Identifying and Measuring Urban Design Qualities Related to Walkability

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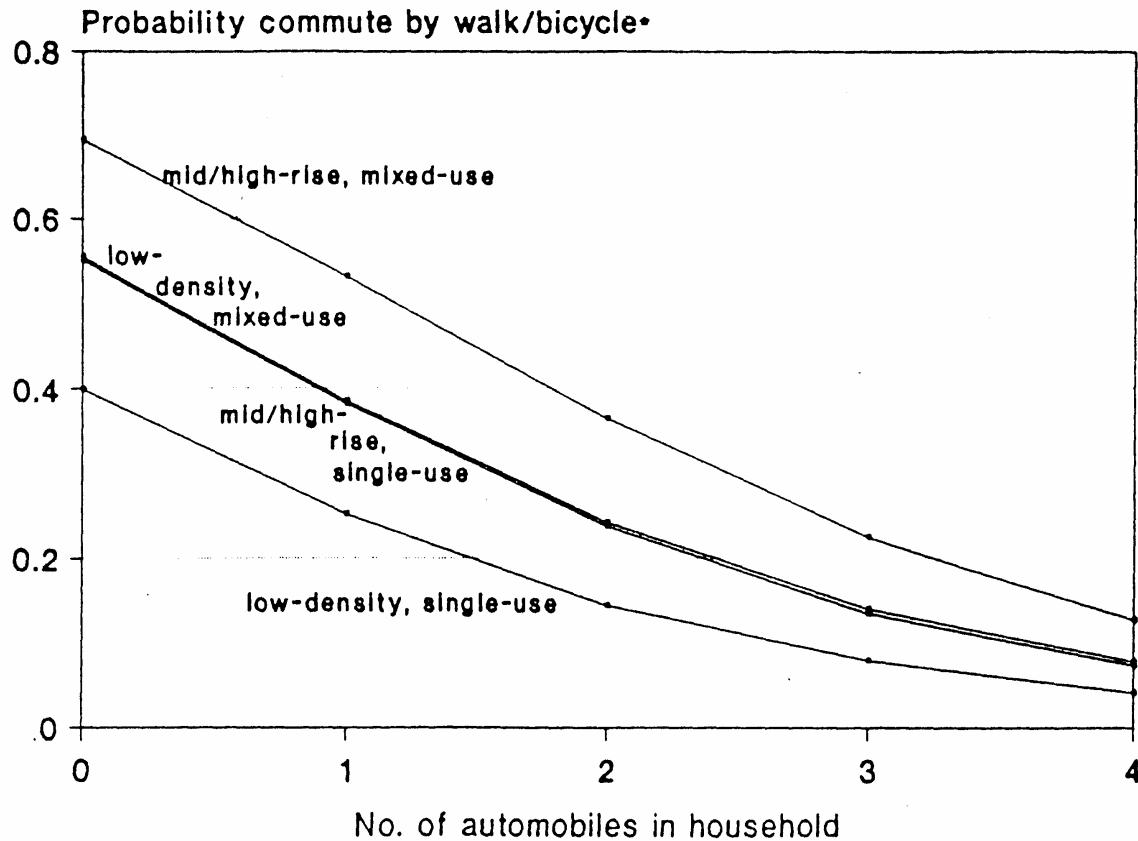
Growing Body of Evidence

SPECIAL REPORT 282

Does the Built Environment Influence Physical Activity?
Examining the Evidence

TRANSPORTATION RESEARCH BOARD
INSTITUTE OF MEDICINE
OF THE NATIONAL ACADEMIES

Mostly Gross Qualities

Probability commute by walk/bicycle·

mid/high-rise, mixed-use

low-density, mixed-use

mid/high-rise, single-use

low-density, single-use

No. of automobiles in household

·   for one-mile home-to-work distance

Even Audit Instruments

	visibility	Field
Street Or Road Segments	Length of segment under consideration for improvement	DOT, Field
	Number of links in grade-separated system	Field
	Intersection	DOT, Local GIS
	Mid-block	DOT, Local GIS
Vehicle Lane	Number of lanes	DOT
	Presence and width of shoulder or bike lane	Field
	Total number of through lanes	DOT
	Center turn lane	DOT
	Number of turn lanes	DOT
	Direction(s) of traffic flow	DOT
Outside Lane	Outside lane width	Field
	Usable width of outside through lane	Field
Bicycle Lane	Existence of bike lane	DOT, Local GIS
	Presence of bicycle lane/paved shoulder	DOT, Local GIS
	Width of bicycle lane/paved shoulder	Field
	Bike lane width	Field
On-Street	Off-street parking spaces with	Field

