Practice-Based Research:
Operationalizing Landscape Performance

March 20, 2014

Allyson Mendenhall, Director of Legacy Design
DESIGNWORKSHOP

Riverfront Park—Denver, CO

Aspen

Austin

Chicago

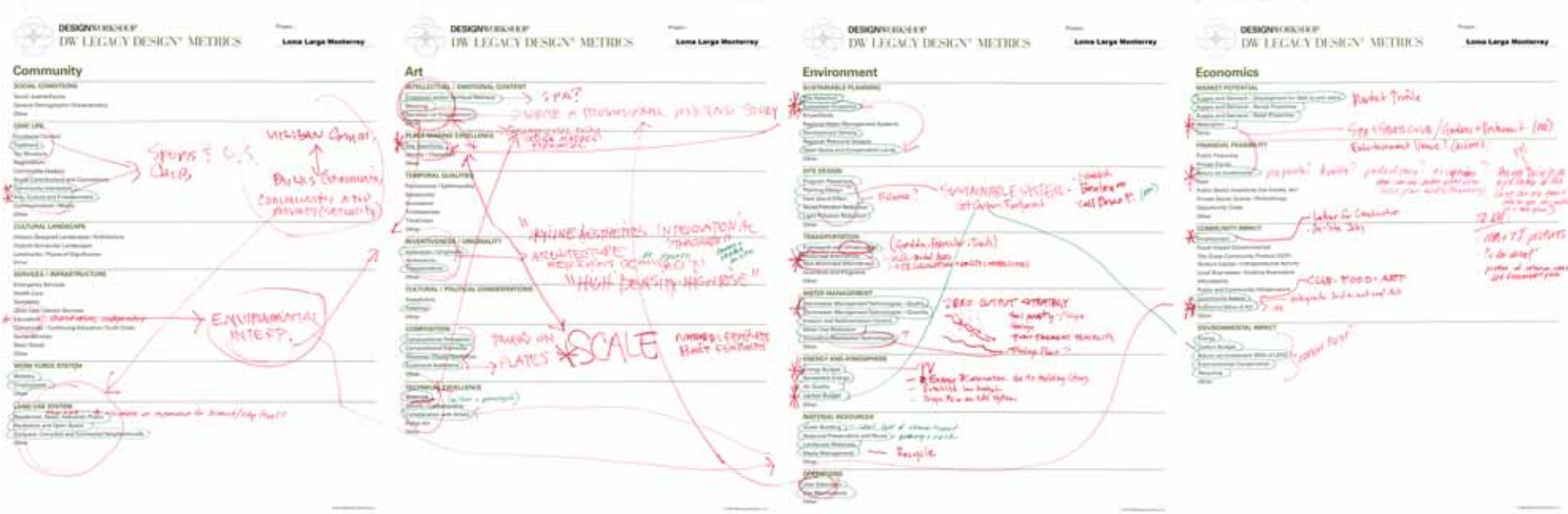
Denver

Houston

Tahoe

DESIGNWORKSHOP

DW Legacy Design


DESIGNWORKSHOP
DW LEGACY DESIGN® METRICS
Lona Large Monterrey
Community
Art
Environment
Economics

Measureable Benefit

THE FULLER MEASURE

BUILDING BETTER METRICS: THE SYNTHESIS OF ECONOMICS, ENVIRONMENT, COMMUNITY, AND ART.

BY KURT G. CULBERTSON, FASLA

In October 2010, the U.S. Department of Housing and Urban Development announced the winners of $100 million in Sustainable Communities grants. These grants went to 45 areas of the country to create what HUD is calling Regional Plans for Sustainable Development. The grants are a huge step forward, part of the Obama administration's Partnership for Sustainable Communities, which unites HUD, the Department of Transportation, and the Environmental Protection Agency to coordinate public investments in infrastructure, facilities, and services across various federal agencies. The hope is that this kind of coordination will amplify the economic, community, and environmental benefits of the projects we target with tax dollars. By considering housing, transportation, and environmental protection in a full, synthetic way, the move marks a potential turning point in land-use planning and design in this country. For landscape architects who are adept at bringing together diverse, complex sets of knowledge in projects, this program presents a huge opportunity.

The Sustainable Communities grants are remarkable because they bring together three federal departments that profoundly shape our natural and built environment—agencies not known in the past for their collaboration—but also because they look for measurable outcomes and heavily emphasize computer modeling and metrics to track the progress of proposed interventions. They help to formalize a new emphasis on measurement in planning and design issues.

These days, landscape architects are obsessed with green certification and rating systems and are busy searching for "points" to achieve the desired rating for their projects. Measurement has taken on a life of its own, especially since the founding of the U.S. Green Building Council nearly 20 years ago, which brought on huge growth in the development and application of rating and certification systems for green building—the council's Leadership in Energy and Environmental Design, or LEED, program now covers approximately 8,500 currently certified buildings. The number of ENERGY STAR–rated buildings is over 13,000. These are just a few of many such systems built around the notion that "what gets measured gets done." A National Association of Homebuilders/McGraw-Hill construction survey shows that more than half of the NAHB's members, who build more than 80 percent of the homes in the United States, will incorporate green practices into their development in the next two years. Metrics-based systems, which reward projects for their proven ability to reduce water or energy use or provide measurable performance in a number of areas, have moved the environmental design discussion from platitudes to positive action. In that regard, they are to be applauded.

But making a limited number of environmental measures synonymous with sustainable design is short-sighted. A project can save water or cut energy use, yet contribute little to the success of a community culturally or economically. The benefits of sustainable development and, by extension, sustainable design

IMAGE CREDIT
Charles Birch

Research Agenda for the Landscape Architecture Profession

RESEARCH PRIORITIES

BY KURT D. CULBERTSON, FASLA

As a practitioner, I am often approached by graduate students in search of thesis topics that will be of value to landscape architecture practice. I have found that, more often than not, their desire is to produce research that will have utility and value to the profession rather than simply meeting degree requirements. But the role of research in landscape architecture has always been weak relative to that of other professions such as medicine or engineering. Though practitioners investigate and gather information in their project work, most of them are not trained researchers. Education in research methods is seldom incorporated into undergraduate curricula. Many firm principals recognize the growing importance of research, especially given the move toward evidence-based design. Evidence-based design, now common in fields such as health care, is a design approach that emphasizes the importance of using credible data to influence the design process. But practitioners may balk at the idea of adding work in the midst of their constant need to get projects out on time and on budget. Even so, a well-grounded foundation of research is needed to ensure that evidence-based design does not fall into the realm of pseudoscience.

Evidence-based design offers a great opportunity for the profession—the chance to build a dynamic relationship between academia and practice by establishing a research agenda for landscape architecture at a national level. A national research agenda would not restrict or bias the research efforts of the academy. Rather, it would aggregate and give structure to the many issues of research important to the profession and identify a context for investigation. Although there is clearly a place for research within professional practice, it is the academy that must provide leadership. Some landscape architecture degree programs are emphasizing evidence-based design, and others have active research programs. But the profession needs a way to raise the visibility of these research efforts. Ideally, an organization such as the Council of Educators in Landscape Architecture (CELA), perhaps in conjunction with the Landscape Architecture Foundation Performance Series, would conduct a periodic survey of the profession to identify topics of research interest and schools where they are a focus.

CELA has historically played an important role in fostering a research community, and ASLA's Professional Practice Networks have circulated and promoted research that is closely linked with practice. The new National Academy of Environmental Design, a consortium of national design organizations including ASLA, will further advance research within the design professions.

A national research agenda could suggest areas ripe for theses and dissertations to help stimulate graduate-level research. It might propose projects of immediate relevance, but it should also include inquiries into topics that may apply more speculatively to the profession—the kind of exploration critical to bringing new ideas to the surface. Potential solutions identified by the academy can be tested by practice. In turn, new areas of interest to the academy will emerge from practice as well.

Providing a framework for the collaboration of academia and practice offers the potential for generating funding sources for academic research. Sophisticated clients are willing to pay for research that will help solve the challenges they face if they have confidence in the research and can see a reasonable return on their investment from the results. Some enlightened practitioners, who face common challenges across multiple projects, may also contribute to research that advances their practice areas.

There are two areas of concern, however. The first is that some academicians are suspicious of privately funded research and its whiff of potential bias. Rather than turn away private funding, we need clear standards to ensure objectivity. The second concern is that some academic programs are eliminating the requirement of a thesis for the graduate degree, substituting instead a final project that, in many cases, is not a framework for rigorous research. Graduate students are often poorly prepared to conduct thesis research because of a lack of training at an undergraduate level.

