

Recognizing Greenway Network for Quantifying Students Experience on Campus-Based Universities: Assessing the Campus Outdoor Spaces at San Diego State University

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Abstract

This paper evaluates the potential of creating a green infrastructure – more specifically, an urban greenway – and its contribution to the students' campus experience, with emphasis on the outdoor university activities. To achieve best value for money – particularly in the current financial climate, with severe budget cuts constraining universities – justifying investments on campus outdoor spaces such as greenways, relies on a clear demonstration of their link to the overall success of the campus. Attempts to quantify the benefits from investments on such spaces are challenged by the scarcity of studies on the relationship between students' experience and design (and related cost) of different types of campus landscape settings. This paper fills this gap by offering a thorough examination of a variety of extant campus developments and by measuring the performance of some selected open spaces against a 'price-tag' mechanism. The case study of the San Diego State University has been chosen as core case study and supplemented by 16 sub-cases across California State. The assessment has been conducted through three steps. First, a site inventory of the physical characteristics and landscape features has been conducted, focusing on 7 typologies of campus outdoor spaces (COS). Second, four main use patterns (Individual-customized, Group-social, Programmed-scheduled, and Active experiences) have been assessed by calculating the intensity of use (function of the frequency and duration of use) for each of them. The data collected was based on syntax observation methods with photos and maps of COS as prompts. Third, a Campus-Experience-Score (C-E-C) has been calculated and normalized to the size and population of the university, matching it against the actual development costs of each COS setting. The C-E-C allows measuring the link between types and features of COS and related students' experience. Findings were discussed and verified through six in-depth interviews with local and international academics and developers/practitioners. This paper offers a valuable benchmark to designers and planners seeking to maximize the value for money of investments on COS such as greenways.

Background and Literature Review

“The Greenway was conceived as a dynamic place to embrace and enjoy rather than simply pass through.”

Amherst College Architect: Michael Van Valkenburgh Associates

This study examines the landscape design typologies used in Campus Open Spaces and relates them to their intensity of use and cost of investment. In so doing, it aims at shedding light on the value for money of capital investment on outdoor landscaped spaces, such as green areas, corridors, greenways. Several studies have discussed various typologies of campus landscapes as accessible places for putting the values and lessons of the classroom into action via both: a working landscape where people learn, teach, observe, farm, garden, and conduct research; and a social landscape to meet, gather, play, and relax (*Aydin & Ter 2008; Dahle & Neumayer 2001; Gumprecht 2007; Hanan 2013; Salama 2008; Sasaki 2010*). As such, a well-designed campus landscape relies on a distinctive network of COS typologies to increase and enhance the student experience. Greenway networks are strategic tools to achieve high levels of connectivity and continuity and create a healthy and responsive learning environment. In contrast, unbalanced distribution of COS typology and size with the intensity of use creates disordered campus patterns with users' dissatisfaction. As such, in order to prioritize campus investments, there is a need to revise and expand the ratios and design attributes of campus greenways for more efficient use. This paper stems from a larger research project on the use of COS and assess to what extents they can provide students with productive learning environments and positive experiences taking cost into consideration - including case studies located in England and California.

A. Greenways Networks and Campus Open Spaces Landscaping

The landscape design articulates vegetation, water features, structures and other landscape elements that help achieving better and healthy sustainable environment and quality of life. Campus greenways are outdoor spaces within campus with potentials to: connect people and places; conserve natural resources; improve public health; enjoy the outdoors and intensify routes with varied and enjoyable student experiences and connect with local community (*Gobster & Westphal 2004; Bahari & Said 2006*). A comprehensive review of what are the landscape features influencing users' behavior would exceed the scope of this paper. The selected landscape variables contributing to the COS Design Index - are developed from Dober's Landscape Taxonomy: border & gateway; structure settings; sign; lighting; circulation routes; memorials/arts, water features; outdoor furniture; planting & vegetation; special effects (*Dober 1992; Abu Ghazzeleh 1999; Dahle & Neumayer 2001; Gaines 1991; Griffith 1994; Eckert 2012; Franklin et al. 2003; Matlooba et al. 2014; Öztürk et al. 2016*).

B. Typologies of Student Experience

In addition to the traditional learning activities, a wide ranges of out-of-class environments - such as social gatherings and co-curricular programs - support the learning experience and maximize students' personal development by facilitating meaningful connections with faculty, peers, and the university. Both formal and informal outdoor experiences are relevant to students' success, and can be framed according to the following 2 main structures:

- (1) Educational perspective (*Kuh 1995; Moos 1979*): The amount of time and effort students put into their campus - through organized curriculum and other learning and social visions - to acquire social practices and other educationally purposeful activities.
- (2) Design/investment perspective (*CABE 2004; Strange & Banning 2001; Tolley 1996; Wiewel 2005*): How the university reacts and utilizes its facilities and resources in an economic way to support social and academic experiences and leading desired outcomes/values such as persistence, wellbeing, satisfaction, sustainability, etc.

The most frequently mentioned outdoor learning experiences are (in order of priority) : 1) Group discussion, 2) Individual studying, 3) Tutoring/consulting each other, 4) Relaxing, 5) Coincidental meetings, 6) Chatting, 7) Sharing current daily issues, 8) Observing surrounding areas, and, 9) Others (*Ender Peker 2012*). Those experiences - and more - were observed in chosen COS and aggregated in 4 categories, as shown in the following table.