	signal phase	Field
	Stop sign frequency	Field
	Traffic control devices	Field
Signalization Pedestrian	Pedestrian signal delay length	Field
	Pedestrian supportive signalization	Field
	Push button	Field
Sidewalks	Presence of sidewalk	Local GIS, Field
Surface	Path condition and smoothness	Field
	Path material	Field
	Pavement factor	Composite
	Street surface	Field
	Surface condition	Field
	Surface quality	Field
	Surface type	Field
Environment along roadway		
General Category	Variable Name	Data Source/Type
Buildings	Architecture (local)	All Field Data
	Buildings features	
	Building frontage	
	Roadside development	
Gardens	Garden maintenance	
Lighting	Lighting	

Not a Lot to Do with Experience of Walking Down a Street

Genesis of Project

- Christopher Alexander, *A Pattern Language - Towns Buildings Construction*

- Richard Hedman, *Fundamentals of Urban Design*

- Allan Jacobs, *Great Streets*

- Kevin Lynch, *The Image of the City*

- Amos Rapoport, *History and Precedent in Environmental Design*

- William H. Whyte, *City—Rediscovering the Center*

Conceptual Framework

Physical features

-Sidewalk width
-Street width
-Traffic volumes
-Tree canopy
-Building height
-Number of people
-Weather
-Etc.

Perceptual qualities

-Imageability
-Legibility
-Complexity
-Coherence
-Enclosure
-Human scale
-Linkage
-Transparency

Individual reactions

-Sense of Safety
-Sense of Comfort
-Level of Interest

Overall walking quality

Walking behavior

More objective ← → More subjective

Work Plan

- Expert Panel

- Literature Review with Definitions

- Library of Video Clips

- Visual Assessment Survey

- Quantitative and Qualitative Analyses

- Instrument Development, Testing, and Training

- Illustrated Field Manual

National Expert Panel

- Victor Dover - urban designer
- Rob Lane - urban designer
- Geoffrey Ferrell - urban designer/code expert
- Tony Nelessen - urban designer
- Anne Vernez Moudon - urban designer/planner
- Mark Francis - landscape architect
- Michael Southworth - urban designer
- Michael Kwartler - architect/simulations expert
- John Peponis - architect/space syntax expert
- Dan Stokols - social ecologist

Perceptual Qualities

41 qualities

8 qualities

- Imageability
- Enclosure
- Human Scale
- Transparency
- Linkage
- Complexity
- Coherence
- Legibility

Textbook Definitions

Imageability is the quality of a place that makes it recognizable and memorable. A place has high imageability when specific physical elements and their arrangement evoke distinct images or positive feelings.

Video Library

- Urban Streetscapes

- 22 Cities

- 205 Video Clips

- 86 Clips Rated by Research Team

- 48 Clips Rated by Panel

Fractional Factorial Design

run	Imageability	Enclosure	Human Scale	Transparency	Linkage	Complexity	Coherence	Legibility
1	0	0	0	0	0	0	0	0
2	1	0	0	0	0	1	1	1
3	0	1	0	0	1	0	1	1
4	1	1	0	0	1	1	0	0
5	0	0	1	0	1	1	1	0
6	1	0	1	0	1	0	0	1
7	0	1	1	0	0	1	0	1
8	1	1	1	0	0	0	1	0
9	0	0	0	1	1	1	0	1
10	1	0	0	1	1	0	1	0
11	0	1	0	1	0	1	1	0
12	1	1	0	1	0	0	0	1
13	0	0	1	1	0	0	1	1
14	1	0	1	1	0	1	0	0
15	0	1	1	1	1	0	0	0
16	1	1	1	1	1	1	1	1