Design approaches without evidence are based on theory alone. Our obligation to maintain the health, safety, and well-being of society demands more. Evidence-based design suggests a need for research in multiple areas, such as sociology, community planning, and economics, as well as traditional design issues. Our efforts must be built upon the collaborative efforts of private practice and the academy guided by a national research agenda that gives focus to our work. ●

KURT D. CULBERTSON, FASLA, IS THE CHAIRMAN OF THE BOARD OF DESIGN WORKSHOP.

Practice-Based Research

http://www.designworkshop.com/documents/world-architecture-review_dec-2013.pdf


33%
of local stormwater
captured by
rain gardens before
it drains into the bayou
Rain Gardens remove 75% of bacteria, 73% of phosphorus, 93% of oil and grease and 85% of total suspended solids from stormwater before it returns to bayou
midtown


88%
of sidewalks
will be shaded
when trees
reach maturity


3X
increase of
pedestrian space
within the right of way
midtown


Average
13°
COOLER
temperatures
due to increased shade and
specific material selection

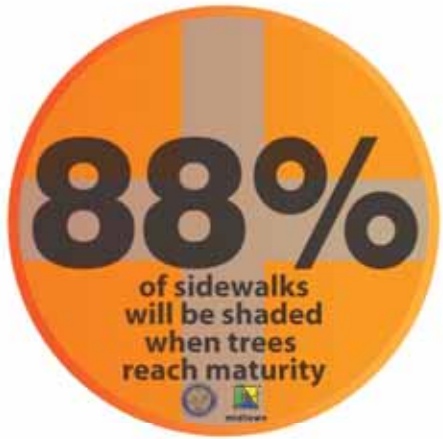

Bicycles
Welcome
on Bagby


See Bagby
Street in a Whole
New Light
(just look at all those new lights making it a safer street)


45%
reduction
of street crossing distance.


33%
of local stormwater
captured by
rain gardens before
it drains into the bayou

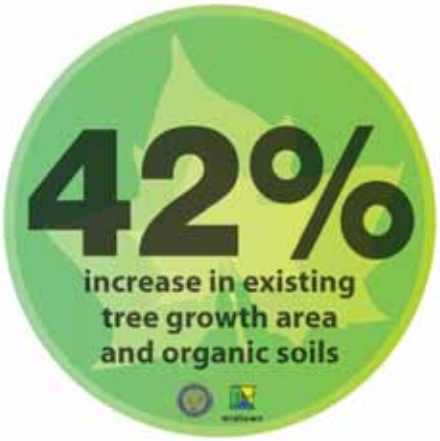

this concrete saved
300
TONS OF CARBON
from being emitted into the atmosphere
(that's equivalent to you not driving a car
for the next 133 years!)


88%
of sidewalks
will be shaded
when trees
reach maturity


more than
3X
the tree canopy
overhead


Dogs
Welcome!
(because Bagby Street is for everyone)


3X
increase of
pedestrian space
within the right of way

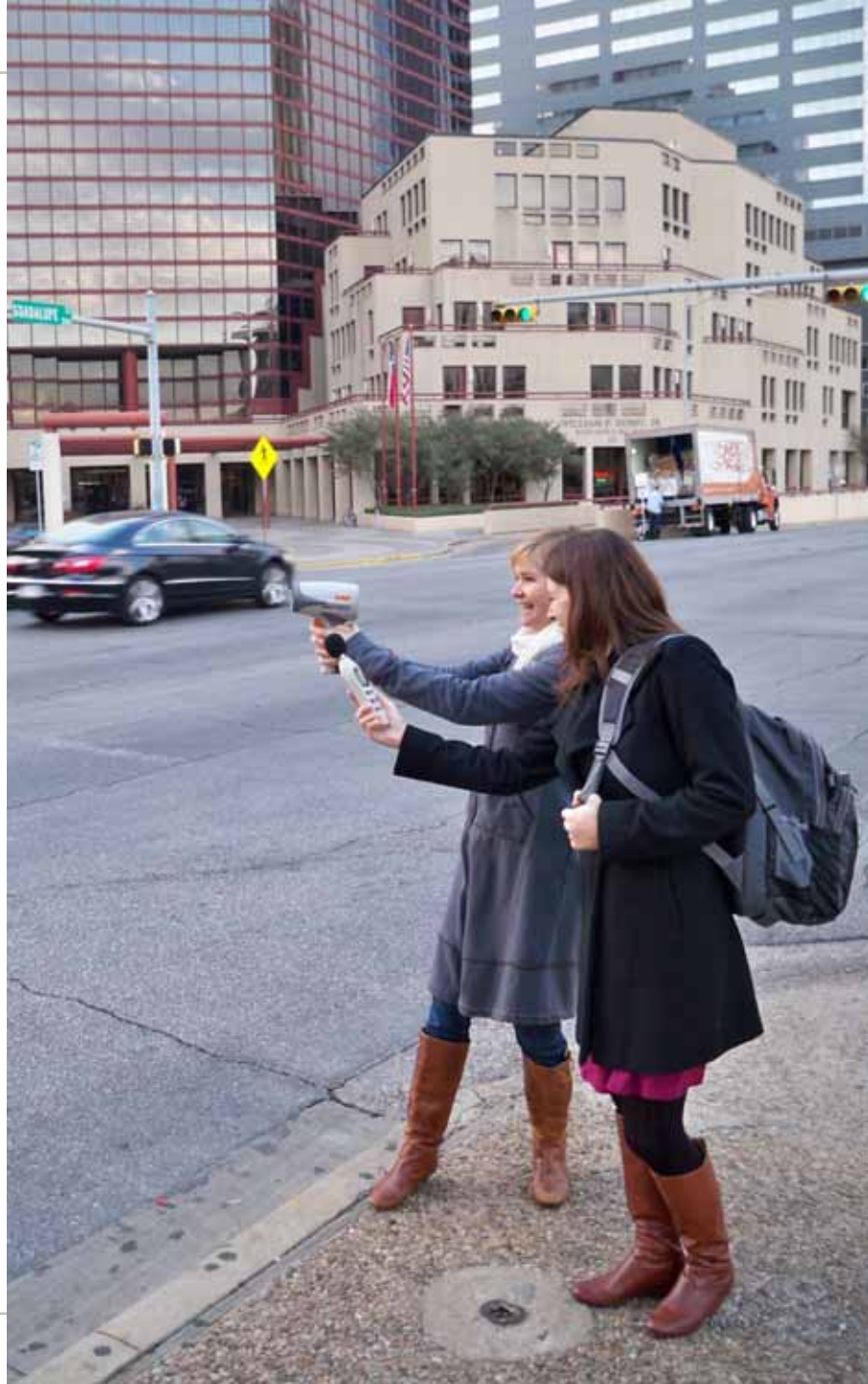

42%
increase in existing
tree growth area
and organic soils


38%
more seating
and gathering
places on the
street

Measurement Tools Backpack

Site Analysis

Baseline Conditions =
As is conditions



Measurement Tools

Temperature

Noise

Light

Speed

Weather

Tree Caliper

Digital Counter

Digital Counter

Manual Counter

Human Comfort

South Grand Great Streets Initiative—St. Louis, MO

South Grand Great Streets Initiative

1. South Grand Boulevard
2. Tower Grove Park
3. Gravois Avenue
4. Interstate 44
5. Master Plan Study Area
6. Phase One Project Area