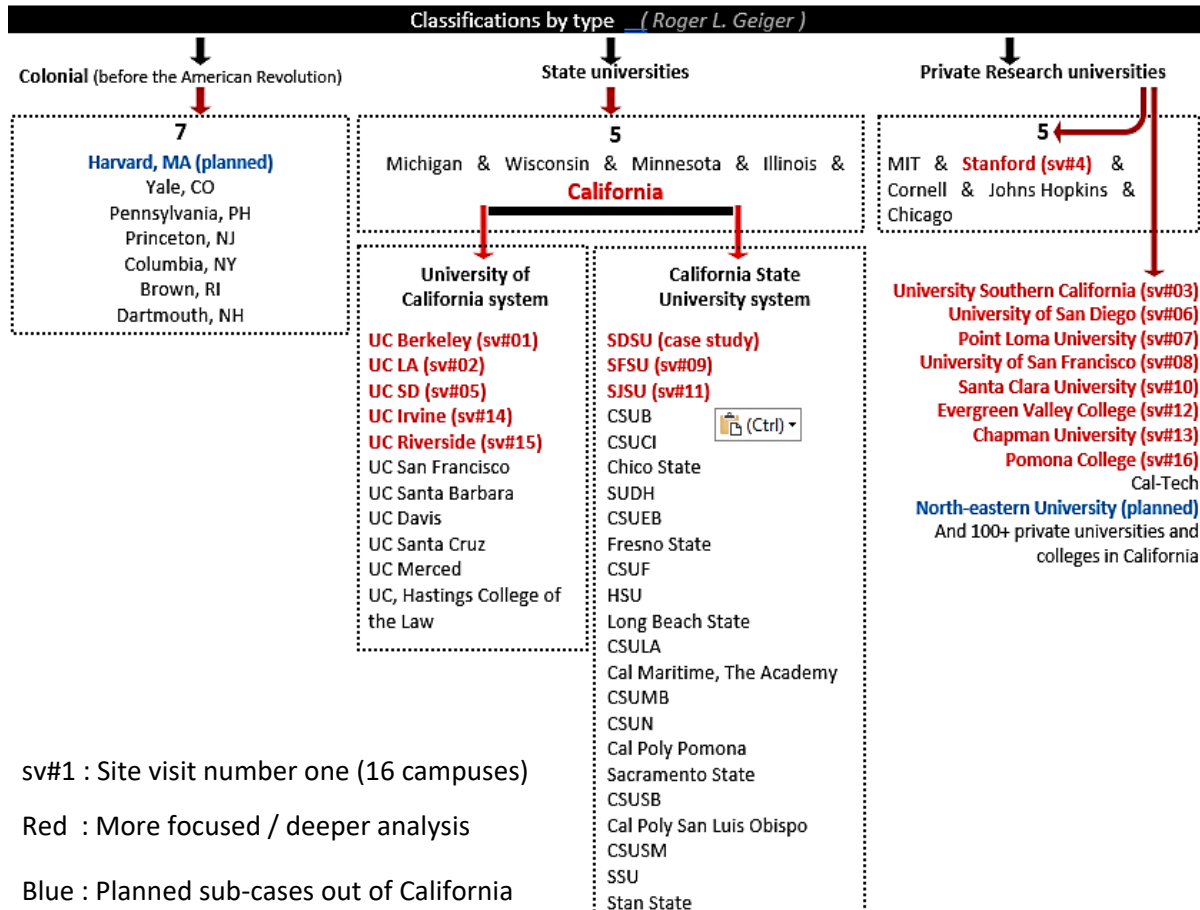
Table 1: Typologies of student experiences – 4 Zones (classification suggested by authors)

SDSU - COS		Description	Impacts
Zone1	Personal Individual	Any individual or personal activity such as reading/studying (2), eating, resting or relaxing (4), and talking/using phone.	Personal development, identity & sense of place.
Zone2	Group Social	Engaged informal, social and life activities done between 2 or more people. This can be group discussion and brainstorming-teamwork meetings (1&5), outdoor lessons or tutoring (3), eating and chatting (6), and observation (8).	Bond social and cultural connections among students.
Zone3	Programmed Academic	Involves formal/organized/scheduled activities such as events, open-speech ceremonies, open markets & local matches.	Integrate learning opportunities and enhance experiences along with the university mission.
Zone4	Active Energetic	Includes all physical activities such as walking, skating, cycling, fitness training or playing.	Improve health and wiliness.

C. The Higher Education system in California (*California Department of Education 2018*)

The California Higher Education system is the largest in the US, with over 2 million students. The state’s relaxed, welcoming reputation and powerhouse tech sector have produced some of the largest and most prestigious universities including UCLA; UC Berkeley; University of Southern California; Stanford University; UC SD; Cal Tech, etc.

Table 2: Selected case studies in California and planned ones classified by university type



D. SDSU Campus

San Diego is California's second largest city, with a population of about 1.3 million. Founded in 1897 as San Diego Normal School, SDSU is the largest and oldest higher education institution in San Diego County. Among the 23-member California State University (CSU) system, SDSU is the top ranked (highest ACT&SAT scores), has lowest acceptance rate (31%), the 2nd largest enrollment after CSU Fullerton, and the 3rd oldest university.

Table 3: San Diego State University - General profile











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Figure 2: Aerial view of the SDSU campus after the 2007 masterplan and the 2012 additions (SDSU interactive map at: <http://www.myatlascms.com/map/index.php?id=801#!ce/15530>)

In 2007, the Board approved the SDSU 2007 Campus Master Plan Revision (“project”). This landscape framework was strengthened in later years by axial malls that provide vistas to buildings, and ceremonial spaces for attracting campus events. The SDSU masterplan classifies the COS into 7 types the campus area. The table below shows the location of the 7 selected COS on the SDSU campus.

Table 4: location of the 7 selected COS within the SDSU 7 typologies

SDSU1	SDSU2	SDSU3	SDSU4	SDSU5	SDSU6	SDSU7
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SDSU1 **Quadrangles - Gardens**

These iconic, mostly native and natural landscapes contribute to the natural beauty and ecological character of the campus and provide habitat - used for educational purposes and passive recreation.

SDSU2 **Courtyards**

Areas of flat ground outside and partly or completely surrounded by one or more buildings. While not strictly defined as having a paved ground plane, most images of courtyards show primarily hard ground surfaces.

SDSU3 **Pedestrian Malls**

Surrounded by an academic and student life buildings, providing more intimate outdoor gathering areas. The scale of these spaces makes for successful, inviting places for students, faculty and staff.

