP budget, UHCDC crafted a Proof of Concept (PoC) scope of work described in the state budget as “stakeholder engagement, applied research, and conceptual planning and design investigation that informs state agencies ahead of project definition, annual budget requests, and procurement of professionals.” These services are preliminary. They typically include (but are not limited to) a set of analyses, design schemes, criteria, and initial costs that assist CIP with project justification and definition. PoC services are typically ahead of—not in lieu of—commercial design services provided by professional consultants. The legislature approved $1.85 M in the 2017 State CIP budget for PoC project allocations to five agencies: Department of Land and Natural Resources, Department of Public Safety, Department of Accounting and General Services, University of Hawai‘i, and Office of Planning, which received $250.000 to fund this Waipahu TOD collaboration.

The prelude to the funding of this project began with invitations to the deans and directors of the University of Hawai‘i at Manoa School of Architecture, the Department of Urban and Regional Planning, and UHCDC to attend the first TOD Council meeting, a large body representing over 25 agencies and interests. The motivation behind this invitation was to see how the university could align its resources in support of the council’s aspirations, largely surrounding the question of how the state might mobilize and address the opportunities and challenges of TOD as a landowner. In response to this inquiry, both departments gathered faculty members with relevant expertise, course assignments, and interest in addressing this question as a team. UHCDC became both convener and platform for a team of eight faculty members:

UHCDC convened the project team prior to the $250K CIP appropriation, which required each faculty member to define scopes of work based on what he or she could integrate into coursework or develop with minor additional funding. This prompted the team to assemble smaller scopes of work that were largely generated or incubated in six different courses. The absence of initial funding helped facilitate this exercise in leveraging, sequencing, and aligning multi-departmental curricula. Participating faculty conceived each of the scopes of work as parts to a whole that would contribute to the development of an overall framework appropriate for all future state-led TOD studies. It is important to note that the scope was defined by the project team primarily based on teaching assignments and available expertise, not by the state Office of Planning. This model fits Stokol’s recommendation that transdisciplinarity should be transepistemological, differentiating between knowledge cultures and traditional disciplines. The UHCDC team was defined by knowledge cultures and/or the teaching/research interests of each professor more so than individual disciplines. Each faculty member in their own way provides unique but complementary and overlapping vantage points.

3.2 Curriculum and extramural coordination

UHCDC structured the project as a sequential, multi-disciplinary collaboration, beginning with studies in Urban and Regional Planning, followed by architecture, landscape architecture, and urban design studies in Architecture, with extramural funding providing opportunities to refine, develop, and synthesize the work produced by all. These various scopes and sequences of work are included in Table 1. The project team met formally once per semester; faculty members who expressly aligned courses and work coordinated more frequently. Courses with scheduled mid-term and final reviews offered natural venues and opportunities to share work, both internally to the project team and externally to stakeholders. The scopes of work produced outside of coursework employed typical client meetings, coordinating with various city, state, and professional organizations. The team presented both the Urban and Regional Planning and Architecture scopes to the TOD Council for feedback, allowing teams direct access to an audience composed of members from almost every major city and state agency related to the built environment, including the governor’s office and select designees representing elected officials.
<table>
<thead>
<tr>
<th>Date</th>
<th>Dept</th>
<th>Faculty</th>
<th>Coursework</th>
<th>Directed Scope</th>
<th>Research Scope</th>
<th>Deliverable Scope</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spring 2017</td>
<td>ARCH</td>
<td>Prof. Simon Bussiere</td>
<td>ARCH Studio Speculative design of transit station</td>
<td>Ecological asset study</td>
<td>Tree canopy study</td>
<td></td>
</tr>
<tr>
<td>Fall 2017</td>
<td>DURP</td>
<td>Prof. Priyam Das</td>
<td>PLAN 678 Site Planning Stakeholder interviews, site visits, planning research to support site selection, program development, site analysis, and conceptual site designs.</td>
<td>Develop report</td>
<td>Planning study</td>
<td></td>
</tr>
<tr>
<td></td>
<td>DURP</td>
<td>Prof. Daniele Spirandelli</td>
<td>PLAN 620 Ecological Hazards Hazards analysis with past, present, and future ecological conditions surrounding the station area.</td>
<td>Develop report</td>
<td>Ecological hazards study</td>
<td></td>
</tr>
<tr>
<td>Spring 2018</td>
<td>DURP</td>
<td>Prof. Priyam Das</td>
<td>PLAN 751 Practicum Development of baseline research from PLAN 678 and 620 to provide a comprehensive planning report. Student-hosted share and learn event with the Waipahu community including important stakeholders and legislators.</td>
<td>Develop report</td>
<td>Planning study Community workshop</td>
<td></td>
</tr>
<tr>
<td></td>
<td>DURP</td>
<td>Prof. Suwan Shen</td>
<td>PLAN 642 Infrastructure Community infrastructure needs survey, stakeholder interviews, build-out land use scenario analysis, and GIS based suitability analysis to estimate the capacity and constraints of existing infrastructure, identify opportunities for multimodal transportation and green infrastructure.</td>
<td>Develop report</td>
<td>Infrastructure and transportation Study</td>
<td></td>
</tr>
<tr>
<td>Summer 2018</td>
<td>DURP</td>
<td>Prof. Wendy Meguro</td>
<td>ARCH 478 Preliminary flood mitigation studies for the transit station area.</td>
<td>Flood Mitigation Measures – criteria and recommendations</td>
<td>Flood mitigation criteria and recommendations</td>
<td></td>
</tr>
<tr>
<td></td>
<td>ARCH</td>
<td>Prof. Colin Moore</td>
<td>Strategic Planning Sessions with each state</td>
<td>Interviews, Recommendations</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
agency to understand the structure of multi-agency collaboration and provide recommendations for best practices.

<table>
<thead>
<tr>
<th>Agency</th>
<th>Prof.</th>
<th>Study Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>CPP</td>
<td>Hyoung-June Park</td>
<td>Design Futures Digital Optimization Study use Urban Network Analysis computational approach to look at reach, gravity, and closeness to investigate walkability, accessibility, desirability for future development.</td>
</tr>
<tr>
<td>Fall 2018 ARCH</td>
<td>Prof. Cathe Ho Schar</td>
<td>Block Study Inventory of existing block typologies and characteristics. Synthesize team deliverables – develop urban design options for the 5 state parcels.</td>
</tr>
</tbody>
</table>

### 3.3 Community engagement

A community workshop hosted in Waipahu provided an opportunity for true inter-disciplinary collaboration, distinct from the sequential or parallel working relationships between faculty and students involved in the other scopes of work. The PLAN 751 practicum class, led by Professor Priyam Das, organized and hosted an evening community workshop event—what we in Hawai‘i call a “talk story”—to gather feedback on course research related to climate change, place-making, affordable housing, transportation, and economic development. They solicited help from architecture students, who in turn developed promotional graphics and interactive tools based on participatory design methodologies. Architecture students devised a Post-it based “Keep it, Toss it, Create it” exercise, a sketching worksheet, and a large 'co-design' site model, finished with chalkboard paint that allowed participants to use colored wood blocks and chalk to represent desired future developments. While the community workshop gathered a diverse group from neighborhoods, the city, and the state government, planning students were disappointed in the absence of young people, which prompted UHDC to reprise their engagement exercises at a Waipahu High School digital technologies class later on in the month. The follow-up also provided students with a chance to critically reflect on the effectiveness of their engagement tools in two very different outreach scenarios. Most importantly the departmental overlap introduced students to the similarities between the two programs.
4 FINDINGS

The Waipahu TOD Collaboration UHCDC staff is currently synthesizing the work of all faculty PIs into a final report, crafting an RFP that can be used for future development projects on any of the Waipahu state parcels. The findings from this process are limited to this vantage point in time and can only describe observations and short-term outcomes from this effort.

As Stokols notes, evaluating the success of collaborative teams must distinguish between process and outcome. The following table compiles information on processes that help measure the effectiveness of the center, based on its mission—teaching, service-learning, research, and service, with costs, benefits, and outcomes listed below in Table 2, Table 3, Table 4, and Table 5.

4.1 Teaching

Table 2. Costs, Benefits, Outcomes for Teaching

<table>
<thead>
<tr>
<th>Costs</th>
<th>Benefits</th>
<th>Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Additional collaboration with other faculty</td>
<td>• Shared knowledge of other departmental programs</td>
<td>• Engagement tools integrated into professional practice</td>
</tr>
<tr>
<td>• Additional coordination with agencies</td>
<td>• Shared syllabi</td>
<td></td>
</tr>
<tr>
<td>• Additional skillsets needed to be taught in order to produce desired results</td>
<td>• Knowledge of how syllabi can provide meaningful services</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Motivated students</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Knowledgeable and invested feedback on student work</td>
<td></td>
</tr>
</tbody>
</table>
• Opportunity to teach community engagement
• Newsworthy coursework

4.2 Learning

Table 3. Costs, Benefits, Outcomes for Student Learning & Professional Development

<table>
<thead>
<tr>
<th>Costs</th>
<th>Benefits</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Additional transportation costs</td>
<td>• Students able to follow a project over multiple semesters</td>
<td>• 65 students enrolled in Waipahu TOD project related courses</td>
</tr>
<tr>
<td>• Additional time commitment outside of class</td>
<td>• Students able to follow a project under different faculty expertise</td>
<td>• Over 2,500 in-class hours</td>
</tr>
<tr>
<td>• Complex problem</td>
<td>• Students able to follow a project under different disciplinary lens</td>
<td>• Over 1500 paid internship hours toward NCARB architectural licensure</td>
</tr>
<tr>
<td></td>
<td>• Students able to address real world complex issues</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Interactions with community</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Interaction with government and multiple stakeholders</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Interaction with faculty and students in other departments</td>
<td></td>
</tr>
</tbody>
</table>

4.3 Research

Table 4. Costs, Benefits, Outcomes for Research

<table>
<thead>
<tr>
<th>Costs</th>
<th>Benefits</th>
<th>outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Large number of collaborators means reduced research funding and</td>
<td>• Funding for faculty</td>
<td>• 2 papers (up to date)</td>
</tr>
<tr>
<td>scope for each individual</td>
<td>• Outcomes based research</td>
<td>• Infrastructure Study</td>
</tr>
<tr>
<td>• Large number of collaborators to coordinate with.</td>
<td>• Applied research opportunity</td>
<td>• Ecological Hazards Study</td>
</tr>
<tr>
<td>• Sequential collaboration means that research partners are not</td>
<td></td>
<td>• Tree Canopy Study</td>
</tr>
<tr>
<td>working at the same time.</td>
<td></td>
<td>• Housing typology study</td>
</tr>
<tr>
<td>• There was no single person providing a continuous thread</td>
<td></td>
<td>• Parking typology study</td>
</tr>
<tr>
<td>between all research and design scopes.</td>
<td></td>
<td>• Housing block typology</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Flood mitigation study</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Digital optimization model</td>
</tr>
</tbody>
</table>

The CIP context for the research studies in this project required the formative “process oriented” nature of design research to also transition to summative, “outcomes based” research. For example, feedback from the TOD Council for the Tree Canopy Study included requests to measure the effects of
tree canopies on temperature and projected reduction in energy use and costs, in addition to increases in property value.

4.4 Service

The costs, benefits, and outcomes from the project with respect to services to OP are indicated in Table 5.

Table 5. Costs, Benefits, and Outcomes for Office of Planning

<table>
<thead>
<tr>
<th>Costs</th>
<th>Benefits</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>$250,000</td>
<td>All-in-one study includes research, planning, and design</td>
<td>Community workshop</td>
</tr>
<tr>
<td>2 years total</td>
<td>Access to research expertise in disciplinary fields of study*</td>
<td>Planning report</td>
</tr>
<tr>
<td>9 months to execute contract</td>
<td>Neutral party working between agencies and with community members*</td>
<td>Infrastructure and Transportation study</td>
</tr>
<tr>
<td>Coordination/project management</td>
<td>Curricular work provided at no cost*</td>
<td>Ecological Asset Study – Tree Canopy Study*</td>
</tr>
<tr>
<td>Proof of concept does not include conventional planning material (Environmental Assessment, Environmental Impact Study, Archaeological Inventory Study, Entitlement due diligence).</td>
<td>Political goodwill working with students*</td>
<td>Flood Mitigation recommendations and Criteria*</td>
</tr>
<tr>
<td></td>
<td>Better prepared students entering the workforce*</td>
<td>Digital Optimization model*</td>
</tr>
</tbody>
</table>

UHCDC work is carefully scoped to provide services that fill-in industry gaps in research, planning, and design, and minimizes overlap with work typically provided by commercial practices. To assess this distinction, the items in Table 5 with an asterisk denote costs, benefits, or outcomes that would not typically be procured by the state or within the capacity of a commercial practice. These items highlight the unique resources that UHCDC offers to the public sector.

4.5 Administration

This novel alignment between UHCDC and the state CIP process introduced a new funding mechanism, contracting process, and account protocols, which required steep learning curves that imposed hardships on collaborators. All CIP-appropriated funds require the governor’s approval and release. Additionally, the first-time agreements required approvals by two state attorney generals, took nearly nine months longer than originally expected. Faculty members who committed to the project taught their courses as originally planned but had to seek loans to cover funding for teaching assistants, materials, and supplies. Faculty collaborators noted that this mis-synchronization of academic and legislative timetables would rule out similar collaborations in the future.

5 CONCLUSION

In many fields, cross-disciplinary collaboration is encouraged by public funding agencies (e.g. NIH, NSF) and private foundations (e.g. MacArthur, Robert Wood Johnson). This paper offers community design centers as an additional catalyst for cross-disciplinary alliances. UHCDC has adopted a platform model that provides an infrastructure for cross-disciplinary collaboration similar to the growing number of
programs adopting the EPIC-framework, which provides a model for university-wide curricular collaboration on city projects; and the SUNY University Center for Community Design Research, which produced a Community Assistance Directory compiling all community service-oriented entities in the university.

While community design is not new, this public sector proof of concept model offers new scenarios. While community design has traditionally attracted faculty members who identify with collaboration and service as distinct from those who prefer individual, autonomous, design speculation, the PoC model allows for both. In its alignment with the state legislature and state agencies, UH CDC offers faculty members new collaborative opportunities with levels of significance and funding that support academic productivity, tenure, and promotion. This win-win scenario is critical to continued faculty collaboration. Only through faculty members can the center connect projects to curricula and problems to the research expertise available within the university.

The Waipahu TOD Collaboration project also demonstrates that there are costs and challenges to collaboration both internally and externally that require continuous adjustment. Administrative burdens need to be streamlined to allow for repeated collaboration. UH CDC needs its own framework for large faculty collaborations that lays out a road map, schedule, coordination, and accountability protocols. Faculty members tended to work at the core of their disciplines, largely due to the fact that their work was defined by coursework or their own expertise. The students and staff who worked with or between multiple faculty members moved closer to and across the boundaries between disciplines. If success is measured by novelty and innovation that occurs from the intersection of disciplines, as previously mentioned, UH CDC project teams would benefit from paying greater attention to these boundaries, allocating more time to that space.

In spite of the challenges and lessons learned, extramural funding for research remains highly competitive. Community Design Centers have the capacity to access design service fees as distinct from research funding, and in doing so, bring opportunities, funding, staff, and recognition to the academic programs represent. In two years, UH CDC has engaged approximately 20 faculty members across 6 departments and executed over $2M in contracts with public agencies. Building on a 50-plus year tradition of university-based community design, UH CDC creates unique space for academic collaboration; unique agency for institutional collaboration, and unique resources for community collaboration. The traditional academic structure of most universities—departmental autonomy, the tenure system, disciplinary silos—can inhibit the potential for authentic hybridity, whereas the community design center model offers space.