full factorial design = 2^8 design = 256 clips

1/16 fractional design = 2^{8-4} design = 16 clips

Best Match Run
High Values of All Eight Qualities

Best Match Run
High Values of Imageability, Human Scale, Linkage, and Tidiness

Best Match Run
High Values of Enclosure, Transparency, Complexity, and Coherence

Visual Assessment Survey Form

	Imageability	Enclosure	Human Scale	Transparency	Linkage	Complexity	Coherence	Tidiness	Legibility	Walking Quality	Comments
Identifying and Measuring Environmental Determinants of Physical Activity: Expert Panel Survey Sheet											
Scene 14	5	5	5	5	5	4	4	4	5	4.6	Annapolis, MD
Scene 15	4	5	4	3	4	2	4	4	3	3.5	Charlotte, NC
Scene 16	3	4	3	4	4	3	4	4	3	4.2	Delray Beach, FL

Individual Ratings

	Imageability	Enclosure	Human Scale	Transparency	Linkage	Complexity	Coherence	Tidiness	Legibility	Walking Quality
Peponis	4	4	5	3	3	4	4	2	4	4
Southworth	5	5	5	4	4	3	4	3	5	5
Lane	5	5	5	5	5	5	5	4	5	5
Ferrell	5	4	5	4	4	4	5	4	5	4.8
Nelessen	4	4	4	4	4	4	4	3	4	4
Dover	5	4	5	5	5	5	4	5	5	5.0

Regression Model for Overall Walkability

Variable	Coefficient	Standardized Coefficient	t-statistic	p-value
constant	-0.226		-1.503	0.140
human scale	0.411	0.420	5.814	0.000
transparency	0.137	0.149	2.366	0.023
tidiness	0.070	0.059	1.598	0.117
enclosure	0.140	0.157	2.504	0.016
imageability	0.307	0.310	5.153	0.000
N	48			
R-square	.959			
Adjusted R-square	.954			

Inter-rater Reliability Ratings of Urban Design Qualities

	Intra-class Correlation Coefficient	95% Confidence Interval of ICC	Cronbach's Alpha
imageability	.494	.385-.618	.930
legibility	.380	.276-.509	.895
enclosure	.584	.478-.697	.945
human scale	.508	.399-.630	.928
transparency	.499	.390-.622	.926
linkage	.344	.169-.621	.896
complexity	.508	.398-.632	.926
coherence	.374	.271-.504	.880
Tidiness	.421	.314-.550	.915
N	48		

Content Analysis of Sampled Scenes

- 48 Clips

- More than 100 Physical Features

- Operational Definitions for All Feature

- 1 Hour-plus per Clip

- Gold Standard

- Inter-rater Reliability Test

Selection of Physical Features

- Logic/Common Sense

- Literature

- Interviews with Expert Panel

- Operational Definitions from Expert Panel

Operational Definitions

Variable Long Name	Variable Type	Counting Criteria	Measurement Protocol
awnings or overhangs – both sides	count	counted buildings fronting along street and passed or 50 feet ahead, both sides	Count number of awnings or overhangs on buildings that have been counted on both sides of street and that are passed or are within 50 feet from the camera at the end of the clip.
height interruptions – same side	proportion	counted buildings fronting along street and passed or 50 feet ahead, same side	Estimate proportion of building frontage that have been counted on the same side that front the street and are within 50 feet from the camera at the end of the video clip with belt courses or other visual interruptions to building height. One storey buildings should be considered as height interrupted. Use 0.10 intervals.
number of buildings with non-rectangular silhouettes	count	counted buildings	Count buildings that have been counted whose shape is not a simple rectangular box. Pitched roofs on buildings that are viewed at an angle and make the building look non-rectangluar, do count as non-rectangular. Building roof trim that makes variations in an otherwise simple rectangular shape do also count as non-rectangular.