SDSU4 **Central Plazas**

The central open space is a large space defined by a collection of the library, administration, food court, and Hebner hall. A relaxed set of paths, undulating topography & some shading plants populate the space.

SDSU5 **Fields**

Set aside for the display, cultivation and enjoyment of plants and other forms of nature. Incorporate both natural and manmade materials & may exhibit structural enrichments such as water features statuary, arbors, etc.

SDSU6 **Inspired spaces**

Unique open space, composed of architecture, landscape and signage to provide subtle, yet iconic demarcations of campus boundaries. A mix of shade & ornamental trees provide shade & seasonal interest.

SDSU7 **Entries & Edges**

The campus has four main points of entry from the neighboring communities, though there is one single dominant entry or main gateway. The campus would benefit from a stronger entry sequence and sense of arrival on campus.

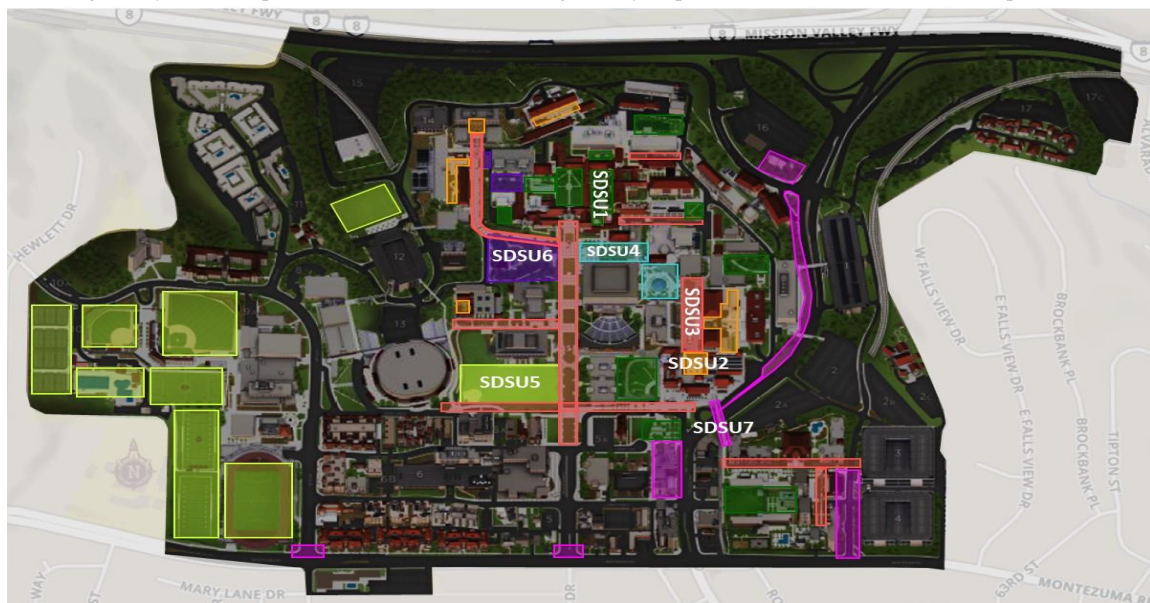


Figure 3: SDSU masterplan showing the 7 typologies and selected COS.

Goals and Objectives

The study aims to offer the campus planners/designers/developers design recommendations for developing investment visions based on students' needs and experiences. Key objectives were:

- To identify design principles for the COS/Greenway network that both enhances a special academic environment (meeting the university's mission and campus identity) and social hub (contributing to a welcoming and inclusive campus environment for all) for bringing students together on a multi-modal pathway connecting buildings and public spaces.
- To find the nexus between the cost of COS (based on area, design, and physical features, landscaping and natural elements) and the real and enhanced experience of outdoor settings (calculating the density, intensity and utilization rates).

Methods

A single case study (SDSU) - supplemented by 16 sub-cases in California of which 5 are top ranked - has been investigated through a mixed method using qualitative (unstructured-structured observations and interviews) and quantitative data. The 7 COS were selected as most representative of SDSU, accessible and highly demanded by students for different users. They were observed and analyzed according to their landuse, landscape features, urban criteria and spatial conditions developed from the "visual quality" methods. The 16 campuses were chosen for a variety of reasons: remarkable universities with top ranks/repetition; significant amounts of students and community users; recently or are under consideration for development.

The C-E-S calculation was based on number of variables representing the frequency and duration of use, university size by population and by area, development costs – and compared with 17 indicators representing the COS landscape typologies. The 7 COS was given C-E-S at SDSU and compared with 21 COS calculated from the 16 campuses. The site inventory was carried out with the COS index to record and analyze the following attributes: 1. Type of social activities 2. Spatial attributes 3. Actual costs of development.

A. Analysis of the masterplans of the campuses at California including SDSU

Included masterplan analysis and site visits at 16 campuses (see table 2) to assess the key physical parameters and current conditions of the COS design that facilitate activity and social interaction (placemaking). This was followed by a focused analysis of the collection of qualitative and quantitative data of the main case study SDSU - studied over 8 months (2018-19 academic year).

B. Unstructured Direct Observations

Additional unstructured observations recorded behavioural patterns using the suitable method and were described in detail using field notes/sketches - supplemented with extensive photographs and short videos (30 seconds to three minutes). The author often acted as a participant observer, taking sketches and notes along with walk-in interviews with students to clarify some experiences, their preferences, and their regular uses in each COS were also recorded. The face-to-face interviews with randomly selected students (n=138) were conducted during, before or after the observation periods as per purpose.

C. Structured Direct Observations

This ethnographic observation has been conducted with systematic classification based on manual counts (Space Syntax methods of gate counts, snap shots, and movement traces) of the 4 experiences (individual, group, programmed, and active) at the 7 COS. The author located himself at a discreet vantage point for maximum visibility of activity. Precise calculations were based on average the three one-hour time periods beginning at 8:30am, 12:00pm, and 4:00pm at 3 of the 5-

week days. Together, activities were recorded in detail on observation data sheets (table 5), attached with the map/plans, and avoiding situations that might affect the regular use (ex. extreme weather conditions or holidays).