6 REFERENCES


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Please consider include in this space a research summery in 100 words or less that would best describe your topic, its principal results and/or impacts, written in clear language that would be of interest to public media outlets. In addition to the research summary, you may provide an optional graphic abstract that further explains the topic.

TITLE OF PAPER OR RESEARCH: Notes on Community Design-led Collaboration: Waipahu Transit Oriented Development

AUTHOR: Cathi Ho Schar

INSTITUTION OR PROFESSIONAL AFFILIATION: University of Hawai‘i at Manoa School of Architecture

AUTHORS PLEASE SELECT ONE OF THE FOLLOWING: I DO_____ DO NOT_ X___ want to prepare a media statement for general release from the 2018 CELA Conference. (If you choose DO NOT, you do not need to prepare a media statement).

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(OPTIONAL) GRAPHIC ABSTRACT: please insert the illustration below.
Authors: please seek copyright permission if copyrighted materials are used.
DIGITAL GRADING EDUCATION AS AN ACCESS ROAD TO BIM IN LANDSCAPE ARCHITECTURE

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1 ABSTRACT
The teaching of BIM will be a major topic in landscape architecture “Design Implementation” in the next years as the building and construction industry worldwide transitions fully to the digital. This paper explains an approach to teaching Building Information Modeling (BIM) in Landscape Architecture and how digital grading and its application play a major role in a BIM site design project. Digital grading is the access road to BIM. Landscape architecture education must include the BIM modelling method, and process in its teaching.

1.1 Keywords
Terrain Grading, Digital Terrain Model, landscapingSMART, Building Information Modeling (BIM).
Figure 1. The landscapingSMART process with the DTM data model in the center.
DIGITAL GRADING AND BIM

'Simply put, grading is design', (Storm 2009: 1). Therefore, grading plays a key role in landscape architecture. Every intervention designed by a landscape architect involves some modification of the earth's surface, although intense grading is not necessarily part of each project. As Storm states, 'The shaping of the earth's surface is one of the primary functions of site planners and landscape architects' (2009: VII).

Building Information Modeling (BIM) was originally developed for complex architectural projects. It is also important to keep in mind, BIM is a method and a process not just a software. The three levels of tasks within the BIM process are BIM construction, BIM coordination and BIM management. The main idea of BIM for Infrastructure, similar to that of BIM for Architecture, is the use of one complete data model by the different project partners. Partners which may include civil, structural and environmental engineers, planners, landscape architects, building contractors and government or city agencies. All planners and engineers use only one model and therefore can detect conflicts during the planning phase instead of on site during construction. BIM for infrastructure is not yet as clearly defined as BIM for Architecture, with infrastructure projects tending to be more diverse and spread over larger geographical areas. On the other hand, the infrastructure industry has been using Little BIM for quite a while. The term little is used when only one discipline is using the data, as is the case with GNSS earth works.

Today the majority of medium to large sized construction companies in Switzerland are using Global Navigation Satellite Systems (GNSS) technology. Combined with digital terrain models for earthwork projects, precision is increased, and costs are reduced. landscapingSMART (Petschek 2014: 179 - 211) describes the Little BIM workflow starting with data generation and the modelling to preparation of data for a GNSS machine-controlled earthwork construction site. It does not cover BIM topics like data structure and work organization, which are BIM coordination and management tasks. landscapingSMART emphasizes the following:

- In order to build a Digital Terrain Model (DTM) for GNSS controlled machines precise data of the existing conditions are necessary. It is better to hire a surveyor to acquire the data, as it is not the job of landscape architects.
- The DTM is the central element in landscapingSMART. The DTM for a proposed site enables a correct, efficient and precise surface and subsurface design. The knowledge to model a detailed DTM is an important skill for landscape architects.
- Analog terrain models are also very important tools in landscape architecture. While hand-built models will always play an important role in grading design studies, eventually they must be transferred to digital terrain models. Photogrammetric software facilitates this transfer. Landscape architects must be familiar with the concept of photogrammetry and able to apply the software.
- Excavators and dozers with Global Navigation Satellite Systems (GNSS) based 3D machine control (guidance) systems need the DTM data for shaping the proposed site. The machines guarantee high precision surfaces. Contractors are responsible for this task, but Landscape Architects need a basic understanding in order to create a correct DTM.

Not only does landscapingSMART improve the efficiency of the construction process, but Little BIM is part of the overall BIM for Infrastructure.
3 DIGITAL GRADING EDUCATION AT HSR HOCHSCHULE FÜR TECHNIK RAPPERSWIL

Grading is more important in the site engineering education at HSR compared to other schools in Europe, for example Germany. The curriculum for analogue grading is very similar to schools in the U.S. and Canada, where rigorous training is required in design using contour lines, spot elevations, profiles, volume calculations, subsurface drainage, etc. In an e-mail by Prof. Bruce Sharky on the topic of history of grading education in the USA he states that, ‘I do know that probably all landscape architecture programs in the USA have included these subjects in their curricula since WWII and perhaps even much earlier’. A whole array of books published in the USA on grading, for example Grade Easy (Untermann 1973), also show the importance of the topic.

Over the years, “most computational and drafting tasks associated with site engineering have become completely automated” (Storm 2009: VIII). At HSR grading is first taught using analogue methods and then followed by digital methods. With a solid background in manipulating contour lines by hand and dimensioning catch basin/manhole/pipe in the first semester (combined with a good understanding of surveying equipment during their practical year or apprenticeship), HSR students are then exposed almost exclusively to digital grading in their second semester. The digital grading course includes the following aspects:

- Import of survey and GIS data
One reason for the emphasis on digital grading is advancement in the construction industry, the second reason is simply that it is easier for students to use. How can we prove that students are better at solving grading problems using digital tools? A couple of years ago, an experiment using a comparative approach demonstrated the advantages of digital tools. HSR students had to take two exams in which they had to solve a typical grading problem. The first exam required calculating and drafting the placement of a tennis court in the traditional, analogue, hand-calculated and hand-drawn method. In the second exam, the students used Civil 3D. The findings were clear, more students solved the task with digital grading than with analogue. The results were presented at the 2009 Council of Educators in Landscape Architecture conference (CELA 2009). Today more intuitive software would likely show that results tend to be even more in favor of digital grading.
DIGITAL GRADING AS PART OF A SITE DESIGN PROJECT TO BECOME BIM IN LANDSCAPE ARCHITECTURE PROJECT

Since the 2018 fall Semester, Revit, a BIM for Architecture software, has been integrated into the first semester CAD teaching as well as in the site design project. In the first semester course, students must model a small architecture project, for example a bus stop, rain shelter, or pavilion. The site design project in the second semester is the core of the site engineering education in the first year and is very important for understanding digital grading. Here students must apply their knowledge of grading in a project. They must define and grade into a landscape the location of a building, drop off area, access road, parking spaces, terraces, and paths. GIS data is the basis for the existing site (aerial photo and asci grid terrain). The students also model a staircase leading on top of a hill (excavation material of the building, access road and parking) with Revit. In the fifth Semester the site design project from the second Semester is refined. Students are required to combine a Revit architecture model and the Civil 3D civil engineering model into one BIM model. The architecture model includes a large terrace covering a parking garage, which is a typical structure in urban Switzerland. This area is constructed using combined Revit and Civil 3D and leads to a BIM construction model for checking possible conflicts (catch basin depth, crossing pipes, grade changes, location of tree root balls etc.). The BIM Revit model, with the integrated Civil 3D data, is the information hub for further calculations, simulations, etc.

The results of the first HSR fifth semester work submitted at the beginning of November 2018 are very promising. A survey was taken by the students and the evaluations indicate a high level of satisfaction. Interviews with students show the same results. The above BIM construction workflow (Civil 3D / Revit) was also tested in several continuing education courses at HSR for Swiss Landscape Architecture offices in spring and summer 2018. In China at SouthEast University in Nanjing the workflow was used in the Advanced Landscape Technology course as part of the SEU Landscape Architecture Master program first time in June 2018, while at Tsinghua University in Beijing it was tested as part of a "Teaching for Teachers" workshop in November 2018. Thus, the approach is valid and reliable.

Besides traditional engineering courses on materials, surveying, geotechnics, and construction techniques, grading is the most important topic in the site engineering education at HSR. Digital grading as part of the landscapingSMART process leads to a BIM construction model and is the access road to BIM in Landscape Architecture.

Figure 4. A combined Civil 3D and Revit model of the HSR 5th. semester site design project.
Figure 5. The Revit model with Civil 3D surfaces (nature stone, bedding, foundation, etc.) on the terrace in the BIM Revit Information Hub. The simple looking trees provide important weight information for the structural engineer.

5 REFERENCES


TRANSITION FROM PRIVATE GARDENS TO PUBLIC SPACE
Applying water management methods of Persian gardens to urban areas

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ABSTRACT:

The urgent need driven by urban development to provide a secure water supply is a challenging task for governments and service suppliers globally (Ahuja 2016). Governments and professionals are exploring innovative water management approaches, which lead them to improve traditional techniques and reconcile these with the changing environments of our rapidly growing cities (Romero et al. 2017). As water scarcity gives rise to growing global socio-ecological impacts, there are lessons to be learned by reviving traditional water management systems in urban spaces (Sharma et al. 2018). Approaches developed for a specific environment, can often translate to successful ideas in other locations such as the United States, Australia, and other arid countries as global warming advances. Thus, the main aim of this research is to improve understanding of the role of traditional and local urban and landscape design in rainwater management and re-conceptualising them in the context of contemporary public space in arid and semi-arid cities.

Case study analysis has been used in urban and landscape design disciplines to link practice and theory (Francis 2001; Steiner 2014). By a combination of scientific and ‘grey’ literature review and site visits (for ongoing research), this paper explores and defines strategies to apply water management methods of Persian gardens to urban areas. Two projects have been used to validate the strategies. These case studies were selected based on their particular water management strategies, availability of literature, and climate characteristics.

Most of Iran falls into the semi-arid or desert climate zones (Dinpashoh et al. 2004). Consequently, Iranians have always applied innovative techniques to realise opportunities for conservation and responsible utilisation of water (Abbaspour et al. 2009). The Persian garden is one of the most important elements in Iranian agriculture and landscape (Manuel et al. 2018). In these gardens, implementing various techniques to collect, distribute, and retain water, has led to water use in various forms such as qanats, diverse types of streams and techniques to collect and evaporate water that creates a unique microclimate and provides comfort to occupants (Yannopoulos et al. 2015; Fekete and Haidari 2015). Thus, this paper outlines a basis for water management at the urban landscape planning scale, derived from traditional water management in Persian gardens, that could improve water management infrastructure and provide ecological and social benefits for semi-arid region communities. It is important to note that this research has focused on urban and landscape design in the context of its environmental performance and does not address the governance or policy aspects, which are yet to be researched.

Key words: water management, water scarcity, semi-arid regions, traditional infrastructure, Persian gardens
INTRODUCTION

With population growth expected to double by 2050 (UN 2017), urban areas around the world are facing the tremendous effects of climate change and impending water crises. Urbanisation, combined with climate change, has a negative impact on groundwater recharge, water supplies, the qualitative and quantitative state of receiving rivers, and urban climate. Clearly, there is a need for more effective solutions for managing urban water while improving cities’ liveability and urban ecosystems (Howe and Mitchell 2011).

Creative approaches to stormwater management and climate change adaptation may be applicable to diverse communities whether with expansive open spaces and limited capital resources or in dense urban areas, depending on the type of initiative. Moreover, innovative design, although developed in a specific environment, can often translate to successful ideas in other climates and geographies (Qiao et al. 2018).

Research on the history of water management in the literature has shown that local and traditional experience and measures that have been taken over the ages can provide inspiration to face future challenges in urban water management (Lofrano and Brown 2010). In some areas, people have tried to adapt to the climate condition of the area they live in. For example, in South Australia as the driest state in the driest inhabited continent, the Indigenous inhabitants were able to survive and thrive under changing climatic conditions (wetter becoming drier) over thousands of years (Kernich 2001). In contrast, early colonial settlement of South Australia required ingenuity and innovative design interventions to enable people unfamiliar with such arid conditions to survive and thrive. A number of early settlements were abandoned as a result; others succeeded. Those that succeeded demonstrate a range of interesting design solutions around water management, and these solutions now represent part of the cultural heritage of South Australia (Kernich 2001). This process of transitioning local and traditional techniques to the contemporary era can be found in other parts of the world.

Iran is a country with a long history of water management strategies. Living on the Iranian plateau means struggling to conserve and preserve water due to geographic and climate conditions. Iran is a combination of mountains and deserts with hot and dry weather in the summer season, cold and dry weather in winter, and low precipitation (5–25 cm a year) (Voss et al. 2013). This affects people’s lifestyles and has required them to use innovative, creative and effective methods to preserve water. The Persian garden, a culturally unique garden design style that responded to the climatic conditions, has played an important role in the history of water management in Iran. These gardens contain practical solutions to help adapt to the extreme climate conditions, especially in the central parts of Iran (Fadaie and Mofidi Shemirani 2014).

Design of the Persian gardens is the result of applying methods derived from different fields of knowledge: water management and engineering, architecture, botany and agriculture (Meskell 2013). As well as gardens, many historical cities in Iran have applied solutions to manage the water in cities and use it for aesthetic, environmental and functional purposes. These solutions have been modified from site specific water management strategies in private gardens and scaled-up to be applied to cities’ public places (Bakhshi 2014). These traditional methods of water management may provide lessons for contemporary urban design in similar climate conditions. Thus, in this paper, water management in public urban space is considered through examining a combination of traditional approaches in Persian gardens with new strategies to control urban stormwater and wastewater treatment, deliver this essential resource for life in in cities.

Water management in Persian gardens

Persian gardens are adaptable to different climatic conditions using the idea of “Chahar Bagh” (four gardens). The origins of this concept extend back to the times of Cyrus the Great, 6th century BCE. Chahar Bagh divides the garden into four parts and water, as an important element for irrigation and aesthetic enjoyment, passes through all the parts (Fekete and Haidari 2015). These gardens are usually set in contrast with their surrounding environment achieved by innovative engineering solutions, water management system and “qanat” as the main source of water. By different structures and techniques such as basins, streams, creeks, and fountains, these gardens provide mental and physical comfort and at the same time, provide water for irrigation (Fekete and Haidari 2015, p. 82).

Donald Wilber in “Persian Gardens and Garden Pavilions” mentioned that Persian gardens are considered as Paradise because of their rich water management system and planting pattern in an environment characterized by extremely hot weather and arid deserts in Iran (Wilber 1994).
Whenever there was a difficult condition to reach water, “qanats” were used to have access to water. In this technology, a number of tunnels are excavated to transfer water from source to arid plains and gardens (Mousavi et al. 2011). There are also some vertical shafts that provide access to the tunnel and are also used for ventilation. This solution is effective in terms of low evaporation rates during water transportation. Further, it is also cost effective as gravity is the main power to transfer water and there is no need of any other energy. In addition, there is a low level of depletion to the water and the environment as in this system, the risk of soil erosion and reduction of the aquifer’s capacity is not noticeable (Yannopoulos et al. 2015). The maintained qanats reveal the sustainability of the system based on nature, that can be considered in the present water management strategies (figure 1).

Figure 1.(Left). Aerial view of a qanat passing underground, Yazd, Iran, (source: Fekete and Heidari, 2015), (Right). Section of qanat system, (source: www.Irandoostan.com)

The major aspect of water in Persian gardens is irrigation which is easier to achieve by dividing the garden into main parts in the shape of a square or rectangle, and each part has its own division that conducts water based on the slope. This helps water to flow between parts and irrigate plants. By this process, the amount of wasted water would be very low (Haghshenas 2014).