Inter-rater Reliability Estimates of Physical Features

Variable	ICC	Alpha	Variable	ICC	Alpha
number of courtyards etc.	.471	.611	proportion street wall – opposite side	.588	.737
arcades	---	---	number of enclosed sides	.389	.640
number of landmarks	.763	.878	average building setback – same side	.215	.338

Relate Urban Design Qualities Ratings to Physical Features

Variable	Imageability	Legibility	Enclosure	Human Scale	Transparency	Linkage	Complexity	Coherence	Tidiness
courtyards/plazas/parks - both sides	X		X		X		X		
arcade – same side			X	X	X	X			
landmarks - both sides	X	X							
major landscape features - both sides	X	X							
memorable architecture	X	X							
distinctive signage	X	X							
long sight lines		X	X	X		X			
terminated vista	X	X	X	X		X			
progress toward next intersection				X		X			
proportion of distance walked versus distance visible				X		X			
street connections to elsewhere		X				X			
number of buildings – both sides							X		

Cross-Classified Random Effects Model

- New Class of Model

- Only a Handful of Applications

- Hierarchical in Nature

- Partitions Variance

Partitioning Total Variance

	Scene Variance	Viewer Variance	Measurement Error	Total Variance
imageability	0.67 (50)	0.16 (12)	0.50 (38)	1.33
legibility	0.46 (39)	0.17 (14)	0.55 (47)	1.18
enclosure	0.83 (59)	0.10 (7)	0.48 (34)	1.41
human scale	0.68 (53)	0.11 (8)	0.50 (39)	1.29
transparency	0.77 (51)	0.13 (8)	0.62 (41)	1.52
linkage	0.51 (34)	0.26 (17)	0.74 (39)	1.51
complexity	0.6 (52)	0.09 (8)	0.47 (40)	1.16

Cross-Classified Random Effects Models (fixed effects too)

actual score = predicted score + measurement error

predicted score = constant + viewer random effect + scene random effect + a*viewer variables + b*scene variables

Best-Fit Transparency Model

Variable	Coefficient	t-statistic	p-value
constant	1.709		
proportion first floor with windows	1.219	3.13	0.002
proportion active uses	0.533	2.96	0.004
proportion street wall – same side	0.666	2.57	0.011
Proportion of Scene Variance Explained	0.62		
Proportion of Total Variance Explained	0.32		

Performance of Urban Design Qualities

	Relationship to Walkability in Best-Fit Model (p-value)	Inter-rater reliability (ICC)	Portion of Scene Variance/Total Variance Explained by Best-Fit Models	Inter-rater Reliability of Significant Variables (number with ICC>0.4)	Criteria Met
Imageability	0.000	0.494	0.72/0.37	7 of 7 (1 missing)	5 of 5
Legibility	---	0.380	0.54/0.21	5 of 5 (1 missing)	1 of 5
Enclosure	0.016	0.584	0.72/0.43	5 of 5	5 of 5
Human scale	0.000	0.508	0.62/0.35	7 of 7	5 of 5
Transparency	0.023	0.499	0.62/0.32	3 of 3	5 of 5
Linkage	---	0.344	0.61/0.21	4 of 5	1 of 5
Complexity	---	0.508	0.73/0.38	5 of 6	3 of 5
Coherence	---	0.374	0.67/0.25	3 of 4	1 of 5
Tidiness	0.117	0.421	0.70/0.30	2 of 3 (1 missing)	3 of 5

Develop Draft Field Manual

Focuses on Urban Design Qualities that Meet Performance Criteria

- Imageability
- Enclosure
- Transparency
- Human scale
- Complexity
- Tidiness

Qualitative Introduction to Urban Design Quality

imageability

Imageability is the quality of a place that makes it distinct, recognizable, and memorable. A place has high imageability when specific physical elements and their arrangement capture attention, evoke feelings, and create a lasting impression.

What do the experts say?

"generic places with no character have no imageability"

"really imageable places are recognizable and memorable"

"distinct views can make an otherwise ordinary place very imageable"

"architecture that suggests importance, presence of historical buildings, and landmarks"

"is the place unique?"

Streets filled with people, many signs to draw pedestrians, and strong landmarks make Times Square in New York City a very imageable place.

Few pedestrians, no street activity like outdoor dining, and no features that serve as landmarks make this street hardly distinguishable from others and thus not that imageable.