Table 5: COS Design-Experience Index – Template used in the central plaza (COS-4)

Calculator vis star Information
 Public, Grade Found/1897 Urban Setting Selectivity 35%
 543,000 * Arctic green
 0.543 km²

University/city	SDSU/San Diego	Type	Grade Univ. Teaching	Area	0.6 km ²	Students	35,000	Rank #127	
Week day	Thursday	Date	15/11/18	Start Time	12:00	Duration	120 mins		
Special occasion	farmers Market	Weather		Period	<input checked="" type="checkbox"/> Morning <input type="checkbox"/> Lunch <input type="checkbox"/> Evening				
COS name	Sycamore Plaza (north of library & library dome)	Cost	385,000	Type	Central Plaza	COS #4	Area 5,500 m ²		
Notes / sketches				Map / location					
Design Index	North	South	East	West					
Ext proximity	Adm. Bldg Hobner Bldg	Library (no ent) 2 corridors bike racks	Front Court/Arms	mail/scrpps					
Int landuse	Shaded boardwalk	gentrifies to plaza 2 corridors to ball							
Heights	1 & 2 floors	5 floors	1 & 2 floors	no buildings					
Access									
Features	Sculpt/art	Samuel Black Stat							
	Siting	7x4=28	2x5=10	5x4=20					
	Water								
	Sign	3 signs	4 central	2					
	Light	5 spots		12					
	Shade/sinc	Central area							
	Vegetation	lawn, flowers	15 large trees central sitting	art edges	3 plant box 1x1.5m (Red)				
	Bike racks	5/11							
	Stair/ramp		stair ramp	stair ramp					
	Others	trash & water pump	trash 2	trash 5	41 + mail 4 handbags				
Space & Gate counts									
Direction	North		South		East		West		
	N1 ent	N1 exit	S2 ent	S2 exit	E3 ent	E3 exit	W4 ent	W4 exit	
Pr Mr Ln Ev	65-100 300	100-350 350	15-250 200	40-160 150	235-150 1300	50-300 280	15-80-65 10-100-50		
Space counts	Morning: ←		Lunch: ←		Evening: Density 0.6		Average: 3150		
Type	Zone1 / Individual		Zone2 / Social		Zone3 / Programmed		Zone4 / Active		
User counts	Phone/laptop ✓ Meal ✓ Study ✓	Meeting-chatting ✓ Meal ✓ Study ✓	Fossil meeting ✓ Event ✓ Tour ✓	Pass-by ✓ Play ✓ board/bike/ramp Rest ✓					
Total use & %	252 28%	522 58%	36 4%	756 84%					
Duration	15 < 20		20 < 15 < 40		40 < 15 < 60		15 > 60		
Intensity of use	31-188-136	62-305-183	10-380-0	36-408-339					
Total	66 x10	25 x30	2 x50	0 x80					
Intensity of use	$\frac{(66 \times 10) + (25 \times 30) + (2 \times 50) + (0 \times 80)}{60 \times 55 - \text{Area}} = 0.6 = 1.1$								

Morning
 Afternoon
 Evening

1.674/m²
 75%
 43.5%
 Int. 26/55
 0.5 per min

D. Validation - Interviews

The data collection has been used for testing the Campus-Experience-Score, a method aimed at measuring the influence of COS on students' experience by first ranking, then appraising the contribution of COS's spatial features on the duration and frequency of their use. Results from the ranking and calculation were validated through 6 in-depth interviews with international and local experts (academic, planners and designers). Validation of the outcomes from the testing of the methodology on the SDSU campus has been conducted through an in-depth discussion of the preliminary findings with the director of the SDSU planning office and one prominent SDSU academic expert on urban design. This led to come up with the recommendations on the future development of the SDSU campus, which were co-developed with the end-users and implemented into the SDSU main campus design guidelines and into the criteria for the design of the SDSU extension.

A. Indicators/Measures for the COS Experience Score

The study examined the consistency between the ranking of campus spaces based on student experience (intensity and duration of use) and its design features inspired by the methodology developed and tested by Gehl (1987). Indicators and calculation method of the Campus-Experience-Score follow.

- Frequency/Density of Use (Fu): Calculated by counting the total numbers of users crossing the COS per 1 hour (space counts) divided by its area. The 1 hour is an average of 9 hours (3 peak hours per day and 3 peak days per week).

Fu = number of users per hour / COS area. **Num/sqm**

- Duration-of-Stay (Ds): Calculated by studying how much time was spent by how many users and a corresponding score was assigned. Recorded under four categories: Ds1. users stayed less than 20 mins (multiply users by 10); Ds2. between 20 and 40 mins (multiply users by 30); Ds3. between 40 and 60 mins (multiply users by 50); Ds4. more than 60 mins (multiply users by 80). 100 is a constant value (Cv).

Ds = [(Ds1x10) + (Ds2x30) + (Ds3x50) + (Ds4x80)] x 100 / 60mins x COS area. **Num/sqm**

- Intensity-of-Use (Is). Function of both frequency and duration of use normalized to the total number of university students and the total area of the central campus. The overall social activity or liveliness of an environment is a product of the number of people and the duration of their stay (Gehl, 1987). Is equation is designed to show less scores if COS has larger use for short durations (as if people just passing through) then if there were fewer people staying for longer durations.

