Streets of Clay:
Transforming Transport Links into Active Places

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Since automobile use became widespread in North America during the first two decades of the 20th century, cities and their streets have been re-shaped to adapt to the surge in motor vehicle use. Efforts are now underway to re-define the purpose of arterial streets and to re-design these important thoroughfares accordingly. This movement has taken a variety of names, including "Great Streets", "Livable Streets", "Context Sensitive Streets" and "Complete Streets". Despite the diverse nomenclature, all these efforts focus on creating streets that are multi-purpose in nature. Such streets are not only tasked to accommodate private motor vehicles, but also pedestrians, cyclists, public transport, and "nature". They are multimodal transport links as well as places for social life and active living. This paper discusses some of the findings from research on assessing just how "active" and "sustainable" are a set of arterial streets in five San Francisco Bay Area cities. Six streets, two re-designed as more "livable" streets, and four more conventional arterial streets, are compared across a set of objective performance metrics and subjective assessments from street users and businesses. Two of the streets are in San Francisco, one in San Jose, and the remaining three are in smaller cities on the San Francisco Peninsula. Streets were evaluated on an array of measures, as well as the results of six street user focus groups and surveys of 716 street users and local businesses. Partial findings reported here are focused on non-motorized modes of travel and affirm the importance of multi-purpose street environments to people and to communities.

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Introduction

Since automobile use became widespread in North America during the first two decades of the 20th century, cities and their streets have been re-shaped to adapt to the surge in motor vehicle use. Efforts are now underway to re-define the purpose of arterial streets and to re-design these important thoroughfares accordingly. This movement has taken a variety of names, including "Great Streets", "Livable Streets", "Context Sensitive Streets" and "Complete Streets". Despite the diverse nomenclature, all these efforts focus on creating streets that are multi-purpose in nature. Such streets are not only tasked to accommodate private motor vehicles, but also pedestrians, cyclists, public transport, and "nature". They are multimodal transport links as well as places for social life and active living. Streets are not only arteries for circulation but also places for outdoor activities of a functional, social, or recreational nature (Gehl, 2006). The street is not only "link" and "place" (Jones, Boujenko, & Marshall, 2007), but also a "social arena" (Lillebye, 2007). Streets become lively due to the presence of people, their activities, and their interactions (Mehta, 2006).

This paper discusses some of the findings from research on assessing just how "active" and "livable" are a set of arterial streets in five San Francisco Bay Area cities. Six streets, two re-designed as more "livable" streets, and four more conventional arterial streets, are compared across a set of objective performance metrics and subjective assessments from street users and businesses. Two of the streets are in San Francisco, one in San Jose, and the remaining three are in smaller cities on the San Francisco Peninsula. Streets were evaluated on an array of measures, as well as the results of six street user focus groups and surveys of 716 street users and local businesses. Partial findings reported here are focused on non-motorized modes of travel and affirm the importance of multi-purpose street environments to people and to communities.

Sustainable Cities and Streets

Newman & Kenworthy (1999) have characterized sustainability in cities as "… the reduction of the city's use of natural resources and production of wastes, while simultaneously improving its livability, so that it can better fit within the capacities of local, regional, and global ecosystems" (p.7). For them, city sustainability is "… not only about reducing metabolic flows (resource inputs and waste outputs); it must also be about increasing human livability (social amenity, health, and well-being)" (Newman & Kenworthy, 1999, p 10). In this perspective, "key techniques" for "overcoming automobile dependence" and moving toward sustainable transport in a sustainable city are "quality transit, bicycling, and walking" (Newman & Kenworthy, 1999, p. 144). For Greenburg (2008), sustainable streets foster increased use of least polluting (travel) modes, promote reduced motor vehicle miles of travel, and address "social public health" (p. 29). To Bevan, et al. (2007), they also result in reduced energy use and "support healthy urban communities" (page 4). Thus research interest in active transport and lively streets is closely related to inquiry into sustainable transport and streets. As shown in Figure 1 below, this inquiry is multi-disciplinary.