Typical Sidewalk Condition


Typical Side Street Character


TowerGrove Park Entrance

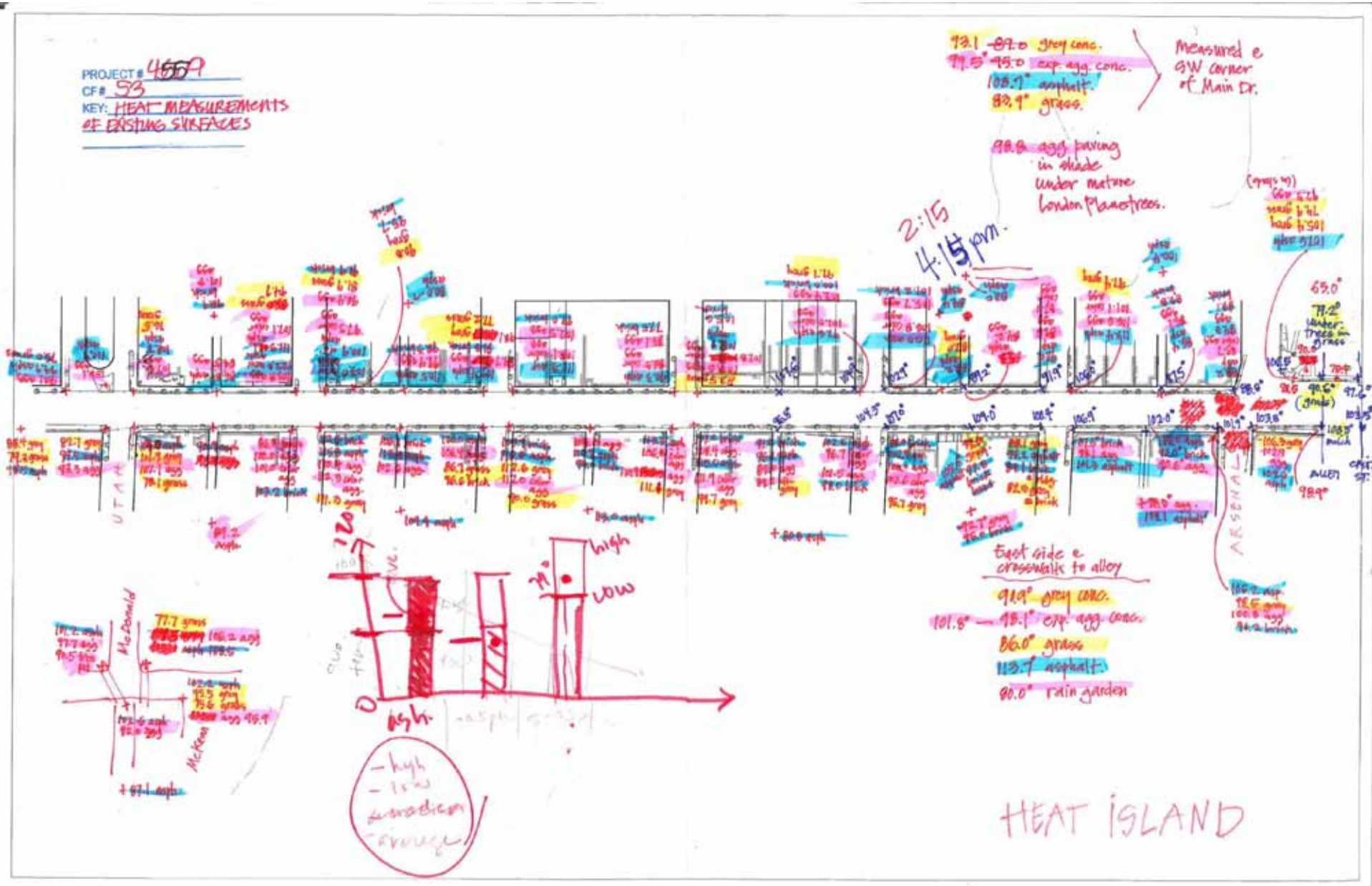

Typical Dining Experience

Infrared Digital Thermometer

Hand-held laser gun measures the surface temperatures of a variety of materials.

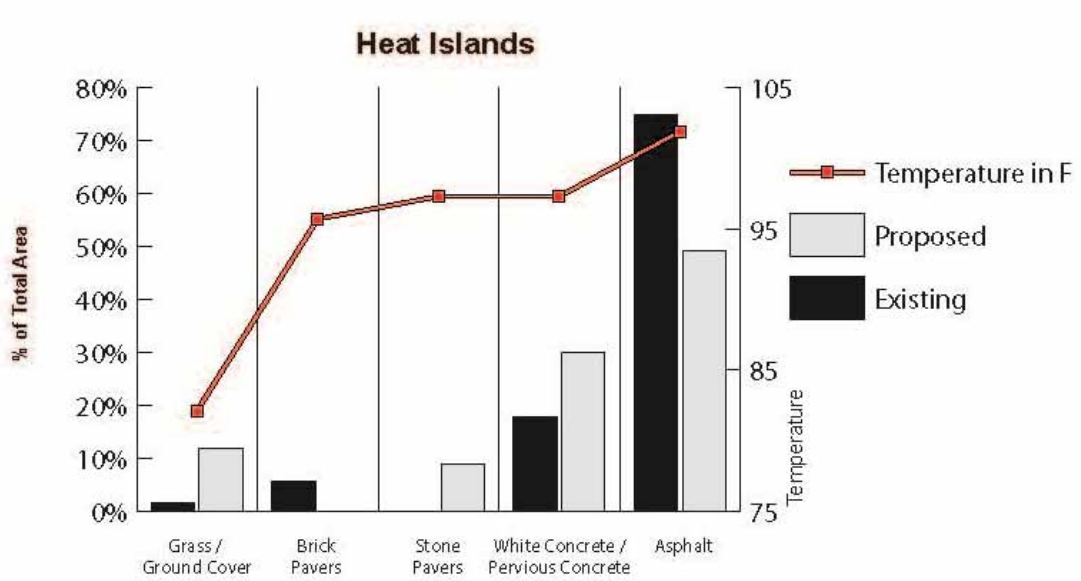
Can be used to compare the relative impact of various materials on the heat island effect and human comfort.

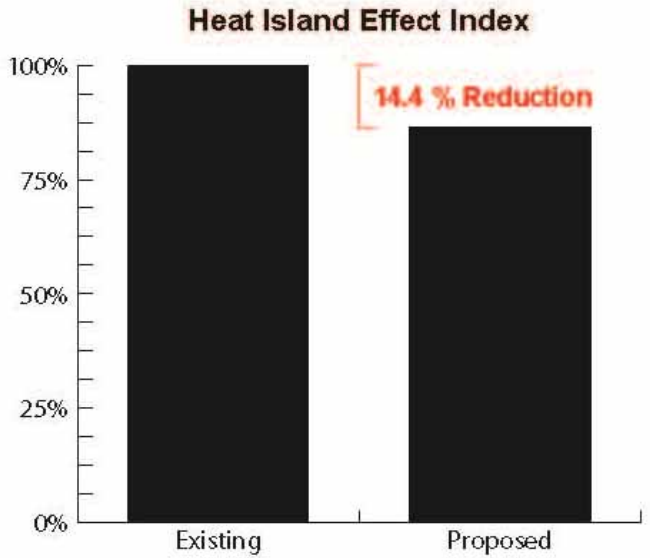
Temperature



Temperature

Evidence: On-site measurements demonstrated that by reducing the amount of asphalt and increasing planted areas and pervious pavement, reduced the heat index by 14.4%.





Digital Sound Level Meter

Hand-held device measures and records sound levels for sounds ranging from 40 to 130 decibels.

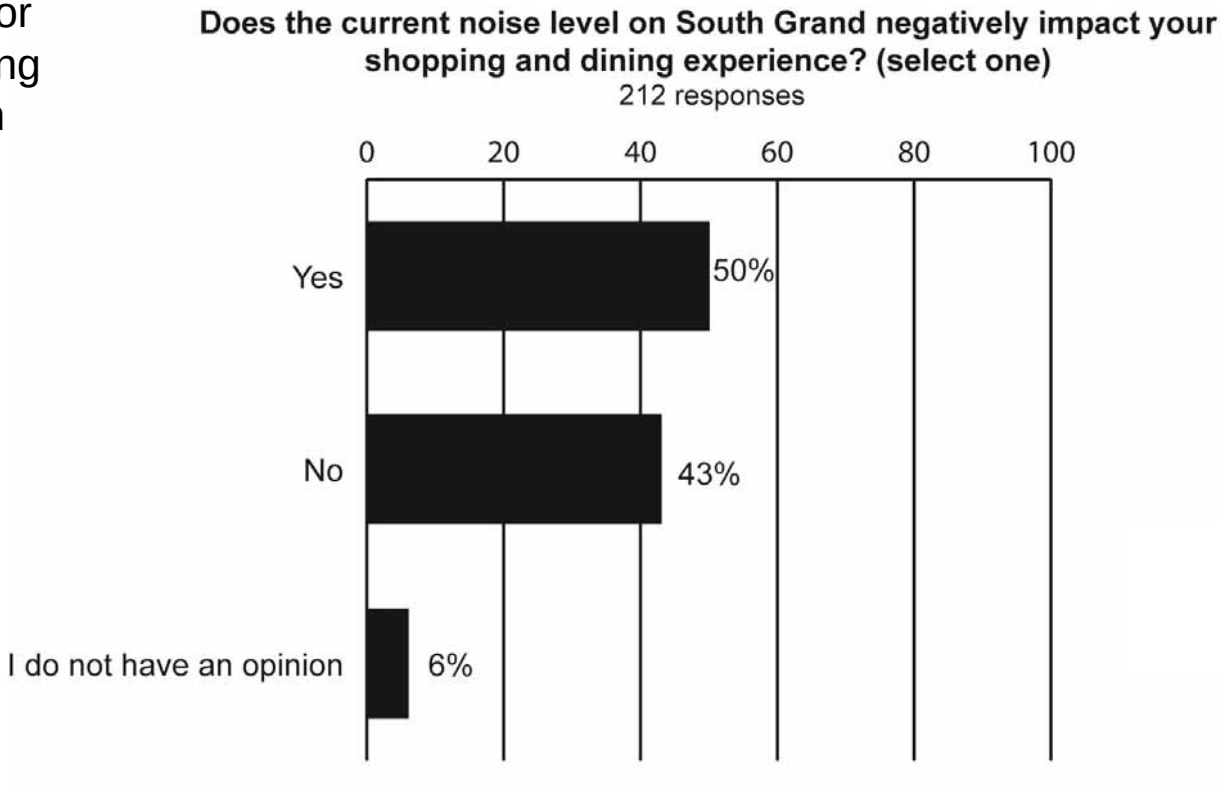
Sound level data can be analyzed to identify where sound levels exist that are inappropriate for human comfort and where design intervention is needed.