Is = [Fu + Ds] x total university students / total campus area. **Ranking score**

- Overall Experience (OEx): indicates number of users engaged in each of the four categories: Individual (Iex), Group (Gex), Programmed (Pex), and Active experiences (Aex). **Not applied on this study**

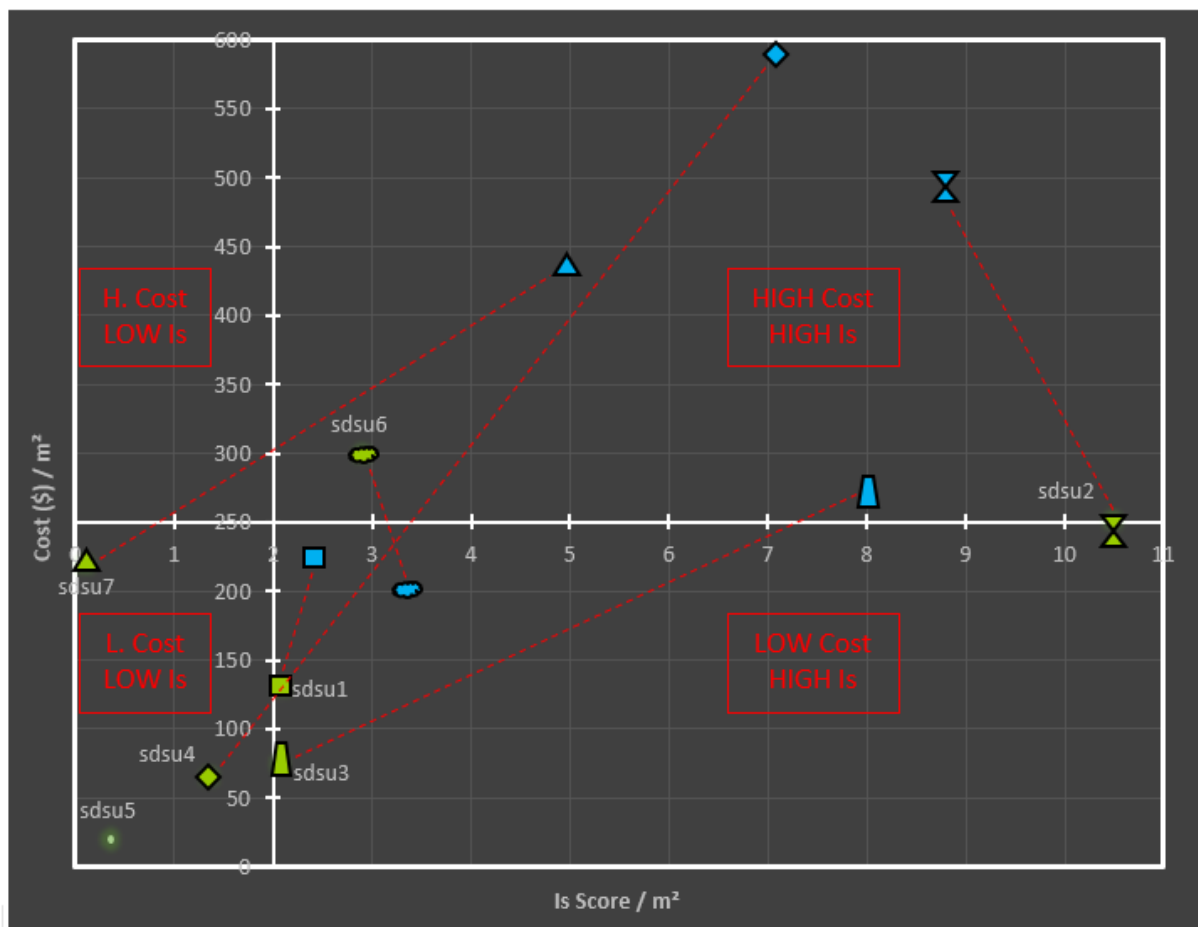
- **Cost of COS:** development cost of each COS specified by the masterplan development or approximately calculated based on the COS floor area and the natural and physical features.

- **C-E-S :** Intensity of use divided by the cost per sqm at each COS multiplied by 100 (Cv).

Table 6: findings of the Campus-Experience-Score at SDSU using the above equations

COS	Duration of stay				Fu (n/sqm)	Ds (n/sqm)	Is Score	Cost \$/ Area	C-E-S Is / cost
	< 20	20-40	40-60	> 60					
SDSU-1 Quad	67	33	18	4	0.3	48 / 35 1.37	2.08	450,000 / 3500 130	208 / 128 1.63
SDSU-2 Court	95	43	23	2	1.4	47 / 8.5 6.96	10.49	215,000 / 850 250	1049 / 253 4.14
SDSU-3 Ped.mall	96	28	12	5	1.1	46 / 84 0.55	2.07	630,000 / 8400 75	207 / 75 2.76
SDSU-4 Plaza	66	25	2	0	0.6	26 / 55 0.47	1.35	360,000 / 5500 65	135 / 65 2.07
SDSU-5 Field	12	15	30	15	0.03	32/121.5 0.26	0.37	260,000 / 12150 20	37 / 21 0.02
SDSU-6 Inspire	185	102	51	33	0.1	169/84 2	2.91	2,500,000/8400 300	291 / 298 0.98
SDSU-7 Entry	4	0	0	0	0.3	1/70 0.01	0.1	120,000 / 700 170	47 / 171 0.23

Figure 4: Graph showing SDSU campus score among top 5 California university campuses (Stanford, UC Berkeley, San Francisco State University, University of San Diego & UC SD)



- Quadrangle
- Field/park
- SDSU
- Courtyard
- Multi-purpose
- California
- Pedestrian mall
- Entries & edges
- Central plaza

Results from Focused Comparative Campus (Site-Appraisal) Study at SDSU campus








After setting a comprehensive profile of the SDSU campus and its context, a clear description of the findings is shown on table-7 for the C-E-S and recommendations of COS. Detailed analysis on the 7 selected COS is shown on the Appendix. A description of the 7 COS is summarized below.