In addition to the main division of the gardens, there are some elements that are added to make use of water and provide comfort and add beauty (table 1):

- **Jets and fountains**: These fountains work with natural water pressure. In some of them the water is sprayed to make the air cooler while the least amount of water is used for cooling.
- **Pools**: These elements are used to reserve water for watering plants. Around the pools, there are gutters to collect the waste water and reuse it in the garden.
- **Channels**: These elements are the most important elements for garden’s arrangement and irrigation that are usually made of local materials.
- **Waterfalls and vertical water surfaces**: Based on the slope of the ground, some gardens contain vertical surfaces of water. These walls provide a condition that water can be seen, and also make the air cooler (Wilson 1976).

To clarify what has been said, following is an example of a Persian garden - Shahzadeh Mahan, Kerman - located in the arid area which illustrates water management as the most important aspect of its sustainability:

**Persian garden: Shahzadeh Mahan, Kerman**

Shahzadeh Garden is a historical Persian garden, which is located in 24 km southeast of Kerman, near the small city of Mahan. The way water is used in this rectangular shaped garden, that is separated by walls around it, contrasting with the surrounding dry and hot environment. Waterflow in the garden is based on the slope that shapes the appearance of the garden. The garden, with its surrounding desert area, is widely regarded as a fine example of a Persian garden that responds to the existing climate conditions (Tajaddini 2011).

**Table 1.** Functional aspect of water features in the Persian gardens, (source: author, Images’ source: Fekete and Haidari 2015)
As with many Persian gardens, water is the most important factor in the sustainability of this garden. The source of water originates from mountains, then is transferred to the garden by qanat system, which effectively changes the microclimate of the garden. The main stream flows into the garden from the highest level and constitutes the garden’s designed irrigation system. Exposure to the body of water in the garden decreases temperature and increases humidity. Mist created by the water fountain produces an evaporative cooling effect, decreases air temperature and leads to an increased comfort level (figure 2). The pools in the garden are sources of water especially in the hot seasons (Tajaddini 2011).

Thus, waterflow is an important factor in the structure of Persian gardens. Division of the garden, main streams, construction based on the slope and topography shape the garden. Beside these factors, the water consumption relates to the selection of plants (Porter and Thévenart 2003). In Persian gardens plants were selected according to the climate condition. Thus, all plants were native plants that needed less water and provided greenery and comfort in the gardens. The use of water in this pattern and elements of Persian gardens makes them unique places in the extreme weather and is the main factor of their sustainability in arid regions (Manuel et al. 2018).

<table>
<thead>
<tr>
<th>Water feature</th>
<th>Functional aspect</th>
<th>Photo</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jet/Fountain</td>
<td>Cooling air</td>
<td></td>
</tr>
<tr>
<td>Pool/Basin</td>
<td>Water reservoir</td>
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<tr>
<td>Channel/Creek</td>
<td>Irrigation and water transfer</td>
<td></td>
</tr>
<tr>
<td>Cascade/Waterfall</td>
<td>Flowing water</td>
<td></td>
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</tbody>
</table>

Figure 2 (Left). View from the Shahzadeh garden, Kerman. The area around is completely dry. (Right). Plan and section of Shahzadeh garden, Kerman (source: Haghshenas 2014)
Transition from private gardens to public space
In 11th century, private gardens were opened to the public that led to define a strong relationship between nature and cities. In 16th century, the prescribed pattern for designing a Persian garden was translated and scaled up into the urban form to create a “garden city”. For example, in Isfahan, the pattern of Chahar Bagh was integrated into the main access road entering the city, with the water course located in the middle, double rows of planetrees (*Platanus*) and poplars (*Populus*) and two pathways facing this avenue. This pattern spread fast in the cities, however, based on the climatic condition, access to water, and distance to the source of water, the techniques for irrigation and having access to water were different (Wilber 1994).

**DESIGN FOR WATER**
Although, case study analysis method does not always contain accurate scientific results and to some extent is more suitable for examining hypothesis, rather than providing new ones (Felson and Pickett 2005; Steiner 2014), urban and landscape design disciplines take advantage of case study analysis to assess the innovative theories into practice and also generate new assumptions (Palazzo 2018; Steiner 2014; Francis 2001; Felson and Pickett 2005). Thus, in this study, scientific and grey literature, documents and examples have been utilized to specify water management features in Persian gardens, and by study of case study examples, these features are defined.

In this research, water management strategies in Persian gardens are presented in the context of two main cities in Iran: Shiraz and Isfahan. In these two cities, the concept of the Persian garden has informed the design and development of each city based on its climate, geography and water resources. This transformation approach can be considered for urban water management in the present and future especially for similar condition such as USA, Australia with arid and semi-arid cities. These case studies are examined against the strategies which emerged in the theory of water management in Persian gardens (Table 2). These projects display best practices and best response to the traditional water management strategies.

**Table 2.** Summary of water management strategies in Persian gardens that are transferred into cities, (source: author)

<table>
<thead>
<tr>
<th>Water management strategy</th>
<th>Description</th>
<th>Transferring to the city scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water irrigation</td>
<td>- Use of creeks</td>
<td></td>
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<tr>
<td></td>
<td>- Division in rectangular or round shapes</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Qanat system based on natural gravity</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Design based on the natural slope</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Use of native plants</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Madies</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- water courses across the city</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Planting in the channels</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Irrigation based on the site’s topography and natural slope</td>
<td></td>
</tr>
<tr>
<td>Water conservation and storage</td>
<td>- Pools as the main source</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Channels</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Planting placement based on their need for water</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Channels as the main source</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Xeriscaping</td>
<td></td>
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<tr>
<td>Water purification</td>
<td>- Use of plants’ roots</td>
<td></td>
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<tr>
<td></td>
<td>- Use of gutters to take particles</td>
<td></td>
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<tr>
<td></td>
<td>- Constant flow of water</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Use of specific native plants to clean water</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Use of native plants</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Use of gutters and impermeable pavements</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Combination of chemicals and plants</td>
<td></td>
</tr>
<tr>
<td>Water for air cooling</td>
<td>- Waterfalls and vertical water surfaces</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Fountains use a minimum amount of water to cool the air with misting</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Flow of water in streams</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Use of water in design in different shapes</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Fountains</td>
<td></td>
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</tbody>
</table>

**Shiraz; arid city with gardens**
The city of Shiraz is located in the south Zagros Mountains in a dry and semi-arid region of Iran. Because of low latitude and extremely hot summers, the average of rainfall is low. Shiraz is well-known for its green gardens that owe their greenness to an optimum use of limited water resources
Shiraz is an example of a city expanded on the base of water. What makes this city different from other cities like Isfahan and Ahwaz—that are shaped based on the structure of a permanent river—is its access to the water flows of qanats that skillfully direct water to Shiraz from long distances, enabling the growth of lush green and abundant gardens (Mousavi et al. 2011, p. 5).

Different techniques were used in different parts of water way to reach and irrigate the city. Siphon (Shotorgaloo) is a water supply that Iranians have used in different cities. It is made of a U-shaped pipe that works based on the water pressure. The water level is the same in both sides of the pipes. When water enters the entry pipe, it pours out from the other side (Mousavi et al. 2011, p. 13) (figure 3). Water storages were considered as reservoirs. Each stream irrigates one part of the city by qanats. Some of these reservoirs have been converted to dams in recent years, which is a modern technique for water conservation and distribution. These reservoirs, wells and qanats shaped the city’s infrastructure systems, managed the water, and add aesthetic and environmental values to the city (Mousavi et al. 2011, p. 13). Once the water reaches the garden, a smaller scale of this irrigation system was applied. One of the main gardens of Shiraz that is well-known for its irrigation system is Eram garden which displays the classic pattern of a Persian garden and is irrigated by one of the main streams called the Miri (Sarvestani et al. 2011).

**Figure 3.** Plan(above) and section (below) of qanat system, (source: Mousavi et al., 2011)

**Isfahan; Chahar Bagh**

Isfahan city is the capital of Isfahan province (32°38’ N, 51°38’ E) located in the lush plain of the Zayandehrud River, at the foothills of the Zagros mountain range. The Zayandehrud River divides Isfahan city into north and south parts. Altitude ranges from 1550m around Zayandehrud River to 2232m in the Sofeh Mountains. According to the Isfahan synoptic station, this city has a semi-arid warm climate (Köppen classification BSk). In Isfahan, there is virtually no rainfall during the year. The average temperature is 15.6 °C and the average annual rainfall is just 125 mm (Modarres and Dehkordi 2005).
The Zayandeh Rud River used to have significant flow all year long, unlike many of Iran's rivers which are seasonal. The existence of Zayandeh Rud in Isfahan is honored as a blessing and one of the most systematic and permanent traditional methods of water conveyance from that river to the nearby farms and gardens is applied and it is called Madi (stream) (Chardin et al. 1811). Originally, Madies were created to irrigate the farmlands surrounding the river in the plain of Isfahan since the Safavids period (Hobhouse 2004). Today their role is completely changed due to the drying up of Zayandeh Rud River and to the expansion of the city with the related land use changes from agricultural into different urban land uses.

The Madi project in Isfahan is a creative one that goes beyond site specific scale and works on the scale of a city or a large region and appears in the form of creation of a special urban element (figure 5). Madies are historical, cultural, and environmental sources. The role of Zayanderud River and the streams (Madies) in Isfahan are very important in terms of agriculture, collecting surface water, and city development (Bakhshi 2014). Madies were wide streams across the city that carried water in the past. However, by the expansion of the city, the main function of Madies is lost. Thus, nowadays, these elements are considered as greenways in the city bringing liveability to the public areas and conserving the urban's ecosystems with planting areas and water flows (Karimi and Motamed 2003).
Although, the role of Madies in the city is not limited to water conservation, other roles of Madies also have emphasized the importance of water in the city. Some of them are as follows (Karimi and Motamed 2003; Fadaie and Mofidi 2014):

- **Madies and urban air purification**: These canals have changed the appearance of the city by adding green space to neighborhoods. Trees and other plants in these paths are the source of increasing the quality of urban climate and air purification. Besides, as water flows in some of Madies, water and plants cause a cool microclimate across the city.

- **Madies and Identity of the city**: These elements are different compared to the other urban elements in the city. In addition, because of the pleasant environment around Madies, they invite people into these open spaces. In this way, public memories and sense of belonging may be shaped by Madies.

- **Madies and forming the structure of the city**: These elements are axes to shape the main activities in the city and also affect the design of public buildings and public places. The main structure of Isfahan is shaped based on green and blue infrastructure: 1) The main street (Chahar Bagh) which is based on a linear geometric form and, 2) the Madies as organic structures that shape the layout of the alleys and main streets.

**CONCLUSION**

Much research emphasises the presence of urban green space and increasing the quality of urban landscape. In this regard, research indicates that the presence of natural resources (e.g., urban parks, water courses, gardens) and components (e.g., trees and water) in urban contexts contributes to residents’ well-being and quality of life in many ways (Carrus et al. 2015; Panagopoulos et al. 2016). Although in this paper, ‘triple bottom line’ sustainability is not an explicit focus, it should be mentioned that in cities such as Isfahan with a history of water management, these specific natural elements (Madies) play an important role in the sustainability of the city in all aspects which can be considered in similar climate conditions that also should be applied based on each area’s culture, economy and policy.

Water is one of the most important factors supporting human and ecological life in cities. The increasing demand for water that will result from increasing population growth, as along with decreasing water resources resulting from climate change, will continue to be serious challenges for nations. Although there are efforts to control and conserve water resources such as improving green areas and irrigation system; providing a sustainable water management system; and controlling floods, the potential for water crisis is still a global major issue (Sharma et al. 2018; Palazzo 2018).

It has been proved that over many years, local and traditional water management techniques have had a significant impact on the sustainability of urban areas. However, many of these techniques are in danger of being in the face of large-scale infrastructure construction to support urbanisation (Kernich 2001). On the other hand, relying on traditional and vernacular water management techniques which are, by comparison small scale and more site specific, cannot be considered as the only system to manage urban water. Identification and integration of traditional science and knowledge with modern technology would be an effective and efficient way for sustainable urban areas. National and international research organizations need to allocate higher priority to the study and investigation of traditional strategies and try to link them in an applicable way to the water system of modern cities. (Tahmasebi 2009; Palazzo 2018).

Historically, Iranians have been pioneers in controlling, conserving and reusing water through different sustainable strategies. There is much to be learned from these traditional methods and they should be considered today as we urgently seek innovative methods for water management that address the challenges of continued urban development. The sustainable water strategies in Persian garden design, presented in this paper, offer the landscape architecture profession alternative approaches to addressing ways of integrating water management in contemporary urban landscapes (Fadaie and Mofidi Shemirani 2014). As it is mentioned before, this research focused on urban and landscape design in the context of their environmental performance and the governance or policy aspects were outside the scope of this paper. However, to reach the sustainable urban water management, other factors will be considered in the future research. In addition, providing a link
between traditional and modern water management strategies in urban landscape implementation has always been a challenging task for professionals and academics, which will be expanded in the future research.

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Spatial Trialectics: A new thinking mode, and the production logic of landscape space

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1 ABSTRACT
This paper intends to explore the concept and the logic of spatial trialectics, then apply it to analysis the landscape space which can lead to a deeper understanding of the landscape space production phenomenon including its process and internal reasons within the urbanization. Compared with dualistic, trialectics are more dynamic and diversified that can be employed to interpret the complex phenomenon resulted by the modern production relations.

With the development of the production forces, social relation that created by relations of production had been more complicated than before. Employing dualism in analyzing the social phenomenon that represented by space is not sufficient. Henri Lefebvre invented the concept of the production of space and use spatial trialectics to interpret space phenomenon. Landscape space, the representation of the relationship between human and nature, is decided by production forces and relations of production. Sometimes, the only thing we know is that landscape space is always producing in all kinds of terms, but why they been produced, what are the meanings behind of them, and who are the occupants of the landscape space actually are unclear.

The concept of the production of space and the space trialectics were explained in terms of literature review referring to Henri Lefebvre, Edward Sojia and Karl Marx, etc. Deducting the internal dynamic mechanism of the space trialectics enable people to think about the space phenomenon depended on spatial-temporal relation. Then space trialectics were employed to deconstruct the production of landscape space into three aspects. Finally, three cases were selected to study the three aspects respectively.

The production of landscape space involves landscape spatial practice, representations of landscape space and landscape spatial representation. And each one aspect involves other two aspects, furthermore, those three aspects, the relations, and influence of each other need to be thought at the same time.

By employing the new thinking mode and spatial trialectics of landscape, for landscape space users, they can know what is happening behind the landscape phenomenon and strive to make them be landscape space occupants rather than just beholders. For the governments, by producing landscape space they can renew urban space with the strategy of landscape spatial practice, strengthen the awareness the ecology with the strategy of representation of landscape space then stimulate the regeneration and cultivate the vitality of the city by the strategy of landscape spatial representation.

1.1 Keywords
Trialectics, Production logic, Landscape spatial practice, Representation of landscape space, Representational landscape space

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2 INTRODUCTION

Everything is the product of productivity and social relationship and the expression of the relationship between man and nature in a specific temporal-spatial relationship. Iterations of different time-space relationships, ‘All that is solid melts into Air’ [1], and landscape (landscape) 1 [2] is also.

Change is the only constant theme [3]. When the poverty of duality has failed to explain the increasingly complex and differentiated social phenomena, great Western philosophers such as Bertrand Russell, Alfred North Whitehead, and Ludwig Wittgenstein have announced Western traditional philosophy has come to an end [4-6]. When uncertainty becomes the most certain thing in the moment, we need employ a logical framework to understand the relationship between the various parts when thinking about objects, rather than to study a single object in a split way. As Engels said, we pay more attention to movement, transformation and connection, rather than specific objects. Because a particular object is the reflection and result of a certain period of temporal-spatial relationship, it is necessary to study logic among those things, not the logic of each thing[6].