Noise

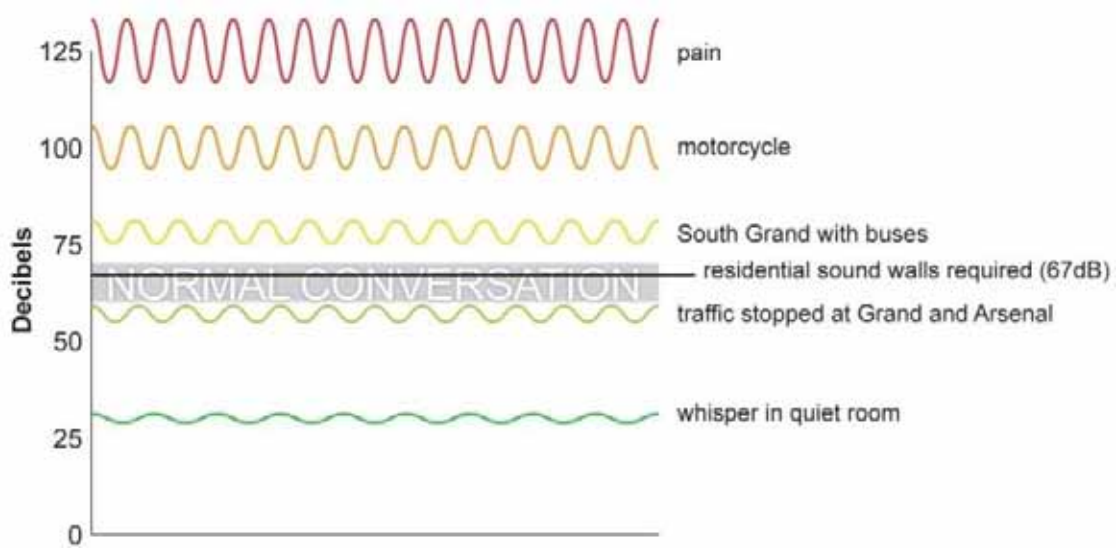
PROJECT # 4659
CF # 58
KEY: EXISTING NOISE READINGS
South Grand Boulevard

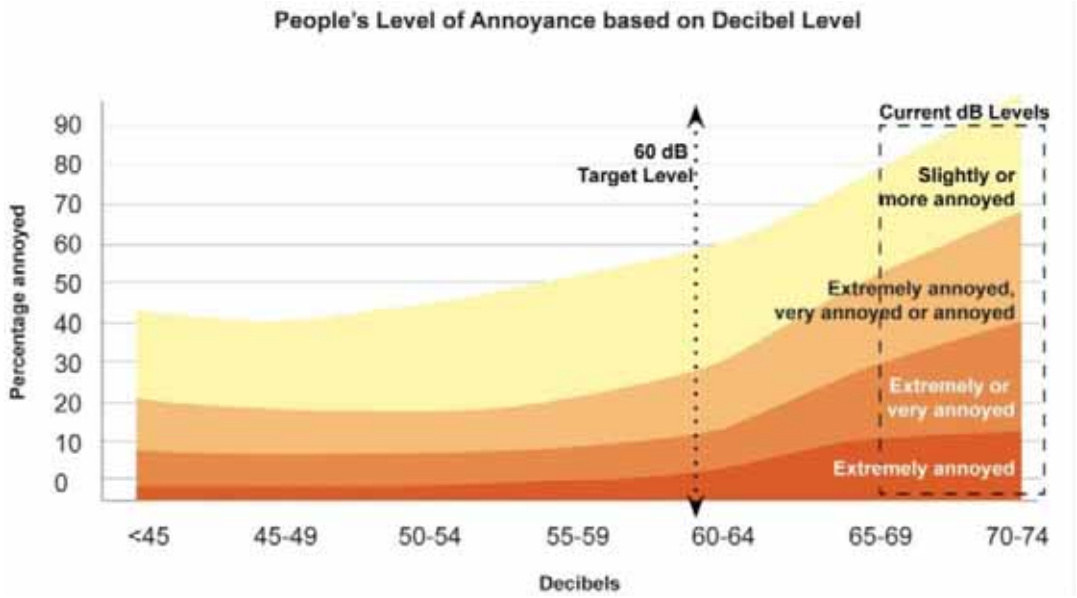
Noise

Strategy: to create a case for a “road diet” by demonstrating to the public the reduction in noise levels due to reduced speeds.



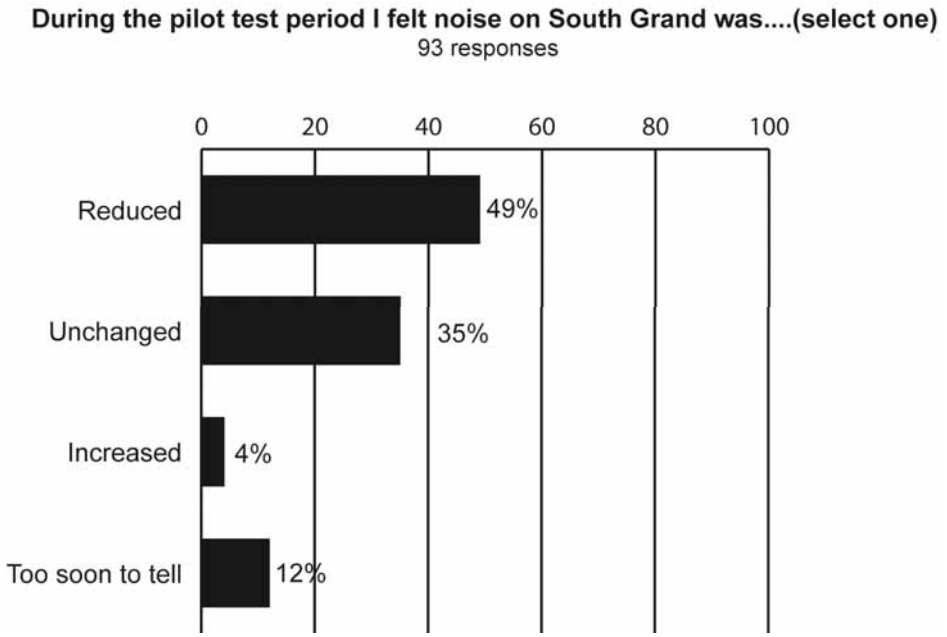
Noise





Source: *Traffic Management and Noise Reducing Pavements: Recommendations on Additional Noise Reducing Measures.* Danish Road Institute Copenhagen: Ministry of transport and energy, 2004.