- The main emphasis on data collection on SDSU campus is on the Center and North sides where majority of students enter on foot from the formal south main entry - specially from the student union (cos2) and the bridge (cos7). Other less-used entries for cars and from the South entry where the \$130M New Student Residence Hall is taking place.
- The new student union development project - commonly referred as Aztec Conrad – cost \$104 M on a 206,000 GSF which was completed January 2014 and got the LEED Platinum for New Building and Maintenance. It has diverse public and private outdoor spaces in the significant courtyard (cos2) and 4-storey building each with shaded terraces and roof deck.
- Following the north entries comes the Centennial Mall (cos3) around the Love Library which was first constructed during the mid-1990s and has been recently developed in 2013 - costing \$600,000 and raising funds of 1 million. Future phases of the project will extend the improvements in front of Student Services West and Manchester Hall.
- At the heart of the campus and just north of the Library, comes the Sycamore central plaza (cos4), which with the 2 pedestrian malls (cos3) represent the main campus greenway. This greenway is a key social and perceptual orienting reference, providing diversity of spaces for waiting, studying, relaxing, displaying and other activities. The plaza has a huge open area mainly used for the weekly events such as the sustainably focused market on campus Thursdays with produce & international food. Students stay less at the plaza due to lack of convenient seating areas and enclosed, welcoming environment. It has however significant proximity to the student services, student union, library, bookstore and stationary, local restaurants and food court, banks, general lecture halls, research centers, amphitheater and the sport field (cos5).
- Adjacent to cos5 and on the west of cos4 is the unique Scripps Terrace (cos6) outside the West Commons - the biggest naturalistic landscape space on campus. The sloped grass areas are ideally suited to sitting, picnicking, reclining, reading and relaxing, and are frequently used for this purpose. The curving walks contrast with the more formal, rectilinear walks in other areas of campus. A mix of shade and ornamental trees provide shade and seasonal interest, but their placement allows a choice of sun or shade. The pond and stream offer a more natural looking water feature than the geometric and contained fountains on other parts of campus. Decks, bridges and a patio outside Scripps Cottage afford locations for programmed outdoor events that are separated by topography from the rest of the space. Although it is classified as unique/special space, elements of cos6 may provide inspiration for some specific locations across campus.
- Finally, the quad (cos1) which students stay extensively as sustained by structural enhancements such as water features, fountains, statuary, arbors, trellises, and the Mediterranean Garden.

After reviewing the assessments and conducting the fieldwork at SDSU as well as 16 university campuses, several factors formulate the students' experiences frequency and duration of stay at COS as follows:

- Natural and weather conditions such as temperature, sun, and rain have the greatest effect.
- Accessible location (e.g. how the COS is seen by potential users, access to major sectors).
- Clearly convey the message that the place is available for use and is meant to be used.
- The university ranks and its local and international reputation.
- The area of university campus and the extends of enclosing community area and future extensions.
- Number of students attending and population of local community.
- Offer a pleasant, comfortable environment that adapts to the above factors with more engaging and flexible space and furniture design that support the most likely and desirable activities, as well as provide a feeling of security and safety.

Table 7: C-E-S findings and recommendations for different typologies of COS

Ranking of the SDSU COS	Score	Design features related to the SDSU COS
1 Courtyard 	SDSU2 70%	Relatively small size, relatively small corridors, strong identity, Proximity to the students Union, active edges of the Plaza (x restaurants, y coffee shops, etc), less vegetation
2 Inspired 	SDSU6 69%	Diverse trees, water, 50% shadowed area, ecological, wild life, strong identity, deep connections to place
3 Quadrangle 	SDSU1 59%	<ul style="list-style-type: none"> - Clearer access to surrounding educational buildings. - Seats and lawn are in poor maintenance. - Smart use of the Garden and backyard area to embed demonstrated sustainability practices.
4 Mall 	SDSU3 56%	<ul style="list-style-type: none"> - Good access, intermediate location, and good opportunity for a greenway that support social and academic interaction. - Better design control (access to scooter/bikes at limited times) to reduce conflicts between pedestrian, cyclists & vehicles. - Ensure this recent greenway design responds in a meaningful way to adjacent Manchester hall area (unused) and broader campus connectivity.
5 Entries 	SDSU7 47%	Opportunities to be SDSU significant landmark, need better design for the start and end nodes of bridge
6 Plaza 	SDSU4 43%	<ul style="list-style-type: none"> - Decreased duration of stay because of uncomfortable seats, central yet lost controls, lack green, shelter and water elements; - Access, circulation, furniture, decorative elements, and plantings must be coordinated to facilitate intended usage
7 Field 	SDSU5 36%	<ul style="list-style-type: none"> - Flexible site furniture (seats, shadows, sport equipment, etc) to provide rich and engaging game experiences; - Increase more programmed activities and advertise more free sessions to regenerate with entertaining & fulfilling activities; - Enhance vegetation on edges with better maintenance; - Interactive technology designed to sense, learn, and adapt to players' behavior.

Discussion and Conclusion

The main goal of this paper was filling the gap in the current scholarship and design practice on how far spatial features of COS influence students' experience on campus and their value for money. This has been achieved by developing the Campus-Experience-Score (C-E-S), a methodology allowing to measure the link between different landscape settings and intensity of use, in relation with their costs. Findings offer valuable insights both to make informed decisions and prioritize investments on COS, and to guide campus designers. However, to gain predictive value such a research would require a huge amount of data, exceeding the scope of this paper. Further parameters could also have been considered, such as urban patterns (connectivity, sustainability, flexibility, etc.), building characteristics (height, architectural style and features, materials, etc.) and COS university policies (such as information on student data 'enrollment profile' and organizing events), which may have a critical impact on the achievement of higher intensity of use.

Is it always true that higher ranked and historical universities rely on better campus spaces? The type and history of campus development including its age, recent and future masterplan, and continuous specified minor development at certain COS is considered in this study and can have a huge impact on student communal and their style of living on campus. For example - although cost more - private universities have significantly higher mean scores than public schools, and teaching (Research I) more than research (Research II) universities. This finding may raise several questions. Campus design may not have a direct influence on freshman retention, but it much more likely provides a "restorative environment" (Kaplan, 1992) and can affect the students' satisfaction and in some cases the graduation rates.