In the Landscape Architecture discipline, there are various kinds of theories and doctrines. Only through logical deconstruction can we clearly understand. As a kind of understanding and application of the inner logic of Marxism, the new Marxist urban theory has applied more and more attention to the methods of using Marxist theory and logic to explain urban problems. Scholars such as Henri Lefebvre, David Harvey have made some achievements in the new Marxist urban theory. In recent years, new Marxist urban theory has been employed to interpret landscape phenomena and internal logic has become a research topic.

3 SPACE TRIALECTICS

The trialectics refers to the fact that all existence should be dialectical thinking from the three dimensions of history, space and society (Figure 1). The trialectics stems from the sublation of the traditional dualism logic. Similar to Hegel's dialectics, the third element is not a simple combination or intermediate state of the original binary term, but is generated by the overall deconstruction of the original binary structure and then reconstructed again. of. The third element contains both other binary and beyond the first two [7].

Space is expressed not only by geometry or geography. Space is a dynamic process of reorganizing social relations and restructuring social order. Just as people create their own history [8], it is a dynamic process of people's practice. It has not been a simple physical definition, but contains complex production relations and social relations, and has launched a triple dialectic of society, history and space.

The study of dialectical thinking is more about the connection, movement, generation and disappearance of things, rather than the connection, movement, generation and
disappearance of things. Because the causal relationship of specific things will lead to
different performances under different time and space [9]. Therefore, the dialectical research
of space is not only the understanding and research of space ontology, but also the study of
various conditions in the formation and development of space. Through this kind of research,
we can understand the differences in different spaces and eliminate the obstacles of cognition,
and the correct understanding of the spiritual nature of space and the true nature of material
can only be obtained by analyzing the process of spatial formation [7].

3.1 Content of Space trialectics
Spatial trialectics is a theory and view of how to think about space, proposed by the French
Marxist philosopher Henri Lefebvre. The spatial trialectics comes from the trialectics and the
understanding of the space ontology, that is, all space can be dialectical thinking from the
space ternary of space practice, space reproduction and reproduction.

Henry Lefebvre uses trialectics to divide space into three dimensions: spatial practice,
representations of space, and representational space, and corresponding to spatial
persistence, Conceived and lived three levels (Figure 2).
Spatial practice is the material process of the social process of behavior and social interaction
and the social space it creates. The latter is a space that can be perceived, and the way to
perceive is to obtain raw materials through the five senses of the human being, that is, the
eyes, ears and nose. In the process of perception, people construct an objective experience
of human existence on space. The perceived space can be accurately measured and
depicted. Space practice includes the behavioral process of production and reproduction, so it
is the embodiment of the production relationship, so the space time has certain logic and
consistency.
The representations of space, contrary to the material practice of space, are spiritual and
conceptual spatial imaginations that are conceived. It includes concepts, languages, texts,
expressions, and more. The reproduction of space is the intended and defined space and
often occurs in conversations, speeches, descriptions, definitions, theories, and so on. The
right to speak of the reproduction of space is usually in the hands of scientists, planners and
others. The expression of spatial representation is based on the construction of
multidisciplinary knowledge and is closely related to the production relationship and its
internal order. It controls the expression of language, discourse, text, logos and is a process
of constant dynamic change [8-13]. The idea of space is based on the perception of space,
which provides the original material for the former. Through the reprocessing of raw materials,
people have formed a conception of space and completed the production of knowledge in this
process [8-13].
The representational space belongs to the lived, which is the space in which people directly
use the external world through relevant established images and symbols and symbols.
Symbolizes expression in space and forms social norms, values, and experiences in ways
that are different according to different societies, history, and cultures. The reconstructed
space is the space dominated by the occupants and users, that is, the real space in which the
The former two interact with the outside world, as a dominant and passive experience space and provides a place for practical and cognitive interaction. In the space of reproduction, imagination seeks to change and occupy the space, so it is a symbolic world full of tension, contradiction and instability. The reconstructed space is different from physical space and spiritual space, but it covers and surpasses both, and overlaps with physical space in scope [8-13].

The space of reproduction is the place where people live really every moment, that is, the space of daily life. As Marx pointed out, “a practical exercise is more important than a single program” [14], Lefebvre believes that the realization of human liberation, all people should be the first to liberate themselves through the change of the most direct way of life around them. The place that breaks the way of life formed by the original social relations, this lifestyle that contains various values and codes of conduct alienates people. Only by completely changing this way of life can people get rid of alienation, thus realizing human liberation and becoming a real person [8-13].

The importance of the ternary space lies in his exploration of various social relations from a spatial perspective. First of all, its three kinds of space are not only objective material existence, but also a kind of construction. The reproduction of space controls and manages social space. It belongs to people with power and scientific knowledge. The description object of the reproduced space is the social space. Space practice belongs to residents, and its way of constructing social space is based on daily practice [8-13].

Each of these items also contains two other items as appropriate, although they can be separated from each other and can be studied in an extremely specialized and isolated state. The three forms of spatial cognition belong to three sides, that is, the three have equal status, but the space for reproduction is strategic. Because of the long-term tendency to limit spatial knowledge in the epistemology of the first space and the second space and related theoretical construction and empirical analysis, the former two are relatively opposed to the third space, so the opportunity for change can only be found in the third space.

3.2 Spatial ternary dialectic logic

When we think about space, spatial trialetics is a simultaneous "one-sided three-sided" way of thinking. There is no specific subordinate or hierarchical order between the three spaces. The first is the deconstruction of the original spatial duality and re-construction, and then introduce another other. Then, under the premise of avoiding simple superposition, the problem is considered in different history, different space and different social conditions, that is, different practices under different time and space conditions (space practice). But the final result of spatial trialetics lies in the third space, the social space (so Lefebvre thinks that the third space has some strategic space). The understanding of space allows us to better understand and grasp the production relations of this society and the logic of its operation.

When we think about the first nature of space, we should use scientific quantitative methods such as size, material, color, and form to describe the process that they are rationally created by tools and experience the laws of the space. Sexual description. The production of physical
space is the product of human expression in the process of dealing with its dynamic relationship with nature.

The second is the rethinking of space, that is, the conception and expression of space. For example, in the Chinese Qin Dynasty royal garden, Shanglinyuan, the name and orientation array of the star is used to plan the layout of the royal palace on the ground [9], that is, the spatial language of “the sensibility of heaven and earth” is used as a tool for expression. The reproduction of the space is further divided into inward reproduction and outward reproduction depending on the manner of expression. The reproduction of introverted space tends to be an empirical expression of the individual. For example, American urban scientist Kevin Lynch in the City Image surveys different levels of urban dwellers through different questionnaires. Urban psychology and conceived images of people’s psychology [15]. The reproduction of extroverted space tends to be an expression of dominant discourse and the interrelationship between different discourse rights. The concept that each space is given is obtained in the overall "collection" by the status of the presenter and the intensity of expression to obtain their respective "ecological niches." The expression of spatial reproduction is controlled by the production relations formed by the interaction of productive forces, and the internal order of production relations affects the expression means and methods of the reproduction of space.

The analysis of the reconstructed space, that is, the analysis of the real living space, is about how people use the space and use it under the symbol of spatial presupposition. It is often symbolized that the spread through the medium exists in the minds of the people who use the space and influences the user’s behavioral judgment. The reconstructed space includes physical space and symbolic (conceptual) space, but it goes beyond both. It is a real living space and a space for interaction between people and the external environment. The reappearing space contains the fission of various possible social relationships between people, just like the chemical reactions in the container. The social relations behind different people meet here to create "wonderful" things, as the deep ecological philosopher Alan Ness pointed out: "People are not a thing in the environment, but a system with no boundaries in space and time. A point of integration." [16] So every phenomenon in the world is always affected by everything else. People have social interactions here and have produced various social events.

In short, the thinking of the three spaces is a simultaneous process. Just as thinking about problems in dialectic thinking must be affirmed and denied at the same time [17]. When thinking about three spaces, we must think about the transition, connection, and disappearance between the three spaces (Fig. 3), such as space practice-space reproduction, space practice-reproduction space, reproduction space-space reproduction, and so on. In short, taking space as the main body, analyzing the meaning of the space under the premise of different history and society.

The final goal of the trialectics lies in the space of reproduction. Because it is the most local presence in the physical existence of the mind and body. Lefebvre believes that the third space is a political choice, and he attempts to use the reappeared space as a medium to "initiate" space events. The space of reproduction (the space of life) or the space of daily life is
the space chosen for the struggle to achieve human freedom and liberation. Because in essence, this is a flexible, dynamic, and enthusiastic center of life. The space of reproduction has the greatest uncertainty. This kind of uncertainty comes from the people in space and their imagination. This kind of uncertainty will make the reproduction space have the possibility of becoming a kind of “reverse space”. A space against rebellion. It has subconscious mystery and sensibility, and is as full of imagination and unknown as “Aleph” 2.

3.3 The relationship between spatial trialectics in landscape
Using spatial trialectics to understand landscape space can help eliminate the “opacity” of landscape, understand the operational logic behind landscape space, help landscape architects to improve subjective consciousness, and break the perception between designers and space users. barrier.

For landscape architects, in the creative process, the landscape space is first designed by thinking about three spaces, namely, the space of perception, the space of conception, and the space of life. The thinking mode of these three spaces should be a reciprocating movement. Designers should prejudge the design process of the landscape space and the living space carried after the completion to avoid the emergence of “urban lost space”, thus making the landscape a medium for promoting urban vitality. For users, spatial trialectics helps to understand their understanding of the “landscape” in which they are, learn how to perceive this existence, and what kind of situational life can exist for this kind of landscape. Increasing people’s possession of landscape space, that is, participation and identity in the landscape space, lays the foundation for promoting the public participation in the landscape design process.

4 SPACE PRODUCTION
4.1 Space production concept
The concept of space production was first proposed by the French thinker and the late Marxist Lefebvre. In “Space: Social Products and Use Values” published in 1979, it is pointed out that the phenomenon of space production mainly exists in the process of rapid growth of urban scale, urbanization of society and distribution of space [18].

It can be seen that the production of space is a phenomenon of urbanization itself. In the process of urbanization, the production and reproduction of the social relations expressed by space also contribute to the production of space.

Space is not a reflection of society, but an expression of society. Space and society are two-sided relationship. Material space as a background for the development of productive forces attaches to a wide range of social relationships. The spatial production relationship is the original starting point for the formation of other social relations, that is, the latter is the reflection of the former in different categories.

4.2 Space production process
Urban space is the result of the interaction between capitalist productivity and production mode. Its change and disappearance reflect the changes in capitalist production relations. And the city is not only the external environment for maintaining labor reproduction, but also the carrier that capitalism must exist in order to maintain itself. From a spatial perspective, cities are produced by capitalism, and capitalism has also completed its own reproduction. Urban space is the base map of the flow of people and objects in the context of specific time and space. The process of urban space formation is dominated by the planning and management of various power organizations in the production relationship. In urban space, capitalist production relations have been regenerated.

The operation of the capitalist system itself must be based on the production of space and the reproduction of social relations. After the industrial revolution, the city was the most active place in the productivity revolution. It became the core of the reproduction of production relations and carried out a large amount of space production.

For the discussion of capital movement in cities and the reproduction process of production relations, David Harvey believes that the urbanization of capital can be summarized into a three-level cycle, that is, capital flows into the production sectors such as industry and agriculture to meet the daily consumption needs of people. Capital flows into urban infrastructure and housing to expand reproduction and capital flows to services to stimulate consumption to meet growing productivity [19]. Lefebvre summarized the process of reproduction of social relations into three aspects, namely: first, reproduction with biological categories, which occurs in family blood relations; second, reproduction of labor and production materials, mainly in the process of social production of material and spiritual; third, the reproduction of various social relations occurs in the process of social interaction. Developed capitalist society usually subtly promotes the reproduction of social relations through the distribution and organization of space, especially the reproduction of the dominant system that lays the foundation for the survival of capitalism itself [20].

5 DECONSTRUCTION OF LANDSCAPE SPACE PRODUCTION

Landscape space production is the expression of space production theory in the landscape field, which is reflected in the accelerated growth of landscape space in urbanization and the general landscape of urban space in a certain historical period. The urbanization of landscape space production itself and the production and reproduction of social relations accompanied by the expression of landscape space.

The landscape space production from the perspective of spatial trialectics includes the landscape space practise, that is, the perceived space of the landscape; the representation of landscape space, that is, the landscape of the landscape (conceived) Space); Representational landscape space, the living space of the landscape (Fig. 4).

5.1 Practice of Landscape Space——Landscape as a tool for urban space restoration

The landscape space practice belongs to the perceived landscape space. The practice of landscape space is the production of landscape material space, that is, landscape material
space is also the link of social capital circulation, and it is the combination space of power and capital.

At this stage, the practice of landscape space in China is more often used as a spatial fix. "Space restoration" was proposed by American Marxist scholar David Harvey. He believes that according to the dual meaning of fix, the first meaning of space restoration is that something is loaded in space, and the second meaning is to solve problems in space. The driving force of urban development lies in the growth of capital, that is, the continuous growth of capital and the necessity of annexation [21]. In the world, the growth of capital always depends on the expansion of space. The long-term extensive development has caused serious ecological degradation, which has aggravated the contradiction between human and land, causing a series of problems, such as forest destruction, groundwater pollution, land desertification, urban industrial wasteland. This phenomenon is the result of the growth of capital and environmental problems, which together form the problem of excess productivity. For example, the city faces problems such as river pollution, air deterioration, industrial waste land, etc. In the rural areas, it faces problems such as loss of labor, dilapidation of buildings, and dispersion of social relations.

Landscape (landscape), as an artificial nature, is mainly composed of water bodies, plants, structures, and the like. The characteristics of the landscape space are vibrant, representing nature and ecology. And in a year or so the landscape can be initially built. Through the means of landscape to repair the original depleted space, on the one hand, it can quickly change the external image of the city; on the other hand, it can also absorb foreign investment and digest excess productivity through the construction of landscape space.

Therefore, the landscape landscaping methods such as landscape ecological restoration and beautiful countryside have become the first choice for urban and rural space restoration. Especially for cities facing depletion of resources, the natural environment has been degraded because of its excessive dependence on the dividends brought by non-renewable resources. Through the practice of landscape space, it can not only quickly cover the status quo of land caused by unscientific development, but also The way to greatly increase the greening rate has transformed the city from a negative impression of “a city that is in urgent need of industrial transformation” to a positive impression of “national garden city”.

Taking “National Garden City” as an example, a city with at least 40% green space rate in the planning area (one of the main conditions) can be rated as “National Garden City”, so the quantitative analysis of “National Garden City” can be drawn. The absolute amount of landscape space in most cities in China has changed.

According to statistics, from 1992 to 2004, the number of national garden cities in China increased from 3 to 310. The growth rate was low before 2000, and the growth rate was rapid from 2001 to 2015, with an average annual growth rate of 17.35%. National Garden County from 2006 It will increase from 10 to 212 by 2015, especially from 2012 to 2015, with an average annual growth rate of 30.2%3 (Figure 5).

Taking green space as an example, the green area of urban parks in China increased from 252,300 hm2 to 161,100 hm2 from 2004 to 2015, with an average annual growth rate of 8%
while the urban park area increased from 133,800 hm² from 2004 to 2015. To 383,800 hm², the average annual growth rate is 10%\(^4\) (Figure 6).