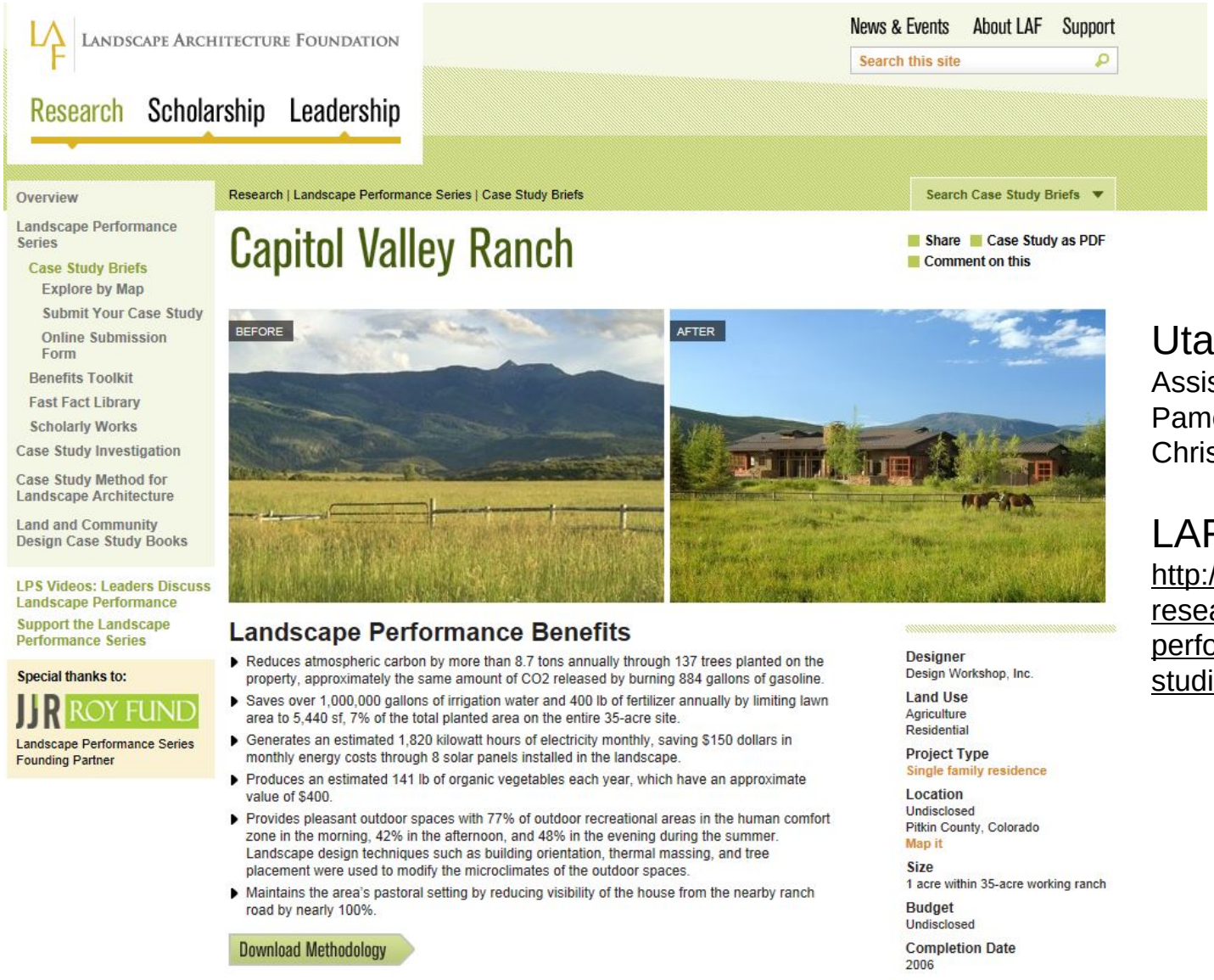
Noise



Evidence : By implementing a pilot test of the proposed lane reduction and bulb-outs, the average peak noise levels fell by 17db, meeting the target noise level of 60db. The street is about one-third as loud as it was previously, therefore providing a more comfortable shopping and dining experience.

Capitol Valley Ranch—Pitkin County, CO

Capitol Valley Ranch



Utah State University:

Assistant Professor Bo Yang
Pamela Blackmore
Chris Binder

LAF Case Study Brief:

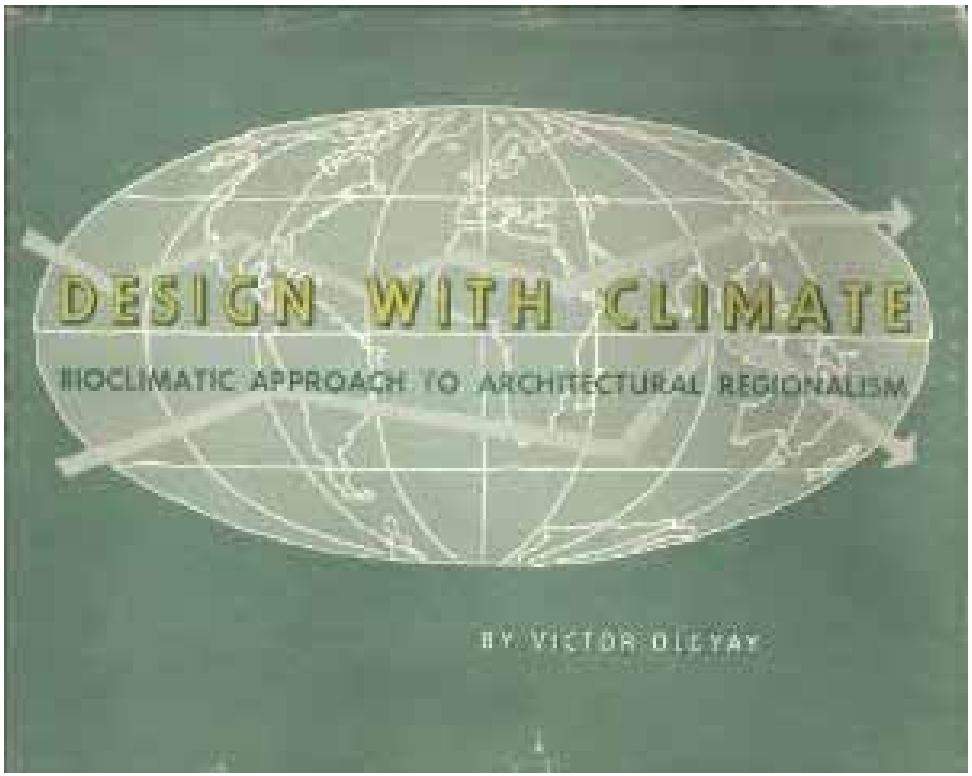
http://www.lafoundation.org/research/landscape-performance-series/case-studies/case-study/627/

Creates outdoor spaces during the summer with **77%** in the human comfort zone in the morning, **42%** in the afternoon, and **48%** in the evening by modifying the effects of wind and using passive solar techniques such as building orientation, thermal massing, and tree placement.

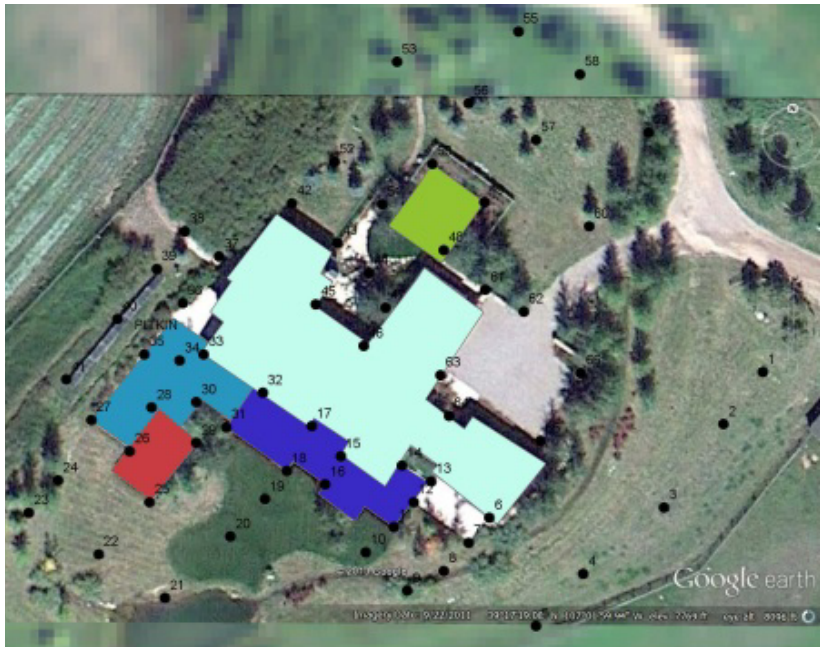
Late morning sunlight allowed in to warm-up space

Evening shade to cool the space

Victor Olgyay's "Human Comfort Zone"