The SDSU campus is remarkable in its simplicity and richness, and it has a very robust structure increasing the attractiveness and safety of the COS which has been continuously developing over more than 50 years. For example, the recent extension of the SDSU transit center and plaza, the shops and restaurants at College Avenue along the southern edge of the campus along with the new Aztec student union enhanced the livability, and created opportunities for new innovative activities and events for students and with residents, thus contributing to the local economy of campus.

Well-designed COS can be fascinating places allowing users to be closer to nature and promoting enriching experiences. Connectivity is an important characteristic for commuting across a multifunctional campus greenway by different means (frequency factor) while performing some physical activity at active nodes is important for health and wellbeing (active experience). Solving assignment or taking a short nap in a green hill setting of campus can be inspiring (individual experience). Facilitating students to congregate for longer (group experience) can indicate how the campus responded to the diversity of the students (different age-fields-cultures) and to different purposes (variety of activities). Performing arts or other activities scheduled at galleries or at vital street or at accessible fields may encourage more students to participate (programmed experience). Therefore, efforts should be done to improve a diverse, safe, and inviting environment in which the university community can conduct its business of learning and research.

The study findings suggest substantial counting of student participation in outdoor activities using observational/tracking measures (Gehl & Svarre 2013). The analysis revealed notable underestimates of the very short engagement at central plaza and other main public spaces as the pedestrian malls although more frequently used specially to fresh students and more seen and accessible, while private and/or special COS - such as the Scripps and the quadrangle - have significantly higher duration scores. This may not be only for their design distinction to

meet the student needs, it may be related to their location as some students prefer quiet, 'hidden' spaces.

Future studies can build on these findings and explore the impact of specific design attributes and affordances/investments on campus for specific learning, social, or environmental outcomes. For example, it would be worth assessing to what extent more inspired and specifically programmed COS do increase positive behaviors among students. Besides, as a subject of future research, the use of the space over the duration of the day is equally important as an indicator of the usefulness of the space.

Looking more closely at questions of outdoor intensity of use and associated costs will help maximize the benefits of campus planning through adequate distribution of COS design and size based on monitoring student behaviors and associated design costs. For example, university directors could increase use of COS through planning for various public and special programmed activities. However, the distribution of such activities needs to be carefully planned along with the COS design and use. A better understanding of these relationships would be of value for campus planners to make evidence-based decisions. C-E-S can be developed to act as a tool to prioritize investments in campus greenway development that help preserve and activate COS.

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Appendix

A. SDSU-1 : Quadrangle

SDSU1					
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Definition : Quadrangles are usually rectangular in plan, the sides of which are entirely or mainly occupied by buildings. Usually planted areas with lawns as a ground surface.

Examples : - Hepner Quad (selected) - Banana Quad

Observation : It is observed that good amounts of students stay although it is not the most used space (people crossing the gates are more in the adjacent Hebner Hall space with less durations of stay). This means that the indicator of the Intensity of use evidence the willingness of students (more favored) to stay in a certain space rather than its functional role as a frequently used space for accessing other destinations (more used).

AREA	3,500 m ²	0.60 % Total COS (540,000 m ²)			
		0.35 % Total Campus (900,000 m ²)			
DENSITY	4200 st / day (per SDSU-1)	12% Total FT students			
	1.32 st / m ²				
Overall 59%	lex 60%	Gex 76%	Pex 28%	Aex 72%	



B. SDSU-2 : Courtyard

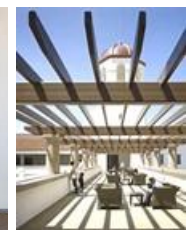
SDSU2				
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Definition : Courtyards are areas of flat ground outside and partly or completely surrounded by one or more buildings. While not strictly defined as having a paved ground plane, most images of courtyards show primarily hard ground surfaces.

Examples : - Goldberg Courtyard at Student Union (selected) - Student Services East & West

Observation : This is the top ranked COS due to several issues : location and accessibility, student friendly environment, student events, combine corridors for movement, shaded seating areas and central area for social gatherings and events.

AREA	850 m ² Including arcades	0.16 % 0.09 %	Total COS (540,000 m ²) Total Campus (900,000 m ²)
DENSITY	6500 st / day (per SDSU-2) 7.65 st / m ²	19% Total FT students	
Overall 70%	Iex 68%	Gex 90%	Pex 30% Aex 92%



C. SDSU-3 : Pedestrian Mall

	SDSU3			
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Definition : Primary purpose of malls is movement. Defined as a public area designed as promenade or pedestrian walk, with a combination of plants and paved areas.

Examples : - Campanile Mall (selected) - Centennial Mall

Observation : As recently developed at 2013/14, the Campanile axial route with arcades on edges and central seating areas with shading trees enhances the sense of campus and place to watch the passing crowd. It generates student's informal activities and becomes a strategic place for social events.

AREA	8,400 m ²	1.42 % Total COS (540,000 m ²)	0.85 % Total Campus (900,000 m ²)
DENSITY	12,000 st / day (per SDSU-3)	35% Total FT students	
	1.57 st / m ²		
Overall 56%	Iex 42%	Gex 79%	Pex 14%
			Aex 88%



E. SDSU-4 : Central Plaza

		SDSU4		
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Definition : Central hard surface areas used for campus social and educational events (afford locations for programmed outdoor events).

Examples : - Sycamore Plaza north of Library (selected) - Area around the Library dome entry.

Observation : Lacking the attractive key issues of central plazas.

AREA	5,500 m ²	0.83 % Total COS (540,000 m ²) 0.50 % Total Campus (900,000 m ²)
DENSITY	7,500 st / day (per SDSU-4) 1.67 st / m ²	21% Total FT students
Overall 43%	lex 28%	Gex 58%
		Pex 4%
		Aex 84%



B. SDSU-5 : Fields

			SDSU5	
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Definition : Central hard surface areas used for campus social and educational events (afford locations for programmed outdoor events).