In terms of urban landscaping construction investment, in 1990, China’s urban landscaping construction investment accounted for 2.39% of the total fixed assets investment in municipal public facilities construction. The investment ratio in 2002-2014 rose from 7.67% to 11.19%, ranking the road bridge and track. After the transportation field, it ranked third [22].

The above data indicators indicate that in the past 20 years, there have been a large number of government-led landscape space practices, which use landscapes to complete urban space restoration.

5.2 Reappearance of Landscape Space——Landscape Becomes Carrier of Industrial Ecology

The representation space of landscape space belongs to the landscape space of conception. In the process of landscape space practice, it is a conceptual landscape space imagination and spiritual space, that is, the actual sensible landscape material space is expressed in the form of concept. The vast majority of the right to speak in this process is in the hands of people in various fields of expertise.

The reproduction of landscape space is related to the production relationship and its order. The language, text and ideology are used to control the production of space and control the production of landscape space knowledge by controlling the means of interpreting landscape space. Therefore, the landscape space that is conceived is the expression of the landscape pathway of a certain social relationship.

“Jinshan Yinshan is not as green as green mountains, green water and green mountains are Jinshan Yinshan” [23] The concept of the signifies that the landscape has become the carrier of industrial ecologicalization. “Jinshan Yinshan is not as green as green hills” shows the correction of industrial values and the reflection on pure pursuit of GDP growth; “Green Mountain is the Jinshan Yinshan” is the determination for industrial transformation, from the development mode of sacrificing the environment The transformation of the way in which people and the environment live in harmony.

Taking Zhangjiagang and Yanghu Ecological Park planning and design as an example, the land used for the project is 441.45hm². The land before the development is the suburban joint land. There are two artificial canals and several canals in the original base. In the project planning stage, there are three options, namely parks, residential properties or CBD. After a series of discussions, the plot has established the goal of coordinated development of urban environmental, social and economic benefits, guided by the concept of landscape ecology, and carried out recreation, recreation and recuperation with landscape space as a carrier, living and other functions. Taking ecological construction as the core, we will increase the external benefits of the land and increase its value by improving the quality of the landscape environment and providing high-quality green infrastructure for the surrounding areas. In the past five years since the construction of the plot, the value of the park and surrounding land has increased by 5-6 times. At the same time, the water quality of the lake is maintained by
the self-circulation of the water body through the combination of artificial and natural wetlands, and the water quality of the lake area is upgraded to level 1~2 (Fig. 7), and the successful realization of “green water mountain is Jinshan Yinshan” [24].

5.3 Reappearing landscape space - landscape as a city catalyst reshaping social vitality
The reconstructed landscape space, the lived space of life, is a landscape space that is directly used through related intentions and symbols. But like the dialectical logic of "positive negation", the reconstructed landscape space is a reflection of the practice of landscape space and the reproduction of landscape space, but it exceeds the organic combination of the two. Because of the human factor, it becomes a dynamic, evolving possibility space.

People have the nature of yearning for nature. In the city, leisure people instinctively choose to live in a space closer to nature. Along with various public activities, people gather in the landscape space to trigger a lot of social interactions and create more possibilities, so the agglomeration effect of people in the landscape space makes a city more dynamic.

In post-industrial cities, landscapes are seen as a city catalyst (catalyst) for local development and revitalization. Landscape catalyst refers to the landscape as a form of urban catalyst to guide the future development of the city. Urban catalysts are not an isolated form, but a structural or skeleton form that can guide future urban development [25].

Take New York's High Line Park as an example. The high-line park was formerly an elevated railroad that supplies meat to the city in Manhattan's West Chelsea (Figure 8). It is connected to numerous factories and warehouses, but with the upgrade of the urban transportation system, the original elevated railway gradually declined. The industry left the West Chelsea area with a new traffic location, making it slowly become a dirty and messy situation. During the 1960-1991 period, the New York government dismantled all elevated rails except the west sideline. In 1999, when the New York government wanted to dismantle the west sideline, a non-profit organization called "Friends of the High Line" began to rush to save the section of the elevated railroad tracks. Finally, the organization’s idea of transforming the elevated railway into a high-line park through landscape space intervention was supported by the government. The reappearing landscape space regenerates the previously worthless elevated railway into a historical landscape that links the surrounding historical and landmark buildings, transforming it from “waste” to cultural resources (Figure 9). The presence of the High Line Park has successfully promoted the overall activation and revitalization of the area along the route, making it a new landmark in New York today, enhancing the image of the city and driving the tourism flow of the entire city, bringing in an annual economic income of 50 million US dollars [26].

The operators of the high-line parks have formed a community of destiny for occupants and practitioners along the high-line park through a series of policies. Relying on its landscape advantages, the High Line Park has carried out a wide range of activities covering various age groups, social classes and technical fields, such as art exhibitions, horticultural exhibitions, and after-school education programs [27]. Native residents have been widely involved in the various operations and activities of the High Line Park, receiving remuneration and greatly
enhancing the sense of belonging in the region. Practitioners along the line have sustained and stable incomes due to business opportunities brought about by the revitalization of community vitality. Everyone finds a place in the “cement forest” where they can inhabit. Here people get a moment of liberation from the "alienation" of capital, because the nature of longing for nature is released and get pleasure, the interaction between people is like the entanglement between quantum to activate the whole city.

6 CONCLUSION
Facing the poverty of dual logic, the space trialectics proposes to understand the space from the space practice, the space reproduction and the reproduction space, and emphasizes the emphasis on the study of the connection between space. Spatial trialectics is a kind of "one body, three sides" way of thinking, and the space of reproduction as the final foothold of trialectics must pay more attention to its role.

Landscape space production under spatial trialectics includes the practice of landscape space, the reproduction of landscape space, and the reproduction of landscape space. Deconstruction of landscape space production under spatial trialectics is conducive to a deeper understanding of the phenomena, processes and internal causes of landscape space production, namely the productivity and social relations under the phenomenon of landscape space production.

Especially for the present China, which is in the critical transition period of urban development, the use of landscape space production, through the practice of landscape space to repair the space, through the continuous reproduction of the landscape space to emphasize the ecological priority development strategy to complete the industrial ecological The transformation and upgrading, through the reproduction of the landscape space to play its catalytic role, to stimulate the city's regeneration and revival, reshaping the vitality of society, is an important space strategy.

EndNote:
1 The landscape (landscape) in this paper contains the existence of the environment and place for human existence, the beauty provided for human life, and the garden that provides satisfaction for human spiritual life, that is, emotion [2].
2 "Aleph" is a short story of Latin American "magic realism" writer Borges, in which Aleph represents an all-encompassing point in space.

6 REFERENCES:
GREENING WASTELANDS: HISTORICAL LINEAGE AND FUTURE PROSPECTS

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1 ABSTRACT
Landscape architecture has overlooked the creative opportunities of waste and failed to develop nuanced approaches to the redevelopment and transformation of waste landscapes. No matter the variation in previous use, these landscapes have been similarly reclaimed “under a thin green veneer” of asphalt and lawn. To discuss such shortcomings, three iconic projects are used to take a cross-section of the profession’s history in redesigning brownfields: Gas Works Park (1975) designed by Richard Haag, and Byxbee Park (1991) and Crissy Field (2001), both designed by Hargreaves Associates. With differing former uses, each project was selected as representative of a different era and paradigm in landscape architecture, while also having falling short in achieving their original design intent over time—long-term remediation and equitable access. Additionally, these three projects represent a repeating pattern to approaching wastelands as a landscape type—they must be greened in order to be functional. In arguing for a more nuanced approach to waste landscapes that results in distinctively diverse outcomes and engages with waste conditions and former uses, Landschaftspark (2002) designed by Latz+Partners and Brick Works (2010) designed by DTAH and Claude Cormier+Associates were selected to illustrate the potentials for actively engaging with waste conditions, generating highly performative landscapes. These projects demonstrate the importance of integrating multiple uses and bringing visibility to processes of remediation and site histories as aesthetic and performative components of brownfield reclamation. They reveal opportunities for developing a new design-research framework, landscape lifecycles, which advocates for transforming underutilized spaces by reactivating waste materials.

1.1 Keywords
Brownfield reclamation, waste reuse, environmental injustice, lifecycles, failures
2 INTRODUCTION

Waste is ideologically constructed as the antithesis of value. The word is embedded with negative connotations retained by a long lineage of cultural attitudes toward undesired material excess. This perception has resulted in the inefficient handling, storage, and regulation of potentially valuable waste products, which should be embraced as desirable, cheap, readily available resources with latent benefits for producing new economies, ecologies, and cultural landscapes. The materials and landscapes associated with waste, excess, and the undesired create vulnerability within and surrounding their sites, which are typically relegated to the peripheries of urban environments along with marginalized communities (Engler, 2004, p. 29-30). “Material waste produces spatial waste” (De Almeida, 2018, p. 17), and these conditions are often associated with terms such as “blight,” “eye-sore,” and “undesirable,” resulting in approaches that move these conditions elsewhere, or attempt to disguise them “under a thin green veneer of grass and asphalt” (Meyer, 2007, p. 62) concealing not only contamination, but also processes of remediation.

The abandonment of former industrial sites produces ruin, and landscapes across the world are strewn with such ruins (Tsing, 2015, p. 6). Brownfields are one type of waste landscape—territories left over from previous industrial activities whose material remnants take the form of contaminants, industrial buildings, and/or infrastructure. These wastelands are in excess supply, with over one million known sites in the United States, encompassing the same land area as sixty of our largest cities (U.S. Department of Housing and Urban Development, 2012). At their peak, these sites were viewed as symbols of urban economic power, but are now perceived as examples of decay (De Sousa, 2006, p. 154), having apparently reached the end of their useful life. Even though they appear to be dead, these sites carry the potential to become highly active once again. We must look for new vitality in these landscapes, which have the potential to yield “new multispecies and multicultural life” (Tsing, 2015, p. 6).

Cultural attitudes towards waste have led to mismanagement, causing widespread vulnerability in brownfields. They are generated in many forms and scales ranging from small abandoned gas stations to large areas where manufacturing, chemical storage, military operations, dumping, or other hazardous activities once took place, resulting in a variety of contaminated legacies (De Sousa, 2006, p. 154). These sites create a periphery of vulnerable territories and communities beyond their boundaries, from leaching into adjoining sites to spreading across a neighborhood, nation, or the globe. Communities physically located on or at the periphery of brownfields are often also at the periphery of social and political worlds (Pellow, 2004). As Lindsey Dillon (2014) observes, twentieth century urban wastelands production is inseparable from constitutive processes of race and racism (p. 1209). Remediation processes tend to move more slowly in and near minority communities (Eckerd and Keeler, 2012), and development fails to address social and economic needs.

Treated, approached, and managed as waste, brownfields and other waste landscapes are perceived as an undesirable cultural condition. These attitudes are reflected in approaches to brownfield reclamation: contaminated materials are handled and removed using conventional waste management strategies (Dillon, 2014, p. 1208), pushing them to the periphery along with marginalized communities. Such shared cultural [mis]perceptions have become embedded in passive design approaches, driving unconscious aesthetic decisions to fix and hide waste rather than engage with it. Modern shifts toward sustainability and redevelopment quietly promised change in marginal landscapes, reclaiming them as public places, museums, and parks, but subsequently hid their former functions and cultural history. These design strategies are particularly apparent in adaptive reuse and brownfield reclamation projects over the last fifty years. As Anna Tsing (2015) asks, “What emerges in damaged landscapes, beyond the call of industrial promise and ruin?” (p. 18).

In the 1990s, brownfield redevelopment surfaced as an urban growth strategy by attracting private-sector investment and expanding municipal tax bases (De Sousa, 2004). Dillon (2014) further describes brownfield redevelopment as signaling “a new historical conjuncture, in which the twentieth century’s industrial wastelands—environmentally degraded, economically divested, and often racially marked—have emerged as sites of investment, resignification, and value formation” (p. 1206). Waste landscape reclamation has also been used as a comprehensive urban revitalization strategy of “improving the state of urban environments and enhancing the quality of city life” with open space (De Sousa, 2004, p. 579) rooted in Olmstedian principles. As Michael Hough (1995) writes, Frederick Law Olmsted “was part of a generation of American landscape architects and reformers who set out to beautify the American
landscape” (p. 129). These traditions are still strongly engrained in contemporary landscape architecture practice and are ubiquitously used as the strategy for reclaiming waste landscapes.

Engler (2004) describes two typical modern approaches to waste facilities as camouflage and utilitarian: the camouflage approach “paid tribute to the urban aesthetics established in the late nineteenth century and continued the tradition of disguising waste sites,” and the utilitarian approach “reused the waste sites as a public amenity for recreation, for agricultural, and sometimes for private land development. The waste, an integral part of these sites, did not inform the design. Instead, the wastelands were recycled into generic parks that concealed their former phase” (p. 37). Although these approaches have added socio-economic, ecological, and aesthetic value, brownfields still carry the stigma of waste and are approached as such—their undesirable, dirty legacy must be hidden away, covered up, and made to appear clean and green for private real estate development, recreation, and ecological habitat (Engler 2004; 1995).

Brownfield redevelopment presents new opportunities for considering environmental justice in the context of handling wastes from 20th century industrialization (Dillon, 2014 p. 1218). They must be revitalized by combining landscape processes that repurpose other wastes and promote productivity. Landscape architecture is uniquely positioned to conceptualize the potentials of waste for adding value in the transformation of waste landscapes, especially brownfields: the most prevalent, complex, and ubiquitous landscape condition faced by this profession (De Almeida, 2018). Landscape architects working on brownfields have largely been focused on private sector projects geared towards greening cities (De Sousa, 2006, p. 156), leaving sites and communities in great need behind. The profession has the capacity to advocate for these communities by rethinking how these sites are approached. Additionally, the wide variety of waste landscape typologies warrant more creative, nuanced approaches and outcomes to their future uses (Figure 1).

Figure 1. Waste landscape reclamation strategies: convergent thinking with conventional methods versus divergent thinking with a landscape lifecycles approach. Diagram by authors

This background provides critical context for the discussion of how waste landscape reclamation practices have (or have not) progressed in the field of landscape architecture. To expand on this context, this paper first presents three historically significant case studies that not only exemplify the shortcomings to the practices described above, but also illuminate a progression in the field toward waste landscapes: Gas Works Park (1975) designed by Richard Haag, and Byxbee Park (1991) and Crissy Field (2001), both designed by Hargreaves Associates. With differing former uses, each project was selected as
representative of a different era and paradigm in landscape architecture, while also having ultimately failed in achieving their original design intent over time—long-term remediation and equitable access. Additionally, these three projects represent a repeating pattern to approaching wastelands as a landscape type—they must be greened to appear cleaned in order to be functional. In arguing for a more nuanced approach to waste landscapes that results in distinctively diverse outcomes that engage with waste conditions and former uses, Landschaftspark (2002) designed by Latz+Partners and Brick Works (2010) designed by DTAH and Claude Cormier+Associates are discussed to illustrate the potentials for actively engaging with waste conditions, generating highly performative landscapes. These projects demonstrate the importance of integrating multiple uses and bringing visibility to processes of remediation and site histories as aesthetic and performative components of brownfield reclamation. In order to do more than clean and green these culturally rich, historically significant sites by converting them into generic parks, these approaches can be pushed further through a landscape lifecycles framework that reactivates waste as a dynamic contributor to local and regional contexts, emphasizing performance and visibility over disguise.