Sampling Locations

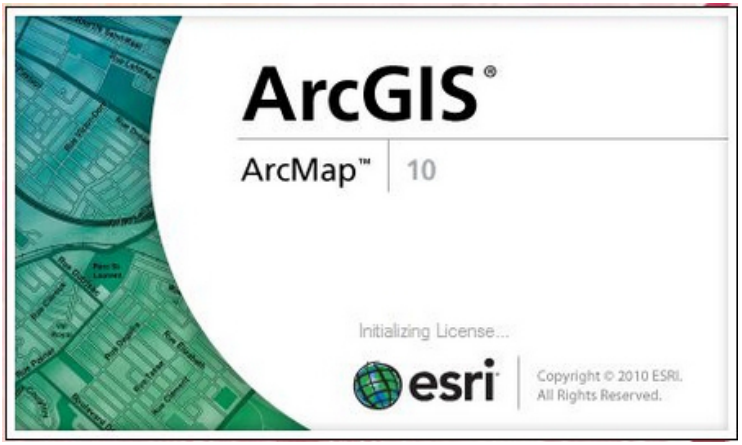


Behavior Mapping

On-Site Data Collection

Kestrel 4000

GIS Interpolation

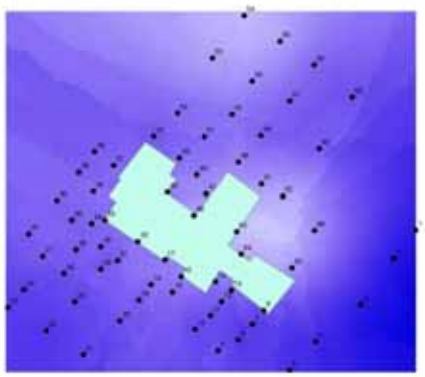


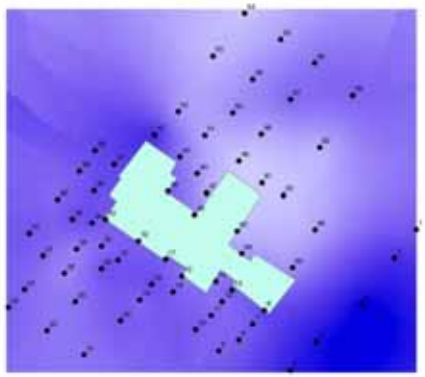
Analysis in Excel

Collecting Bioclimatic Data

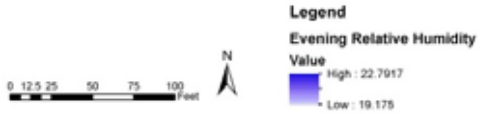
Temperature
Relative Humidity
Wind Speed

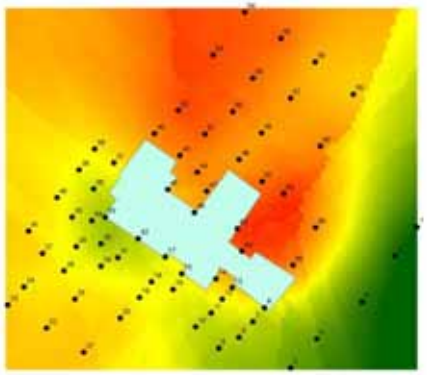
		Evening				Afternoon				Morning			
Location	oint	time	Rh	Temp	comfort?	time	Rh	Temp	comfort?	time	Rh	Temp	comfort?
Agricultural Irrigation Ditch	1	5:06	19.5	84.9	hot & dry	12:35	20.0	81.9	hot	9:16	40.5	66.2	cold
Agricultural Irrigation Ditch	2	5:07	18.9	82.6	hot & dry	12:36	23.8	79.1	comfort	9:21	43.2	65.9	cold
Agricultural Irrigation Ditch	3	5:08	22.2	79.2	comfort	12:37	25.8	78.2	comfort	9:21	43.1	68.0	comfort
Agricultural Irrigation Ditch	4	5:09	21.5	79.9	comfort	12:38	24.6	77.1	comfort	9:22	41.1	70.6	comfort
Agricultural Irrigation Ditch	5	5:12	21.0	80.5	hot	12:39	24.1	76.9	comfort	9:23	37.0	72.0	comfort
Agricultural Irrigation Ditch	6	5:14	23.8	82.6	hot	12:40	22.9	78.6	comfort	9:25	39.5	69.4	comfort
Agricultural Irrigation Ditch	7	5:15	24.1	81.4	hot	12:41	19.6	79.5	dry	9:26	42.1	73.5	comfort
Agricultural Irrigation Ditch	8	5:16	23.5	77.7	comfort	12:42	20.6	81.0	hot	9:27	39.2	78.9	comfort
Agricultural Irrigation Ditch	9	5:17	23.7	78.6	comfort	12:43	19.6	75.2	dry	9:28	32.3	72.0	comfort
South Lawn	10	5:19	18.6	83.3	hot & dry	12:43	21.4	75.3	comfort	9:29	41.1	73.6	comfort
Sun Terrace	11	5:21	22.7	78.9	comfort	12:44	19.9	75.6	dry	9:29	37.2	72.6	comfort
Sun Terrace	12	5:21	23.7	79.2	comfort	12:45	18.5	78.4	dry	9:30	40.7	78.0	comfort
Sun Terrace	13	5:23	22.2	80.0	comfort	12:46	21.5	80.0	comfort	9:31	35.0	76.6	comfort
Sun Terrace	14	5:24	22.7	79.2	comfort	12:47	19.7	80.6	hot & dry	9:32	32.0	81.0	hot
Sun Terrace	15	5:25	22.7	81.4	hot	12:48	17.8	77.9	dry	9:34	29.8	76.8	comfort
Sun Terrace	16	5:26	21.1	79.1	comfort	12:49	21.4	79.6	comfort	9:36	34.4	75.3	comfort
Sun Terrace	17	5:28	23.1	76.7	comfort	12:50	20.6	77.9	comfort	9:39	35.7	71.9	comfort
Sun Terrace	18	5:29	24.7	76.8	comfort	12:51	23.0	78.1	comfort	9:43	35.0	75.8	comfort
South Lawn	19	5:30	21.2	76.6	comfort	12:52	18.3	78.1	dry	9:45	39.5	78.5	comfort
South Lawn	20	5:31	21.6	77.0	comfort	12:52	21.4	76.1	comfort	9:49	34.3	79.2	comfort
South Lawn	21	5:32	22.5	76.9	comfort	12:55	19.0	78.6	dry	9:51	37.4	79.1	comfort
South Lawn	22	5:33	25.0	77.6	comfort	12:56	19.3	71.1	dry	9:52	41.0	77.5	comfort
South Lawn	23	5:34	23.1	75.2	comfort	12:57	20.7	80.8	hot	9:53	38.3	80.6	hot
South Lawn	24	5:36	22.9	77.8	comfort	12:59	20.1	77.5	comfort	9:55	38.8	72.9	comfort
Swimming Lap Pool	25	5:38	21.6	82.2	hot	1:02	19.1	79.1	dry	9:57	38.0	77.9	comfort
Swimming Lap Pool	26	5:43	20.1	93.3	hot	1:03	17.8	82.8	hot & dry	9:58	38.4	77.9	comfort
Swimming Lap Pool	27	5:51	22.4	83.5	hot	1:05	20.4	77.1	comfort	9:59	31.5	80.1	hot
Swimming Lap Pool	28	5:52	23.0	78.2	comfort	1:07	16.8	78.1	dry	10:01	33.8	76.6	comfort
Swimming Lap Pool	29	5:53	20.9	79.1	comfort	1:08	23.0	79.2	comfort	10:02	35.2	74.8	comfort
Swimming Lap Pool	30	5:55	21.7	76.7	comfort	1:10	18.6	83.9	hot & dry	10:03	41.3	69.1	comfort
Sun Terrace	31	5:56	23.3	75.8	comfort	1:12	21.1	78.9	comfort	10:05	34.6	77.9	comfort
Sun Terrace	32	5:57	21.4	77.8	comfort	1:14	20.2	76.6	comfort	10:06	31.3	76.5	comfort
Swimming Lap Pool	33	5:58	19.7	77.0	dry	1:18	19.4	74.2	dry	10:07	35.9	69.7	comfort
Swimming Lap Pool	34	6:00	18.7	78.7	dry	1:19	22.8	74.9	comfort	10:08	35.7	74.3	comfort
Swimming Lap Pool	35	6:02	20.6	82.5	hot	1:20	22.8	75.7	comfort	10:09	38.2	76.0	comfort
Swimming Lap Pool	36	6:03	18.1	82.6	hot & dry	1:21	21.6	74.3	comfort	10:09	33.0	74.6	comfort
Swimming Lap Pool	37	6:04	20.5	82.5	hot	1:23	21.5	77.9	comfort	10:10	33.4	76.2	comfort
Solar Panel Array	38	6:06	17.6	88.5	hot & dry	1:24	21.9	81.9	hot	10:12	37.3	75.6	comfort
Solar Panel Array	39	6:08	19.4	83.9	hot & dry	1:25	20.1	80.8	hot	10:13	35.0	76.4	comfort
Solar Panel Array	40	6:09	25.4	78.5	comfort	1:27	18.4	74.1	dry	10:14	36.5	79.0	comfort
Solar Panel Array	41	6:10	22.5	77.6	comfort	1:33	21.5	77.9	comfort	10:15	36.5	78.8	comfort
Outdoor Living Room	42	6:12	25.1	79.6	comfort	1:34	26.2	80.2	hot	10:16	41.6	81.0	hot
Outdoor Living Room	43	6:13	22.0	79.8	comfort	1:36	18.8	82.2	hot & dry	10:17	33.7	80.2	hot
Outdoor Living Room	44	6:14	21.3	78.6	comfort	1:38	18.5	77.8	dry	10:18	33.5	81.8	hot
Outdoor Living Room	45	6:15	19.2	79.6	dry	1:40	21.3	84.9	hot	10:20	35.2	78.9	comfort
Outdoor Living Room	46	6:16	18.1	80.0	dry	1:42	19.5	81.7	hot & dry	10:20	35.2	79.4	comfort
Outdoor Living Room	47	6:17	19.4	79.6	dry	1:43	16.4	81.8	hot & dry	10:21	33.3	76.8	comfort
Raised Vegetable Garden	48	6:18	19.7	78.1	dry	1:44	15.0	80.5	hot & dry	10:22	32.5	75.5	comfort
Raised Vegetable Garden	49	6:20	18.3	79.6	dry	1:45	16.5	81.7	hot & dry	10:24	40.4	75.9	comfort
Raised Vegetable Garden	50	6:22	17.1	82.5	hot & dry	1:46	19.7	82.7	hot & dry	10:25	37.5	82.3	hot
Raised Vegetable Garden	51	6:23	20.3	80.7	hot	1:47	16.5	82.2	hot & dry	10:27	34.8	85.5	hot
North Trees and Berm	52	6:24	21.3	77.8	comfort	1:50	15.8	88.5	hot & dry	10:28	35.4	84.6	hot
North Trees and Berm	53	6:25	24.2	75.8	comfort	1:52	16.3	85.8	hot & dry	10:29	30.1	82.1	hot
North Trees and Berm	54	6:26	21.6	77.0	comfort	1:54	15.8	82.1	hot & dry	10:30	29.7	81.0	hot
North Trees and Berm	55	6:28	21.4	75.9	comfort	1:56	17.1	82.5	hot & dry	10:31	28.3	86.0	hot
North Trees and Berm	56	6:29	20.5	76.3	comfort	1:58	18.2	84.1	hot & dry	10:32	32.2	81.6	hot
North Trees and Berm	57	6:29	20.8	75.6	comfort	2:00	21.3	84.2	hot	10:33	35.1	79.6	comfort
North Trees and Berm	58	6:30	21.6	74.8	comfort	2:02	19.6	83.1	hot & dry	10:34	39.4	75.4	comfort
Gravel Entry Drive	59	6:31	20.3	75.3	comfort	2:03	21.1	83.5	hot	10:35	38.6	74.9	comfort
Gravel Entry Drive	60	6:33	18.9	75.8	dry	2:05	15.9	86.6	hot & dry	10:36	39.6	82.3	hot
Arrival Court	61	6:34	19.1	75.7	dry	2:06	15.7	84.5	hot & dry	10:38	31.5	80.8	hot
Arrival Court	62	6:35	19.7	75.1	dry	2:07	16.4	82.8	hot & dry	10:39	32.2	84.5	hot
Arrival Court	63	6:36	21.2	75.5	comfort	2:09	15.6	88.0	hot & dry	10:41	29.4	85.5	hot
Arrival Court	64	6:36	21.4	74.5	comfort	2:10	17.9	87.5	hot & dry	10:42	29.9	88.2	hot
Arrival Court	65	6:37	18.7	75.4	dry	2:12	16.9	83.3	hot & dry	10:44	27.6	86.2	hot
Arrival Court	66	6:39	17.0	77.7	dry	2:13	16.7	84.6	hot & dry	10:46	28.7	83.5	hot