HIGH IMAGEABILITY

LOW IMAGEABILITY

Detailed Illustrated Steps

measuring imageability

Step 1
Walk entire length of study area (1 block or approximately... feet?

Step 2
As you walk, note buildings whose shape is not a simple rectangular box. on either side of the street.

Note:
Consider a non-rectangular building to be any building that from any angle is not a simple rectangle. Buildings with a basically rectangular shape but have a pitched roof or ornamental trim will be considered as non-rectangular. Use the figures to familiarize yourself with the concept.

Step 3
Record the number of buildings that have a non-rectangular shape.
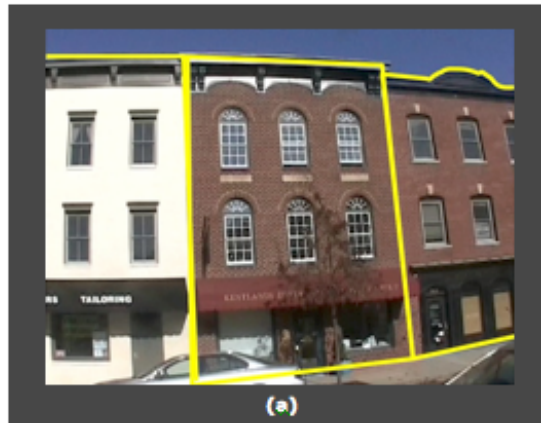
(a) 1 non-rectangular building
The building trim on the left most building does enough to deviate the otherwise rectangular building to non-rectangular.

(b) 2 non-rectangular buildings
The pitched roofs and chimneys make the two left most buildings non-rectangular.

(c) 3 rectangular buildings
These modern skyscrapers all have simple rectangular shapes.

(d) 1 non-rectangular building
While the office park building shown does not have any curved edges and is comprised of all right angles, it does not have a simple box shape.

5. count buildings with non-rectangular shapes
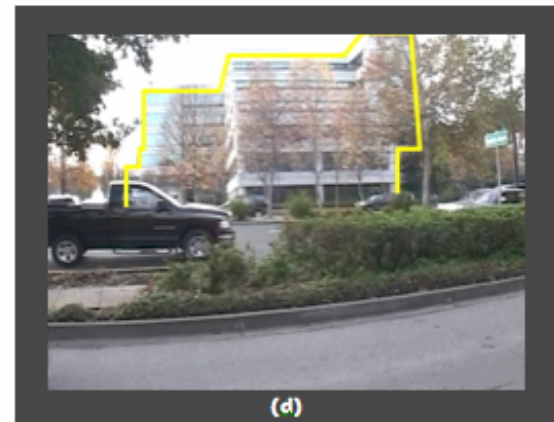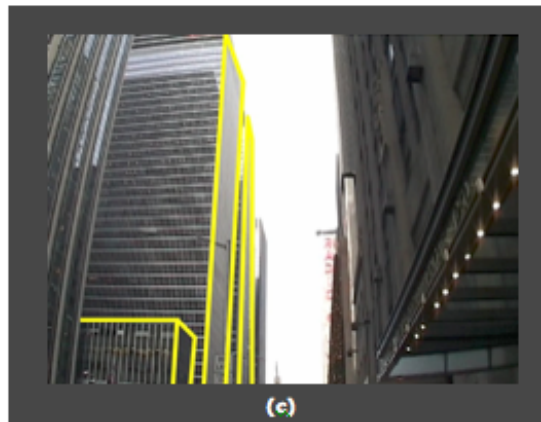
Scoring Sheet

measuring imageability			score tabulation
step	recorded value	multiplier	(multiplier) x (recorded value)
1. count courtyards, plazas, and parks		0.393	
2. count major landscape features		0.735	
3. estimate historic building frontage		0.948	
4. count buildings with identifiers		0.115	
5. count buildings with non-rectangular shapes		0.0745	
6. count places with outdoor dining		0.703	
7. count the number of pedestrians		0.02741	
8. estimate the noise level		-0.195	
		subtotal	
		add constant	+2.516
		imageability score	
street: date:	notes		

Next steps

- Test and Refine Instrument

- Provide Lab and Field Training to Lay Observers

- Finalize Instrument