3 GREENING WASTELANDS: THREE HISTORICAL MOMENTS IN LANDSCAPE ARCHITECTURAL HISTORY

3.1 Project 1: Gas Works Park in Seattle, Washington (1975); Richard Haag

Located on the north edge of Lake Union, Gas Works Park is a 20-acre site that is interwoven with Seattle’s urban fabric. As one of the first projects that effectively provided public access to a formerly industrial site that would have otherwise been left untreated and vacant, this is a highly significant project to the field and to the discussion of reclaiming contaminated landscapes. As a revolutionary project, it achieved excellence for expanding the field of landscape architecture to tackle a new landscape typography—brownfields—introducing possibilities for how site designers might engage with these culturally significant contaminated landscapes. Throughout its development, the site has been historically controversial regarding its form, use, and strategies for addressing contaminants directly beneath the surface. Seattle communities were bewildered when they realized Haag had gone against the favored plan of clearing the site to convert it into “a Victorian-style park,” but have since grown fond of the now Nationally Registered Historic Place (Howard, Thompson, & Waterford, 2013, p. 410). The inclusion and conservation of the gasification towers became a model for successful brownfields—advocating for visibility and admittance to the processes entangled in the site’s industrial past.

Owned and operated by Seattle Light Company (1906–1956), the site was originally a gasification plant that converted coal to gas, and later on, oil to gas. After 1956, it was abandoned and laid in ruin until Richard Haag’s Park Master Plan was completed in 1972. The original plan preserved the old gasification towers as Haag considered them “the most sacred, the most iconic thing on this site,” and were left as a reminder of the site’s former use (Figure 2, left) despite controversy around injuries that had occurred on top of the towers after the plant was shut down (University of Washington Press Blog, 2015). Although Haag originally reimagined the main cracking towers as “climbing equipment, lookout platforms, camera obscura, café, and art gallery” spaces (Satherley, 2016, p. 15), they were evidently fenced off. A massive amount contaminated soil became the iconic 45-foot-high Kite Hill—the first project to keep contaminants on site rather than moving waste offsite to a landfill (Way, 2013, p. 30). Two existing buildings on the eastern portion of the site were refabricated to house the Playbarn, programmed for picnics and child’s play with repurposed equipment. The history of contamination and deliberation at Gas Works Park is no secret, and as a pilot project for in situ remediation, challenges associated with industrial waste have emerged.

Haag originally used a combination of leaves, soil, and sawdust as a cover for the contaminants during its reconstruction as a park—a strategy that would be considered hazardous if used today (Diltz, 2015) due to contaminant migration. These contaminants consisted of “solvent-soaked wood chips, slag, lamblack carbon, coal by-products, and tar...polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), and elevated concentrations of arsenic, copper, lead, zinc, and other [heavy] metals” (Washington State Department of Ecology, 2003, p. 2-3). In 1997, a “black substance bubbled up near Kite Hill,” resulting in the excavation and offsite disposal of 3,000 pounds of tar (Diltz, 2015), failing to meet Haag’s original intent of keeping the site’s waste in place. As contamination challenges have
surfaced, capping has been the main remediation strategy. This, however, has been insufficient, as the capping process has been repeated often in order to protect users from contaminants that resurface or leach into surrounding areas. While the strategies for remediating industrial waste materials encountered challenges, the site’s original “sacred towers” have been fenced off with chain-link, only to be viewed from a distance. This fence, however, has been ineffective as visitors cut holes in order to access, climb, and discover the unique qualities of these towers, engaging in a game of defiant rule breaking. These holes are repeatedly patched with layers of chain-link band-aids that visually register users’ desire to interact with these structures, and the park department’s failure to fully prevent what they perceive as an undesirable use (Figure 2, right). Rather than preventing this engagement from occurring, one could design a catwalk that weaves through the towers, allowing visitors to safely interact with the unique structures (Table 1), a strategy used in Peter Latz’s Landschaftspark, described later in this paper.

Figure 2. Gas Works Park. Main gasification towers with Seattle’s urban fabric in background (left); fence patchwork around towers (right). Photographs by Catherine De Almeida.

Table 1. Gas Works Park Assessment Summary

<table>
<thead>
<tr>
<th>Successes</th>
<th>Shortcomings</th>
</tr>
</thead>
<tbody>
<tr>
<td>First major brownfield reclamation project – offered insight for future projects.</td>
<td>Creates a baseline for minimal strategies to reclaim waste landscape typologies.</td>
</tr>
<tr>
<td>Provides social and cultural benefits through access and preservation.</td>
<td>Contaminants remain today and continuously resurface.</td>
</tr>
<tr>
<td>Retaining original industrial structures on site informed future practice.</td>
<td>The retained industrial structures became viewable ruins, rather than interactive spaces.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Questions</th>
<th>Opportunities</th>
</tr>
</thead>
<tbody>
<tr>
<td>How might this site adapt to future conditions, especially when facing climate change?</td>
<td>Create safe access to the existing towers with catwalks.</td>
</tr>
<tr>
<td>Will new structures be built here?</td>
<td>Experiment with phytoremediation on site to manage contaminants.</td>
</tr>
<tr>
<td>What new strategies might address the challenges associated with resurfacing contaminants?</td>
<td>Use site as a research and learning opportunity through transparent story-telling and engagement.</td>
</tr>
</tbody>
</table>

By vastly opening the field of landscape architecture to new site type, Gas Works Park stands as a successful brownfield reclamation project that charted a new course for the discipline. It has become a baseline model for post-industrial landscape design that acknowledges a site’s former use while working toward remediating contaminants for future use and public access. Akin to how the site fell into ruin when industrial operations ceased, the project has fallen into a publically accessible ruin that drifts further away from Haag’s original intent, failing to meet his original objectives. In describing entropic qualities of significant projects, Marc Treib (2017) states, “strange in form or material, may be unappreciated by their audiences, setting in motion public reactions that in time may undermine their integrity or perhaps their very existence” (p. 1286), a statement that resembles Gas Works Park’s history and current condition. The project has fallen into a different type of ruin as it drifts further away from Haag’s original intent, failing
to meet his original objectives. However, as the first post-industrial park of its time, Gas Works Park faced much adversity; the park is a significant point of departure for developing new frameworks that engage with waste landscapes.

### 3.2 Project 2: Byxbee Park in Palo Alto, California (1991); Hargreaves Associates

Located along industrialized western shore of San Francisco Bay, the 45-acre Byxbee Park designed by Hargreaves Associates revolutionized the possibilities for reclaiming landfills as another significant waste landscape typology. Adjacent to a tidal creek and flanked on the western edge by a sewage treatment plant, the site was at one point covered in up to 60 feet of refuse (Rainey, 2009). Constructed sixteen years after Gas Works Park, the site’s greening strategy and use of topographical features is similar, but varies in its reclamation strategies and park culture.

Originally marshland and wildlife habitat (Rubin and Meisenheimer, 1998), the site became an area of industrial processing and dumping, similar to many waterfronts in the early 1900s. Over 150 acres of marshland was purchased for waste disposal in 1904 by the City of Palo Alto, and landfilling began in the 1930s when the city’s incinerator burned down (City of Palo Alto, 2018). Dredging and filling activities along with other industrial development consisting of “a sewage treatment plant, an airport, flood control area, and a golf course” eliminated large areas of marshland habitat (Rubin and Meisenheimer, 1998). Left as a vacant wasteland for years, planners advocated for creating an accessible public park among the city’s waste. While many were interested in treating the site as a seemingly blank slate, early activists saw the importance of the baylands’ diverse ecology. Community members insisted on converting the landfill into a public park for walking trails, birdwatching, and more, putting pressure on the City to take action. After years of landfilling, community leaders decided to create a plan to reclaim the site as a naturalistic park.

The baylands were dedicated to parkland in 1965, beginning the process for the former landfill of Palo Alto, California to become Byxbee Park as usable and accessible public open space (City of Palo Alto, 2018). In 1991, the park by Hargreaves Associates completed its first phase of construction, giving the public access to this space, winning an ASLA Honor Award in 1993 (Lee and McKee, 2013). To remediate years of landfilled waste, a three-foot-thick soil and clay cap was laid, while methane created from decomposing refuse was captured and burned to prevent its emissions into the atmosphere (Treib, 2001). To place emphasis on this space, a layer of gravel shaped to appear as a keyhole suggests, “we are peering into the secrets of the landform whose essential core is a decomposing bed of trash” (Rainey, 2009, p. 176). Mira Engler (2004) points out that “uncompromising closure standards forced the team to accept a kidney-shaped hill that had formed based on an earlier plan…possibly intended as a golf course” (p. 111). No trees were planted and no irrigation was added in order to avoid gases possibly escaping into the atmosphere and prevent pollutants seeping into the water table (Treib, 2001). These original precautions, however, are no longer in place. The grasses and landforms have become the iconic features of the site, using the previously formed land built by accumulation as a topographic reminder of waste below. A 72-pole field erected at the northwest corner (Figure 3) has incidentally become a visible registration of the unanticipated settling of the landfill and park. Crushed oyster shells used as substrate for paths (Rainey, 2009) nod to the site’s ecological and cultural heritage of tidal flats and shellfish harvesting (Lee and McKee, 2013).
Byxbee Park’s landscape ultimately serves as an art-piece to be interpreted by the user. Due to the reclamation strategies used before Hargreaves’ design, and the natural decomposition of materials within the former landfill, the site has fallen into disrepair. In 2013, Byxbee Park’s original mounds were leveled and filled due to major settling issues on the former landfill site (Lee and McKee, 2013), losing the authentic topographic and artistic qualities of the park. Before the remaining landfill was closed, however, the lack of integration between past and present landfills was criticized (Engler, 2004, p. 111). An overused remediation strategy, capping was ineffective, as layers of soil need to be reapplied, and contaminant levels measured and monitored regularly. There was also a missed opportunity to fully consider future site maintenance.

Table 2. Byxbee Park Assessment Summary

<table>
<thead>
<tr>
<th>Successes</th>
<th>Shortcomings</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Showcases the artistic potentials of landfills as</td>
<td>• Contamination challenges and landfill settling led to the project’s entropy,</td>
</tr>
<tr>
<td>waste landscape typology for practice</td>
<td>leveling significant areas of the site.</td>
</tr>
<tr>
<td>• Landfill mounds used as the foundation for topographic interest,</td>
<td>• Single-use (passive recreation) likely also led to the site experiencing</td>
</tr>
<tr>
<td>referencing the site’s history.</td>
<td>entropy.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Questions</th>
<th>Opportunities</th>
</tr>
</thead>
<tbody>
<tr>
<td>• How might this site adapt to future conditions?</td>
<td>• Create more visual interest with built structures and grade changes.</td>
</tr>
<tr>
<td>• How could the site have been designed to accommodate settling?</td>
<td>• Experiment with other strategies to intentionally visibly register site processes.</td>
</tr>
<tr>
<td>• Will there still be leveling efforts in 10-20 years?</td>
<td>• Develop a longer-term management plan to accommodate future changes and fluctuations to the site as an integral aspect of the design.</td>
</tr>
</tbody>
</table>

Byxbee Park illuminates potential opportunities for engaging with landfills as a waste landscape typology. Limiting site uses to passive recreation reflects a lack of diverse approaches to designing the site in terms of landscape performance and collaborative multiuse programs raises questions as to how these landscapes may be approached differently from other wastelands. Although the former landfill is an award-winning project and wildlife hub for Palo Alto community members, there are opportunities to increase the usability and adaptability of the site (Table 2).

3.3 Project 3: Crissy Field in San Francisco, California (2001); Hargreaves Associates

Crissy Field, which opened in 2001, provides another avenue for understanding a broadening site type associated with wastelands—sites of former military use. The capping and greening of the park is similar to Gas Works and Byxbee Parks, with an added layer of complexity: engaging with coastal conditions through ecological restoration. Over the course of 70 years, ownership passed from Spanish, to Mexican, to American control (M’Closkey, 2013, p. 45). Known as El Presidio, this landscape had been used for waste dumping, even after the U.S. Army outpost was established (Bevk, 2014). Activity at the outpost increased during the Panama-Pacific International Exposition, during which a racetrack was constructed out of fill (Bevk, 2014). Operated by the U.S. Army Air Service, the racetrack became an airfield from 1920 to 1974, (Porter, 2003, p. 42). Left with contaminants from decades of trash disposal and aviation activities, the U.S. Department of Defense began cleaning up cannonball debris, tar/skeet disks, and PAH contaminated soil and groundwater in the early 1990s (Porter, 2003, p. 42).

Nearly a decade after Byxbee Park, Hargreaves Associates’ design for El Presidio, Crissy Field, was constructed. Primary project goals included restoring the shoreline to its original marsh conditions and highlighting forms from the site’s previous uses (Porter, 2003) as a strategy for registering its history. Crissy Field’s most expansive feature is the mile-long promenade, connecting West Bluff (a picnic area) and East Beach (a large gathering and parking area) (Reed & the Museum of Modern Art, 2013). An artificial marsh was constructed as an integral part of the park, planted with 100,000 indigenous plants.
consisting of 110 different species. These plantings are distinctly grey-green and silvery to contrast the bright green lawn that covers the majority of the site (Reed & the Museum of Modern Art, 2013). Although the marsh restoration efforts were admirable and occurred at a time in the field of landscape architecture in which designers were increasingly integrating ecological systems thinking and functions into designs, the marsh was not large enough to be fully functional. Biologists, however, have found over 17 fish species and 135 bird species visiting the revitalized tidal marsh (Presidio of San Francisco). A low seawall beneath the beach’s surface was added to prevent shoreline erosion, one of the many goals in restoring the shoreline. This seawall prevented devastating erosion, allowing for open views without disturbing ocean wave patterns with a more obtrusive structure (Porter, 2003, p. 45) (Figure 3).

Although Crissy Field engaged with the complexity of the site’s shoreline, the park could benefit from a multifaceted design approach to the former airfield that engages with this history not only formally, but also programmatically. Although the marsh attracts native wildlife, it does not play an active role in remediating the soil below. To address some contamination challenges on site, a magnesium peroxide compound was injected to encourage native bacteria consume the petroleum plume that extends 12 feet underground; this treatment, however, requires endless maintenance and injections over a long period of time (Porter, 2003, p. 42). Although old-growth redwood materials from over 50 historic World War II era buildings were recycled, the building were dismantled rather than restored, without considering their potential future use (Porter, 2003, p. 43). Additionally, 70 acres of asphalt and concrete were crushed and used as fill for pathways and parking lots, while over 87,000 tons of contaminated soil were hauled to distant landfills (Reed & the Museum of Modern Art, 2013). Hauling these waste materials “away” implies that contaminated waste landscapes should first become a tabula rasa in order to become something else—hauling them away does not exactly mean they are gone. The incorporation of more mindful and site-specific waste management strategies on site is a missed opportunity for the project to fully engage with its own legacy (Table 3).

Table 3. Crissy Field Assessment Summary

<table>
<thead>
<tr>
<th>Successes</th>
<th>Shortcomings</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Showcase the potentials for designing historic military sites as a waste landscape typology.</td>
<td>• Used conventional hauling and capping waste management tactics for contaminants.</td>
</tr>
<tr>
<td>• Creates public accessibility to the waterfront as open space.</td>
<td>• Although successful in attracting diverse bird and fish species, marsh is not fully functional due to size constraints.</td>
</tr>
<tr>
<td>• Ecological restoration practices were innovative for the time and informed future practice.</td>
<td>• Site programming for users limited to passive recreation.</td>
</tr>
<tr>
<td>• Reused waste materials from demolition for onsite construction.</td>
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</table>

<table>
<thead>
<tr>
<th>Questions</th>
<th>Opportunities</th>
</tr>
</thead>
<tbody>
<tr>
<td>• How might this site adapt for future conditions, especially when faced with climate change?</td>
<td>• Create more diverse programming within the site, especially those that relate to previous uses.</td>
</tr>
<tr>
<td>• Will the shoreline maintain its size and form over the next 20 years?</td>
<td>• Experiment with other waste management strategies to achieve visible, mindful site-based practices.</td>
</tr>
<tr>
<td>• How could the project have accommodated more insitu waste management strategies?</td>
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Crissy Field presents potential opportunities for reusing historic military bases, more specifically airfields, as a waste landscape typology for landscape architectural practice. The project reused materials on site, and reestablished an eroding shoreline and diverse marsh ecology. However, its use of conventional methods of excavating and hauling soil, capping with new soil, and greening the site to appear as a clean tabula rasa reveal missed opportunities for actively engaging with the performative qualities of waste landscapes. Maintaining a greater number of historic buildings, allowing for extensive phytoremediation in applicable places, and creating layers of a multifunctional uses could provide more visibility to the site’s history and future possibilities.