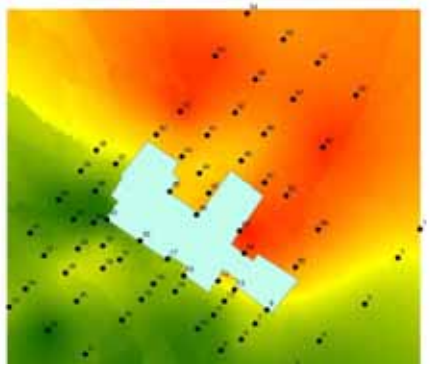


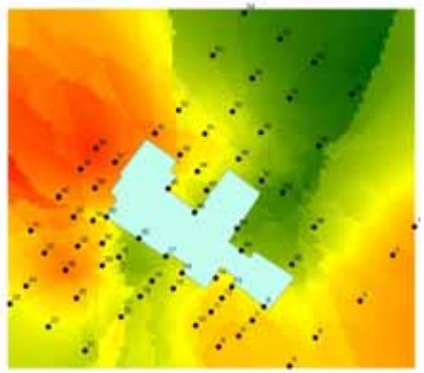


Relative Humidity









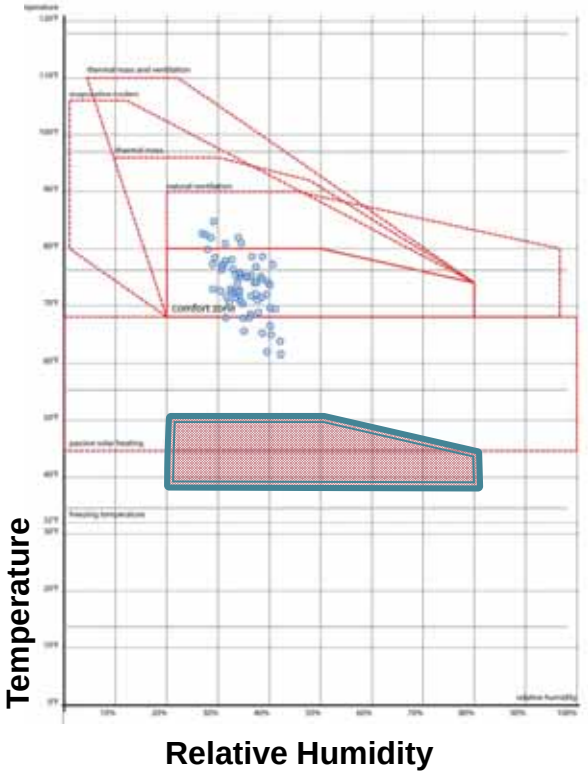
Temperature

Morning

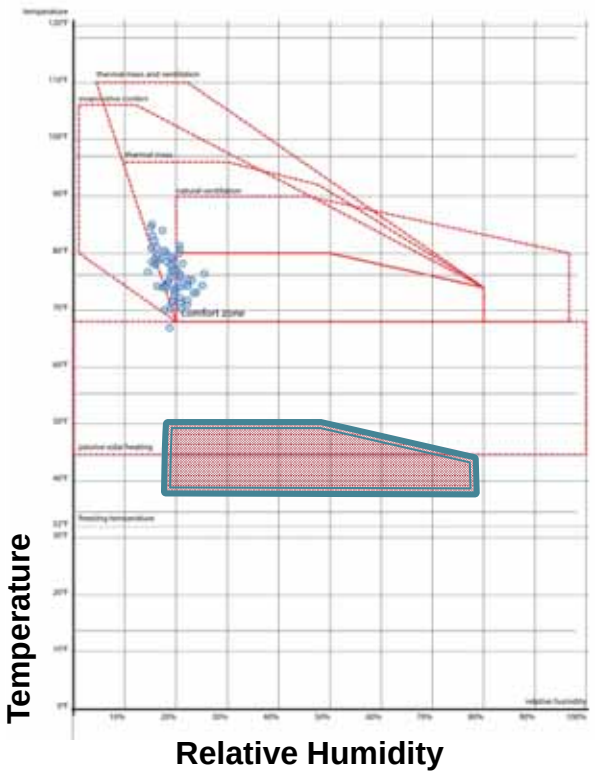
Afternoon

Evening

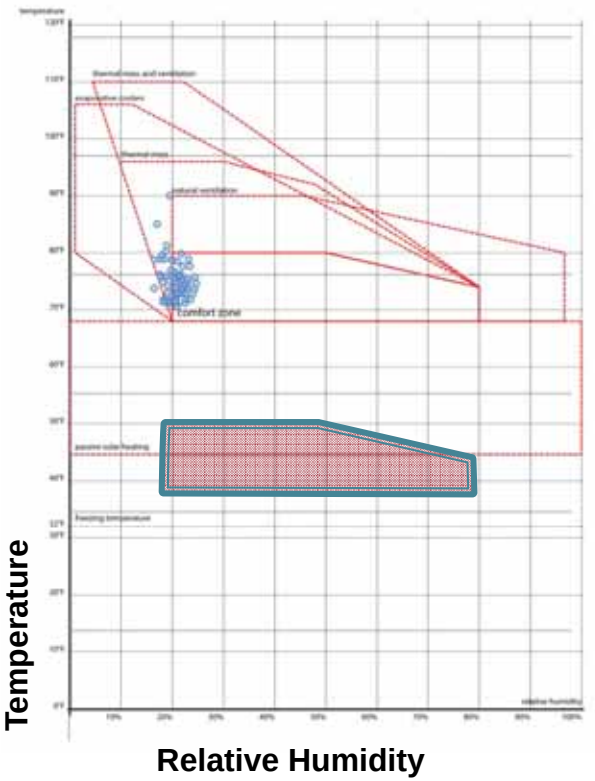
Morning



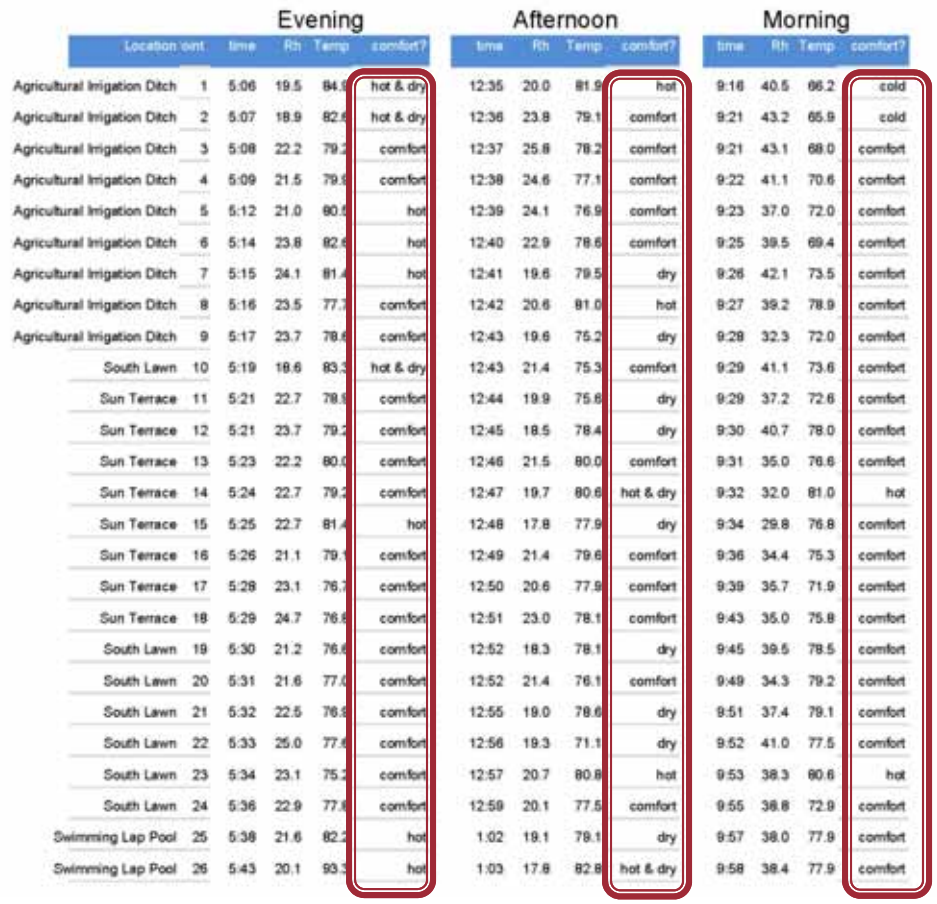
Afternoon



Evening



Victor Olgyay (1973). *Design with Climate: Bioclimatic Approach to Architectural Regionalism*. John Wiley & Sons, New York.



		Evening				Afternoon				Morning			
Location	ont	time	Rh	Temp	comfort?	time	Rh	Temp	comfort?	time	Rh	Temp	comfort?
Agricultural Irrigation Ditch	1	5:06	19.5	84.9	hot & dry	12:35	20.0	81.9	hot	9:16	40.5	66.2	cold
Agricultural Irrigation Ditch	2	5:07	18.9	82.6	hot & dry	12:36	23.8	79.1	comfort	9:21	43.2	65.9	cold
Agricultural Irrigation Ditch	3	5:08	22.2	79.2	comfort	12:37	25.8	78.2	comfort	9:21	43.1	68.0	comfort
Agricultural Irrigation Ditch	4	5:09	21.5	79.9	comfort	12:38	24.6	77.1	comfort	9:22	41.1	70.6	comfort
Agricultural Irrigation Ditch	5	5:12	21.0	80.5	hot	12:39	24.1	76.9	comfort	9:23	37.0	72.0	comfort
Agricultural Irrigation Ditch	6	5:14	23.8	82.9	hot	12:40	22.9	78.6	comfort	9:25	39.5	69.4	comfort
Agricultural Irrigation Ditch	7	5:15	24.1	81.4	hot	12:41	19.6	79.5	dry	9:26	42.1	73.5	comfort
Agricultural Irrigation Ditch	8	5:16	23.5	77.7	comfort	12:42	20.6	81.0	hot	9:27	39.2	78.9	comfort
Agricultural Irrigation Ditch	9	5:17	23.7	78.6	comfort	12:43	19.6	75.2	dry	9:28	32.3	72.0	comfort
South Lawn	10	5:19	18.6	83.3	hot & dry	12:43	21.4	75.3	comfort	9:29	41.1	73.6	comfort
Sun Terrace	11	5:21	22.7	78.9	comfort	12:44	19.9	75.6	dry	9:29	37.2	72.6	comfort