Examples : - ENS Field (selected) - Hebner Mediterranean Garden (plants from Mediterranean climates across the globe).

Observation : Has relatively low ranks in both frequency and duration of use. For this reason, university might consider and post a greater number of organized activities as well as free sessions that promote moderate physical activity for students families, community, and seniors.

AREA	12,150 m ²	2.25 % Total COS (540,000 m ²)
		1.35 % Total Campus (900,000 m ²)

DENSITY	71,500 st / day (per SDSU-5)	4% Total FT students
	0.12 st / m ²	

Overall 36% lex 42% Gex 12% Pex 16% Aex 92%



B. SDSU-6 : Inspired/Multipurpose spaces

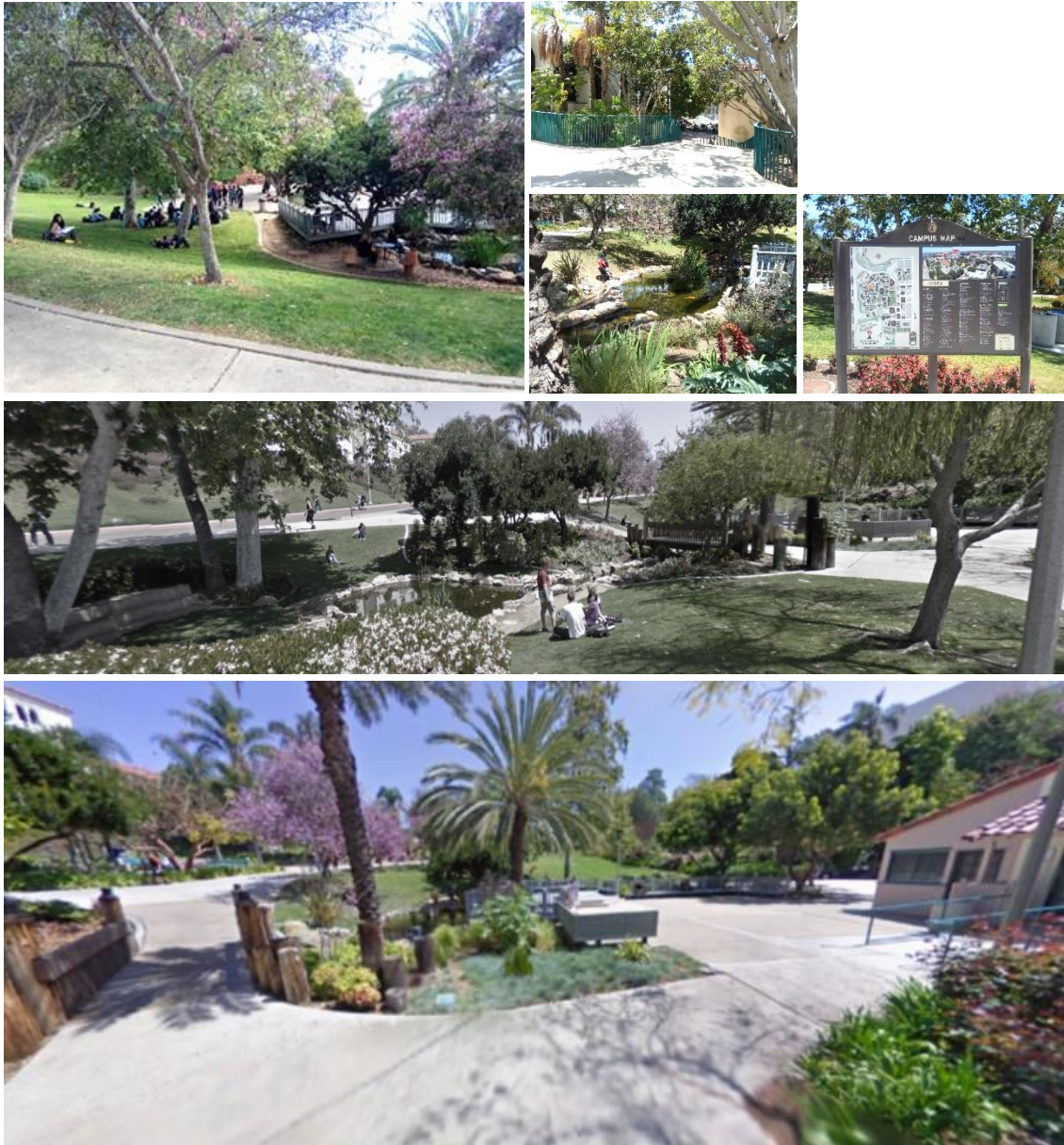
					SDSU6	
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Definition : Unique open space, composed of architecture, landscape and signage to provide subtle, yet iconic demarcations of campus boundaries. A mix of shade & ornamental trees provide shade & seasonal interest.

Examples : - Scripps Terrace (selected)

Observation : This natural environment has the second highest ranks.

AREA	8,400 m ²	1.56 % Total COS (540,000 m ²) 0.93 % Total Campus (900,000 m ²)
DENSITY	2000 st / day (per SDSU-6) 0.23 st / m ²	6% Total FT students
Overall 69%	Iex 76%	Gex 84%
		Pex 38%
		Aex 80%



B. SDSU-7 : Entries and edges

						SDSU7
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Definition : Entrance elements use a mix of architecture, landscape & signage to provide special appearance of structural elements & landscaping along the visible edges.

Examples : - Bridge (selected) - Clay Gateway at the main entrance at Campanile and Montezuma.

Observation : Considered as the main gateway for entering the campus.

AREA	7,000 m ²	1.30 % Total COS (540,000 m ²)			
		0.78 % Total Campus (900,000 m ²)			
DENSITY	2000 st / day (per SDSU-7) 0.29 st / m ²	6% Total FT students			
Overall 47%	Iex 16%	Gex 78%	Pex 0%	Aex 96%	