3.4 A summary of project critiques

These projects are important for the cultural significance and value they provide. Reclaiming wastelands with insitu remediation and repurposing them for new uses is a significant step towards
continuing their lifecycles. Nevertheless, is it always appropriate to default to parks? As De Sousa (2004) argues, "greening projects should be considered along with other possible uses for brownfields because they tend to fulfill community desires, revitalize neighborhoods, and enhance the economic and aesthetic appeal of inner cities" (p. 598). Greening projects can, however, be combined with other uses. Conventional approaches to brownfield reclamation, using parks and ecological habitat to inject new life into decaying landscapes limit their future possibilities. Instead, they must be revitalized using diversified, dynamic, and adaptable site programming that engages with their neighboring communities and users.

4 ENGAGING WASTELANDS: TWO CONTEMPORARY SHIFTING LANDSCAPE ARCHITECTURAL PRACTICE

Marginalized communities need advocates, including landscape architects, who see the potentials for brownfields and other waste landscapes to become active contributors to local economies once again. Together with adding recreational programming and reestablishing ecological functionality, many of these sites have existing infrastructure that can be reused for 21st century economic and cultural programming. How can public accessibility and ecological management be interwoven with active, economically generative programming that engages with its surrounding community?

4.1 Project 1: Landschaftspark in Duisburg, Germany (2002); Latz + Partners

Landschaftspark is one of the first projects to unConventionally confront a waste landscape condition by bringing visibility to the slow processes of remediation, and developing moments for openly engaging with a site’s history. It differs from its predecessors in that it allows direct and indirect interaction with waste materials: slag heaps remain visible, but untouchable, and industrial walls are fully tactile, even climbable.

After extensive work on the former Thyssen steelworks, Latz + Partners’ design for Duisburg-Nord became publicly accessible in 1994 (Rosenberg, 2009, p. 209). Located in Germany’s Ruhr valley region Landschaftspark represents the fall of pig-iron manufacturing as a pertinent industry, and the economic and physical trail of decay it can leave behind (Hemmings & Kagel, 2010, p. 247). Littered with abandoned factories, mines, and material processing plants, the region is known for its deteriorated aesthetic. Landschaftspark’s 500-acre site consists of “old blast furnaces, elevated rails, slag heaps, and a polluted river” turned landscape park (Raver, 2000). Some of the most prominent features of the site are blast furnaces that project out and upwards from the horizon. Lighting designed by Jonathan Park illuminates the furnaces at night, making the site iconic and remembered at all times of day. Landschaftspark is celebrated for its visibility, admittance, and interaction with its past combined with the juxtaposition of new interventions.

Existing sanctioned industrial buildings are used for offices, restaurants, and gallery spaces, or are off-limits to contrast active uses with slow decay (Langhorst, 2014, p. 1119). Key features of the park include a large plaza, “Piazza Metallica,” an adaptable space for events, gardens hidden in storage bunkers, blast furnace structures, catwalks, climbing walls, rock gardens and hedge gardens, and an interactive pond. Described as an experimental park that highlights the site’s temporal qualities, it enables interactions with waste conditions and accommodates diverse environments that overlap across multiple spaces over multiple time periods (Figure 4). Within the park, climbers “practice rappelling on container walls. Scuba divers descend into the old gasometer. Gardens flourish within the confines of ore bunkers” (Lubow, 2004, p. 47). Latz has created, what he considers to be, a neutral design that allows visitors to interpret the site and interact with the park as they see fit. People are given a sense of history, culture, and even ownership, with accounts of teenage hideouts, graffiti, local gardens, and other intricacies, that have been given a home in this deindustrialized landscape (Langhorst, 2014, p. 1120).
The Emscher area was developed in the 1800s by manufacturing and transporting “coal, steel, chemicals, and energy” (Nnadi, 2000). Latz states, “the old way was to cover up these sites with clay and soil and plant indigenous plants, but that does not do justice to them,” highlighting his design-reclamation strategy as differing from past conventions (Raver, 2000). Industrial ruins are transformed into interactive components, coupled with remediation and restoration strategies. The most hazardous areas of parkland were capped or removed, and “ecological function was restored by relieving the sewage burden on the Emscher canal, or planting vegetation to remediate soil and water” (Hemmings & Kagel, 2010, p. 248). The open-sewer Emscher River, running directly through the park, has been converted into a pretreated runoff and rainwater collector (Stilgenbaur, 2005, 9). The site “engages emergent ecologies as an exploratory, open-ended and fluid interaction between human intervention and non-human process,” as contaminated fields are left to naturally break down by weathering, with growing wild plants (Langhorst, 2014, 1126). Pragmatic waste management, material preservation and reinterpretation, viewer interaction, storytelling, and dynamic programming allow Landschaftspark to stand as an example for the future possibilities of reclaiming deindustrialized waste landscapes when long-term adaptation is prioritized to meet user needs.

**Table 4. Landschaftspark Assessment Summary**

<table>
<thead>
<tr>
<th>Successes</th>
<th>Shortcomings</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Conversion of a former raw materials energy plant to a multiuse park with ecological and social benefits.</td>
<td>• Inability for the site to deal with hazardous waste from the beginning.</td>
</tr>
<tr>
<td>• Creates safe public accessibility to a deindustrialized landscape.</td>
<td>• Potential to integrate a greater diversity of uses to increase economic benefits.</td>
</tr>
<tr>
<td>• Adaptable qualities of designed spaces.</td>
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<table>
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<tr>
<th>Questions</th>
<th>Opportunities</th>
</tr>
</thead>
<tbody>
<tr>
<td>• How might this site adapt to future conditions?</td>
<td>• Rotating gardens consisting of different plantings throughout the year, managed by interested local population.</td>
</tr>
<tr>
<td>• Will more buildings be added over time?</td>
<td>• On-site remediation research and education.</td>
</tr>
<tr>
<td>• How will the remediation strategies perform over time?</td>
<td>• Reimplementation of new, sustainable industry/processing for more diverse uses.</td>
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</table>

Landschaftspark is a high performing waste landscape. The site’s former use as a material processing plant has given it unique, unintended characteristics, providing site-specific programs that enhance its visual quality. Unconventional remediation methods allow remnants of past site activities to be visible and is a stark contrast to the previously described waste landscapes. Landschaftspark differs from Gas Works Park because visitors are allowed access to industrial ruins by safe catwalks, designed to offer a closer look at temporal site conditions, while ensuring visitor safety. The site’s interaction with water (river, instead of lake, bay, or marshland) remediates the banks, redirects wastewater, and treats rainwater runoff. Palpable slagheaps and long-term decay create visibility of waste conditions and remediation processes, an approach that contrasts with the previous projects.
4.2 Project 2: Evergreen Brickworks in Toronto, Canada (2010); DTAH and Claude Courmier + Associates

Evergreen Brick Works in Toronto, Canada is an example of how a new assemblage of multicultural and multispecies life—an open-ended gathering of programs and users—can arise out of death and decay through transformative design. In its former life, the site was known as Don Valley Brick Works, which operated for nearly a century from 1889 to the early 1980s, producing 43 million bricks per year at its peak. When operations ended after depleting the site’s clay and shale resources, it left behind 42 acres of a damaged ecosystem, 16 dilapidated industrial heritage buildings (Irvine, 2012, p. 22), and soils contaminated with heavy metals, asbestos, and PAHs (De Sousa, 2003, p. 189). During this time and in to the early 1990s, excavated fill material from the construction of the Scotia Plaza tower in downtown Toronto was land-filled in the quarry—the beginning of the site’s remediation (Flannery and Smith, 2015, p. 36).

The Toronto-based landscape architecture firm, Hough Stansbury Woodland Limited, developed the Don Valley Brick Works Master Plan in 1990, which sought to restore the quarry as an ecological park by reestablishing the river’s ecological and hydrological function. This emphasis on environmental performance was coupled passive park-like programs and “provisions for peripheral mixed use commercial and green-industrial densification (North and Waldheim, 2013, p. 394). The provisions for peripheral densification in anticipation of the effects from the site’s redevelopment were innovative for the time—the firm was integrating economic performance goals into their plans. The overall vision for the new quarry park was based on “its role as a natural focus for interpretation and education of the biophysical, cultural, and industrial history of the Don Valley, its future restoration to a state of health, and its ongoing influence in the affairs of the city as a whole” (Hough Stansbury Woodland Limited, 1990, p. 34). The restoration work was completed in 1995 by the City of Toronto and the Toronto and Region Conservation Authority, which created a series of five connected wetland ponds that daylighted Mud Creek and slowed its flow, improved water quality, and provided habitats for fish, reptiles, and birds. Now known as the Weston Quarry Garden, its 28 acres consists of native trees, shrubs, and a wildflower meadowland traversed by walking trails, bridges, and boardwalks, and punctuated with ponds and channels that connect the creek back to the Don River, alleviating flooding in the valley (Flannery and Smith, 2015, p. 36; Lobko, 2011, p. 405). Two of the 16 buildings were restored, but the contaminated industrial pad and buildings were fenced off, and inaccessible to the public, remaining abandoned for the next decade (Evergreen, 2008, p. 13).

In 2002, Evergreen, a Canadian national non-profit organization whose core mission is to bring nature back to cities, began plans to revitalize the industrial pad and buildings of the former Don Valley Brick Works (Lobko, 2011, p. 405). They assembled a diverse multi-disciplinary design team made up of three architectural firms, two landscape architectural firms, engineers, hydrologists, ecologists, and planners (Lobko 2011, p. 406). This team, led by the architectural and urban design firm du Toit Allsopp Hillier (DTAH) and landscape architecture firm Claude Cormier + Associates, developed a master plan in 2006 focused on fostering diverse experiences connected to nature (North and Waldheim, 2013, p. 401). Their design strategy was based on flows through the valley, and these trajectories of motion extended “to inform layers of design including water, cars, walkers, electricity, trains, and wildlife” (Flannery and Smith, 2015, 36). The proposed master plan became Canada’s first large-scale environmental discovery center “integrating cultural and natural heritage, and ecological and social services” with many on-site features (Lister, 2010, p. 531). Opened in the fall of 2010, four themes underpin the project: Innovation & Discovery; Food & Community; Natural & Cultural Heritage; and Gardening & Greening.

The project features wide-ranging programs and adaptive uses of over 110,000 square feet within existing structures, consisting of a native plant nursery, a demonstration kitchen, children’s gardens and camps, family and youth leadership, youth-at-risk programming, a year-round local farmer’s market, and an organic restaurant (Lister, 2010, p. 531). Cultural, industrial, and natural heritage are all celebrated at the site through the juxtaposition of managed gardens and wild habitats, arts and cultural activities in the old industrial buildings, and the deployment of many different ecologies across this complex urban landscape (Lister, 2010, p. 532) (Figure 4). To help achieve this vision and mixture, a new LEED Platinum rated 5-story building was constructed to house the Centre for Green Cities (Flannery and Smith, 2015, p. 38).
Table 5. Evergreen Brickworks Assessment Summary

<table>
<thead>
<tr>
<th>Successes</th>
<th>Shortcomings</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Former quarry restored as wetland, connecting back to the larger hydrological network.</td>
<td>- Moved lead-contaminated soils offsite.</td>
</tr>
<tr>
<td>- Existing structures as adaptable public space.</td>
<td>- Demolished portions of existing structures moved offsite to landfill.</td>
</tr>
<tr>
<td>- Addition of new building for Centre for Green Cities demonstrates how site moves into future and the integration of greater site uses.</td>
<td>- Programs could be more integrated with one another.</td>
</tr>
<tr>
<td>- Achieves environmental, economic, and social benefits with educational and cultural programs.</td>
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<table>
<thead>
<tr>
<th>Questions</th>
<th>Opportunities</th>
</tr>
</thead>
<tbody>
<tr>
<td>- How can the project incorporate more active and diverse uses?</td>
<td>- Integrate light industrial/manufacturing uses to increase engagement with past and future uses.</td>
</tr>
<tr>
<td>- How might the project adapt to future conditions?</td>
<td>- Waste materials generated from varying programs can feed into one another.</td>
</tr>
<tr>
<td>- Will the site’s adaptability and diversity increase or decrease over time?</td>
<td>- Use site as an educational platform for deindustrialized wastelands.</td>
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Evergreen Brick Works transformed a former brick manufacturing industrial complex and quarry into a cultural center for community engagement and development. The existing industrial structures are adaptively reused for multiple purposes, creating a place for new and old multispecies and multicultural programs and life to mix and interact, engaging with the economy, ecology, and culture of its context. The project allows for flexible uses catering to the larger community, resulting in an active, adaptable scheme that transforms over time (Lister, 2007, p. 52). This generates cultural capital, which complements and enriches recreational uses associated with the ecological functions of wetlands and trails within the former quarry, connecting to a larger network. Toronto is a multi-cultural city whose residents come from many different backgrounds, and Brickworks has become a new cultural center and destination attracting local residents and international visitors. The variety of community-oriented programs on-site adds a layer of complexity to the overall project, where the community is engaged in an intellectual economy integrated with remediation, recreation, ecological functions, and habitat. The layering of uses creates a dynamic relationship between different programs that feed off one another while negotiating the same space, ultimately strengthening the function of each program.

4.3 A summary of project critiques

Duisburg Nord and Evergreen Brickworks are examples of how active cultural programming can be combined with passive recreational uses and performative ecological habitat while engaging with surrounding communities. The approaches, tactics, techniques, private-public partnerships, and interdisciplinary design teams used in the redevelopment and operation of Evergreen Brick Works have the potential to be applied to similar deindustrialized waste sites. However, these approaches may be pushed even further. Layering multiple uses that share the same space and utilize one another’s waste streams increases the possibilities for developing diverse, overlapping multispecies spaces and activities. This diversity in turn increases the efficiency, resiliency, and adaptability of the system as a whole. Conceiving of active industries with such approaches could potentially prevent the generation of deindustrialized sites by using waste products as resources, integrating mutually beneficial programs, and anticipating economic, cultural, and environmental change.

5 TOWARD A LANDSCAPE LIFECYCLES APPROACH
Waste sites and materials must be reframed as desirable, high value opportunities for extending lifecycles and shaping culturally significant waste places. In order to restructure cultural attitudes towards waste, the notion that there is an end-of-life for materials and landscapes must be rejected. Rather than viewing ecology, economy, and culture as separate, linear systems, a landscape lifecycles approach understands them as integrative and cyclical (Figure 5): they can be interwoven through the exchange of waste materials to create new hybrid landscapes with the capacity to evolve over time. Combating waste by generating new economic streams built on and propelled by waste resources can drive environmental and economic justice. As an ecologically grounded landscape-based design approach, landscape lifecycles offers a comprehensive perspective of technological and environmental systems; one that does not see them as mutually exclusive or operating in isolation of one another, but recognizes that such systems are boundless and fluid.

Figure 5. Landscape Lifecycles: from separate linear systems toward intertwined, cyclical systems exchanging waste to create hybridity and complexity (2016). Diagram by Catherine De Almeida.