Sun Terrace	12	5:21	23.7	79.2	comfort	12:45	18.5	78.4	dry	9:30	40.7	78.0	comfort
Sun Terrace	13	5:23	22.2	80.0	comfort	12:46	21.5	80.0	comfort	9:31	35.0	76.6	comfort
Sun Terrace	14	5:24	22.7	79.2	comfort	12:47	19.7	80.6	hot & dry	9:32	32.0	81.0	hot
Sun Terrace	15	5:25	22.7	81.4	hot	12:48	17.8	77.9	dry	9:34	29.8	76.8	comfort
Sun Terrace	16	5:26	21.1	79.1	comfort	12:49	21.4	79.6	comfort	9:36	34.4	75.3	comfort
Sun Terrace	17	5:28	23.1	76.7	comfort	12:50	20.6	77.9	comfort	9:39	35.7	71.9	comfort
Sun Terrace	18	5:29	24.7	76.8	comfort	12:51	23.0	78.1	comfort	9:43	35.0	75.8	comfort
South Lawn	19	5:30	21.2	76.6	comfort	12:52	18.3	78.1	dry	9:45	39.5	78.5	comfort
South Lawn	20	5:31	21.6	77.0	comfort	12:52	21.4	76.1	comfort	9:49	34.3	79.2	comfort
South Lawn	21	5:32	22.5	76.9	comfort	12:55	19.0	78.6	dry	9:51	37.4	79.1	comfort
South Lawn	22	5:33	25.0	77.6	comfort	12:56	19.3	71.1	dry	9:52	41.0	77.5	comfort
South Lawn	23	5:34	23.1	75.2	comfort	12:57	20.7	80.8	hot	9:53	38.3	80.6	hot
South Lawn	24	5:36	22.9	77.8	comfort	12:59	20.1	77.5	comfort	9:55	38.8	72.9	comfort
Swimming Lap Pool	25	5:38	21.6	82.2	hot	1:02	19.1	79.1	dry	9:57	38.0	77.9	comfort
Swimming Lap Pool	26	5:43	20.1	93.3	hot	1:03	17.8	82.8	hot & dry	9:58	38.4	77.9	comfort

Percent of outdoor spaces that fall into human comfort zone:

Morning: 24 / 31 = **77%**

Afternoon: 13 / 31 = **42%**

Evening: 15 / 31 = **48%**

iPhone Apps

Travel Altimeter Light

Anti-Mosquito Repellent

Decibel Gauge

GPS Locator

Level

Leaf Identification

Light Meter

Pedometer

Night Sky

Resources

Amazon

http://www.amazon.com/

Forestry Suppliers, Inc.

http://www.forestry-suppliers.com/

Extech

http://www.extech.com/instruments/


EXTECH
Light Meter
HOLD