As a design research framework, landscape lifecycles aims to push the design disciplines to tackle these waste landscapes with integrative approaches, strategies, and techniques that reactivate waste as a dynamic contributor to local and regional contexts. It is a method for integrating multiple diverse programs rooted in economic, ecological, and social performance to form hybrid assemblages in the transformation of perceived physical and spatial wastes. Broadening the scope beyond industrial land uses, site-based programmatic relationships are forged through the exchange of internally and externally sourced material byproducts that create new waste economies and ecologies, capitalizing on waste’s generating capacity. This method aspires to engender new culturally significant landscapes of multiplicity with waste, providing venues for multispecies users negatively affected by waste landscapes to participate in their transformation. Landscape lifecycles disputes conventional modes of reclaiming waste landscapes as generic passive parks by reframing waste as a resource with material, spatial, experiential, and aesthetic dimensions, which has the capacity to generate highly performative, diverse, and active landscapes as cultural destinations (De Almeida, 2018; 2019).

6 CONCLUSION

Landscape architecture has been constrained by the cultural construction of waste as undesirable—there is no single solution for approaching any particular type of waste site due to their diverse origins and conditions. Rejecting the notion of undesirable waste reveals there are infinite possibilities for reimagining how brownfields can be revitalized. A landscape lifecycles approach proposes to generate new, hybrid landscapes that interweave ecology, economy, and culture within the same landscape while engaging with a site’s broader community. These programs benefit one another through the exchange of waste materials, spatializing industrial ecology and integrating traditional and radical landscape architectural methods. In this approach, the end-of-life of materials and landscapes does not exist—these perceived wastes contain latent power to produce value, transforming their legacies by continuing their lifecycles.
7 REFERENCES


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THE EXPANDED FIELD OF BOTANY: AGRONOMY AND ECOLOGY IN THE BORDEAUX BOTANIC GARDEN

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Botanic gardens have historically synthesized influences from the aesthetic canons of landscape gardening and the scientific codes of botany. Today, however, botanic gardens often incorporate ambitions that go beyond pleasure and the base research program of plant collection and classification. They seek to better engage the general public, to provide information about current environmental issues, and to educate about the values that have guided the relationship between humans and the botanic world over history.

Two specific galleries of the Bordeaux botanic garden, designed by Catherine Mosbach and built between 1999 and 2007, constitute a clear example of the capacity of landscape architecture design and scholarship to successfully integrate the scientific and research objectives intrinsic to any botanical garden with the establishment of a strong public and educational program. Through the Fields of Culture, the garden is conceived as an agronomic demonstration that represents the different cultural roles of plants across different geographies and historic periods. In the Gallery of Environments, different geomorphological conditions found across the Aquitaine region are reproduced in a series of amorphous “promontories,” where management is kept at a minimum, so that the plant communities on top develop along successional processes with no major human intervention.

This article discusses Mosbach’s use of agronomy and ecology as a way to expand the scientific program of the modern botanic garden, and as a way to ultimately emphasize the capacity of landscape architecture to internalize, help advance, and make publicly accessible current conversations about the very constitution of the natural order.

Keywords
botany, agronomy, ecology, garden, design
Botanic gardens incorporate today ambitions that go beyond plant collection and classification. Although questions of plant taxonomy, which during the period following the age of explorations constituted the fundamental attractor in the emergence and development of this landscape architecture type, do still remain at the core of botany and continue to be important in the establishment of the program of a botanic garden, there is, however, a growing interest today in fostering stronger connections between botany and the general public. Botanic gardens are today public gardens with the potential to also address some of our current environmental issues, as well as the different forms of relationship between humans and the botanic world that have been constructed over time. In this article I shall use the botanic garden in the city of Bordeaux, designed by the French landscape architect Catherine Mosbach and built between 1999 and 2007, as a case study to represent some of these contemporary ambitions.

The botanic garden at Bordeaux is part of a larger municipal project of redevelopment of the right bank of the Garonne river. Contrary to the more urban and consolidated left side of the river, the right bank has been immersed since the late twentieth century in a process of postindustrial reconversion, for which the botanic garden was thought of as an opportunity to compose a new local centrality (Figure 1). Following the typical morphology of the French system of land subdivision in riverine areas, the garden was assigned an elongated and narrow plot defined by Dominique Perrault’s local masterplan for La Bastide district. Six hundred meters long and only one hundred meters wide, adjacent to the river on one of its extremes, the garden takes this morphological constraint as an opportunity to exploit the permeability of its long urban interface, in contact with new office and residential buildings, and also to define the structure of the garden as a sequence of galleries that unfolds perpendicularly to the water course. In the internal organization of these galleries, but also in the overall structure that formulates their sequence, there is an attention towards the scientific and research objectives intrinsic to any botanical garden, but there is also the ambition to establish a strong public and educational program that incorporates the garden into Bordeaux’s network of public green spaces.

Figure 1: Satellite image of the Bordeaux Botanic Garden. Bordeaux, France.
Source: Google Earth.
The sequence of main spaces of the garden begins at the area that is closest to the Garonne river, in the so-called jardin aquatique. Here, a mosaic of pools serves to grow various kinds of aquatic plants, and constitutes the point of departure of the exhibition, for aquatics was the first form of plant life that appeared on earth (Figure 2). The second stage in the sequence is the galerie des milieux, or “gallery of the environments,” which shows a variety of natural landscapes found across the Aquitaine basin in southwestern France, in which the city of Bordeaux sits. The next major area in the garden is the champs de culture, or “fields of culture,” where the visitor gets acquainted with the different uses that plants have developed as they have been cultivated by humans over history. The sequence ends in the area that is further from the river, where species that are not suited to Bordeaux’s climate are cultivated in a set of greenhouses, with particular emphasis on plants from the Mediterranean region. There is also an arboretum, which is broadly distributed across the whole space of the garden, and other minor events situated on the flanks of this central sequence in the garden, such as the vertical gardens, where a collection of climbing plants is cultivated to raise awareness about the diversity of plant morphologies and the allée of pioneers, an old and denuded oak fence, 450 meters long, recovered after a storm in 1999, which is being progressively colonized by lichens, ferns, and sedums growing under the shade of nearby trees. But the general discourse offered by the structure of the four central sectors—the aquatic garden, the gallery of environments, the fields of culture, and the greenhouses—is primarily educational, consisting of a spatial reading of a botanic timeline, which departs with the exhibition of early plant life kinds such as hydrophytes—plants that grow in water—and helophytes—plants that grow in marshy environments—to then enter into the plants’ conquest of the land in the form of “natural” formations, then progress to the domestication of plants for a multitude of different cultural purposes, and culminate in a glimpse of the potential “mediterranization” of the Aquitaine as a epiphenomenon of global warming.

Figure 2: Detail of the Jardin Aquatique, Bordeaux Botanic Garden. Bordeaux, France. Photograph by the author.
Besides the more scientific pursuit of the classic botanic garden, that is, the incorporation of a wide collection of plants as a means to recognize, investigate, appreciate, and preserve the diversity of the botanic world, the design puts the emphasis on the educational potential of botanic gardens in the twenty-first century. In order to bolster this vocation, Mosbach proposes two additional programs in the garden: the agronomic, in the *champs de culture* or “fields of culture,” and the ecological, in the *galerie des milieux* or “gallery of environments.”

Through the *champs de culture*, the garden is conceived as an ethnobotanical demonstration, that is, as an exercise of representation of the different social roles that the kingdom of plants has developed across the different cultures of the world and over centuries of agriculture. The *champs de culture* follow, in the manner of Leiden’s botanic garden, a regular organizational framework made of long, straight, and narrow *pulvilli* or planting beds (Figure 3). Despite their small size—they have widths that vary between 7 and 4 meters, and lengths between 20 and 12 meters, approximately—and as a way to bolster the cultural dimension of the world of plants in this section of the garden, these planting beds are labored through the traditional technique of ridges and furrows, as if they were actual agricultural fields. The elongated shapes of the fields, their linear combination, and the direction of the furrows, all together, exaggerate the overall site’s length, and seek the optical effect of creating a real agricultural landscape. As in agricultural fields, the plots serve as permanent canvas for the growth of temporary crops. And, since crops are in continuous transition, each planting bed is provided with an adjacent and independent water reservoir for irrigation, which allows for maximum control of soil moisture towards the growth a maximum variety of species.

Following the agronomic program of the garden, the rotating collection that is exhibited on the 44 different planting beds is not organized in accordance to the morphological expression of species in the collection, but rather in accordance with the social values that plants have acquired over time. In this sense, among other categories and subcategories, the collection presents edible plants (oils, mints, berries, vines, grapes, leafy vegetables, cereals, sugar plants, plants for the production of alcoholic beverages), ornamental plants (flowered legumes, aromatic plants, or simply assortments of flowers), medicinal plants (allergenic plants, conifers, essential oils), toxic plants, plants that are useful in various ways (dyeing plants, textile plants, basketry plants, and agrofuels), and other stand-alone chapters, such as plants that move rapidly, horsetails and fossil rocks, pioneer species, bulbs, bamboos, and so on. Each of the planting beds is monographically dedicated to a different subcategory and, therefore, the garden offers spaces which display, for example, a collection of textiles, such as mulberry (*morus alba*), cotton (*gossypium hirsutum*), or teasels (*dipsacus*)—anciently used as comb for raising the nap on fabrics, particularly wool—or plants for production of alcoholic beverages, such as wormwood (*artemisia absinthium*), sugarcane (*saccharum officinarum*) or hop (*humulus lupulus*), among others. But the regular organizational framework serves as armature to overlay, on top of this utilitarian classification of plants, a sensorial classification of the collection, which highlights the senses that are most adequate in the appreciation of the different species. In this sense, the garden features plants that are better sensed by touch and smell, such as mints, lemongrasses, and other aromatics; by ear, such as bamboos and plants that attract and feed birds; or by sight, such as ornamentals, plants that move rapidly, or dyeing plants. In order to favor this experiential aspect of the crops, the fields are flanked by small sitting rooms with bench in the shade under a tree, which is part of the arboretum.

In line with these fields of crops, the aquatic garden, situated right beside the Garonne river, follows a similar logic of discretization of species in accordance with their cultural values, resulting in seven different categories: medicinal, purifying, edible, aromatics, ornamental, captivating, and useful plants in general, for purposes that range from the production of papyrus
and ink in antiquity to colorants in today’s pastry making. A mosaic of sixty-five small independent pools surrounds a larger body of water, altogether a hectare in area. The compartmentalization of the aquatic environment allows for independent manipulation of the conditions in each pool, control of parameters, such as the composition and depth of the substrate, and, in some cases, introduction of additional elements, such as protruding rocks. The controlled design of the environmental conditions for the development of the plants serves to unfold on top of this cultural classification of plants, as in the case of the field of culture, an alternative recombination of plants, in this case based on the physiological expression of plants as a response to the conditions of the aquatic medium where they develop. As such, in the aquatic garden, some of the plants, regardless of their utilitarian purpose, flourish between air and water on the protruding rocks; some others rise up from the bottom of the pools, while others float on the water and more yet grow in underwater planters.

In pursuing this multifold reading of the collection, Mosbach stresses the idea of modularity. The establishment of a modular system is a central tenet in the internal organization of both the champs de culture and the jardin aquatique. Modules put the emphasis on the discrete individuality of each unit but without implying fragmentation: each unit is presented and evolves independently but is also understood as part of a larger whole, and as such is seen in continuity with the forms and rhythms of other units in the garden, the result being a landscape with innumerable possibilities of combination. Modules allow a focus on the content of particular moments and, at the same time, integrate them into larger scales of landscape that transcend the physical limits of the garden and enter the scope of the territorial.
This is the ultimate aspiration of the galerie des milieux or “gallery of environments,” where the controlled reproduction of different environmental conditions turns the garden into a synecdoche that seeks to represent the whole Aquitaine basin in southwestern France. In the galerie des milieux, eleven natural landscapes are reconstituted above ground, on their geological base, as emerging “promontories.” The five milieux to the north represent the landscapes of the right bank of the Garonne—the wet meadowlands, the pubescent oak forests, the dry meadows, the limestone green fields, and the limestone hills—and the six to the south represent the left bank of the river—the dunes, the dune fixation forests, the dune hinterland forests, the ponds, the dry moors, and the wet moors. The reconstruction of these landscapes is produced exclusively by using natural substrates, derived as synthesis from a series of surveillance campaigns carried out in these different environmental categories. And the exposure of these substrates offer, on the one hand, an understanding of the geomorphology and the stratigraphy of the regions, and, on the other, and more importantly, an understanding of the interrelationships that exist between plants, soils, and subsoils—an understanding of how the composition of the abiotic components of the physical environment determine, to a great extent, the vegetal formations that are perceived on the face of the land (Figure 4).
Part of the scientific program of the garden, these galleries are intended for researchers to study the development of ecological processes. As such, they are subject to scientific monitoring and periodic botanic inventories, but the overall management regime is kept at a minimum, so that the plant communities develop along successional processes with no major human intervention. With clear resonances with Derborence Island, the inaccessible and unmaintained structure that Gilles Clement completed in the Henri Matisse Park in Lille in 1995, the environmental galleries produce a very powerful visual effect on the urban environment, as if fragments of the Aquitaine landscape had been actually cut out and deposited on the gravel. Each of these plinths unfolds independently, and each constitutes an individuality, an island with its own internal processes. But following, however, Mosbach’s idea of modularity, as in the other sectors of the garden just discussed, their individuality is not at odds with the possibility of reading these landscapes in continuity with each other. The design proposes a set of different criteria that allow a construction of these continuities. The five galleries to the right of the Garonne, in this sense, are arranged according to a twofold progression, that of geological time, from the Secondary period of the limestone hills to the Quaternary wet meadows, on the one hand, and that of the evolution of the vegetal formations, from the absence of soil to the richest soil, on the other. The structural logic of the six galleries to the left of the river all formed during the Quaternary period is a topographic progression that moves inland from the ocean, a section where the gradual disappearance of the sea sand of the dunes gives way to the moors. The different geologic sections share tones and palettes that also allow for these visual interconnections and enhance the unity of the composition.

Referred by Mosbach as a cabinet of curiosities, where the natural history items of exhibition are, in this case, the landscapes, the galerie of milieux can be certainly regarded as
a theater of the surrounding environment, as an ecological microcosm, ecological insofar as it puts the accent, not on the natural objects or phenomena themselves but on the active interrelationships that exist between them, and on the combined forms and evolutionary processes that derive from them (Figure 5). This position recalls quite neatly the very establishment of the agenda of ecology as a scientific field, where Haeckel had criticized physiology as a biological science for being “incomplete,” for being limited to the study of the relationships of the different parts of the organism to each other and to the whole. Physiology had focused, in other words, on internal relationships within the organism, neglecting external relationships between the organism and the environment. In his view, this was problematic, for it was not possible to understand the organism independently from its processes of formation, which, in line with Darwin’s recent and groundbreaking theory of evolution, were governed by the adaptive relationships of the organism to its medium. In line with Haeckel’s program, the botanic garden at Bordeaux rejects a focus on the study of plants through different frameworks and criteria for internal classification. Instead of being a closed system arranged in accordance to relationships—be they arithmetic or morphological—that exist within the world of plants, the botanic garden at Bordeaux emphasizes the external relationships these plants establish with their physical medium, made of both biotic and abiotic components, as well as on the external relationships established with the world of humans.
Endnotes


iv Ibid.


vi Mosbach, “Le Nouveau Jardin Botanique de Bordeaux.”

vii Ibid.


x Catherine Mosbach, in an interview carried out by Bernadette and Jean-Marie Blanc, as part of a video documentary, “Bordeaux et ses paysages”. YouTube video, 3:00. Posted by Agora Bordeaux, November 22, 2017, www.youtube.com/watch?v=WaIB2Gz9AhU.
REFERENCES