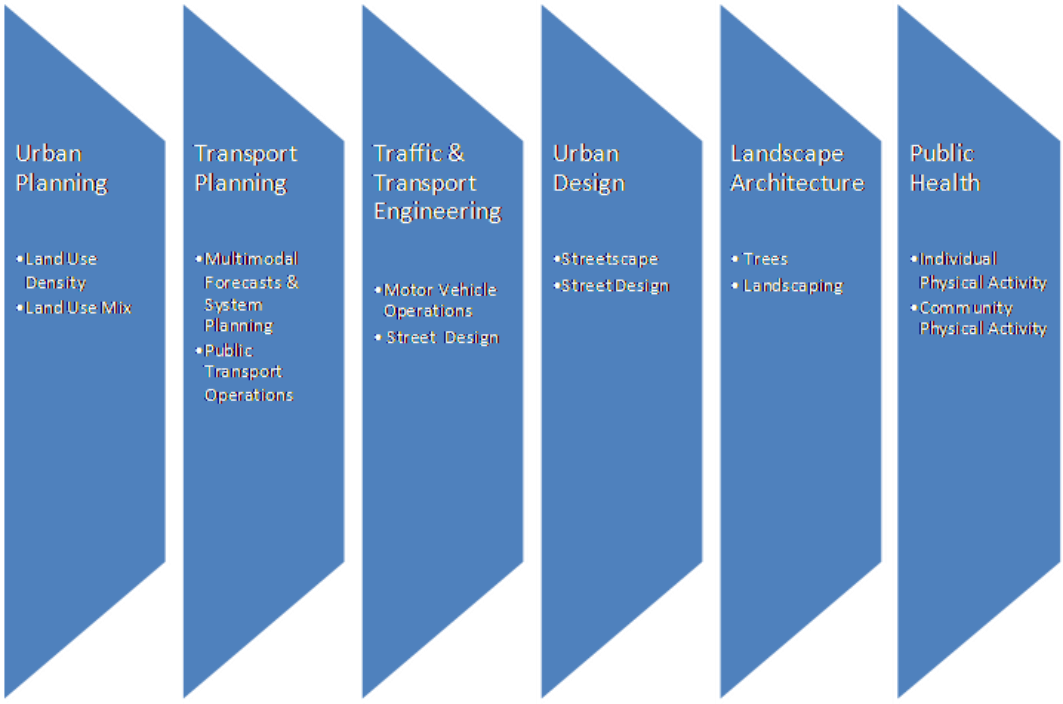


Figure 1: Disciplinary Domains Pertaining to Sustainable, Active Streets

Gehl (2006) points out that "in the entire history of human settlement, streets and squares have been the basic elements around which all cities were organized". Thus, they "constitute the very essence of the phenomenon 'city'". Streets are "based on the linear pattern of human movement" and squares on "the eye's ability to survey an area" (Gehl, 2006, p. 89). In the words of the noted British scholar of streets and street patterns, Stephen Marshall (2009), "the arrangement of cities in streets is not just about physical circulation, but is inextricable from the very concept of a city" (p. 111).

The exploration of what makes streets active and sustainable takes place on three geographic scales: Citywide and regional, district and neighborhood, and street-level. The emphasis given in this research, a portion of which is described in this paper, is inversely proportionate to geographic scale. More attention and a tighter focus is placed closer to the apex and further from the base of the inverted pyramid displayed in Figure 2.

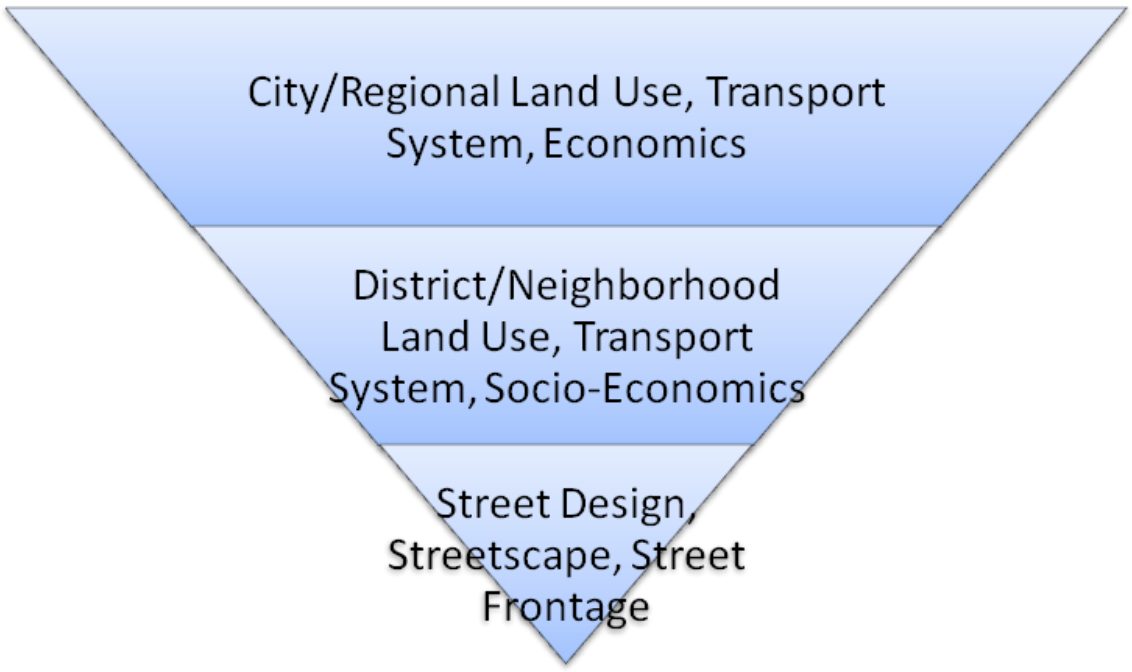


Figure 2: Geographic Scales for Inquiry into Active, Sustainable Streets

Pathways of inquiry into the nature and determinants of sustainable, active streets are diverse. Some of the most important are the built environment (land use, transport systems, street front), urban design (streetscape, provision for nature), socio-economics (demographics, incomes, employment), socio-cultural (cultural norms, peer and family influences on street users), and the psychology of individuals (perceived comfort, safety, satisfaction of street users). The focus in this research is on the visible and countable. Figure 3 shows these observable, measurable influences on active, sustainable streets.

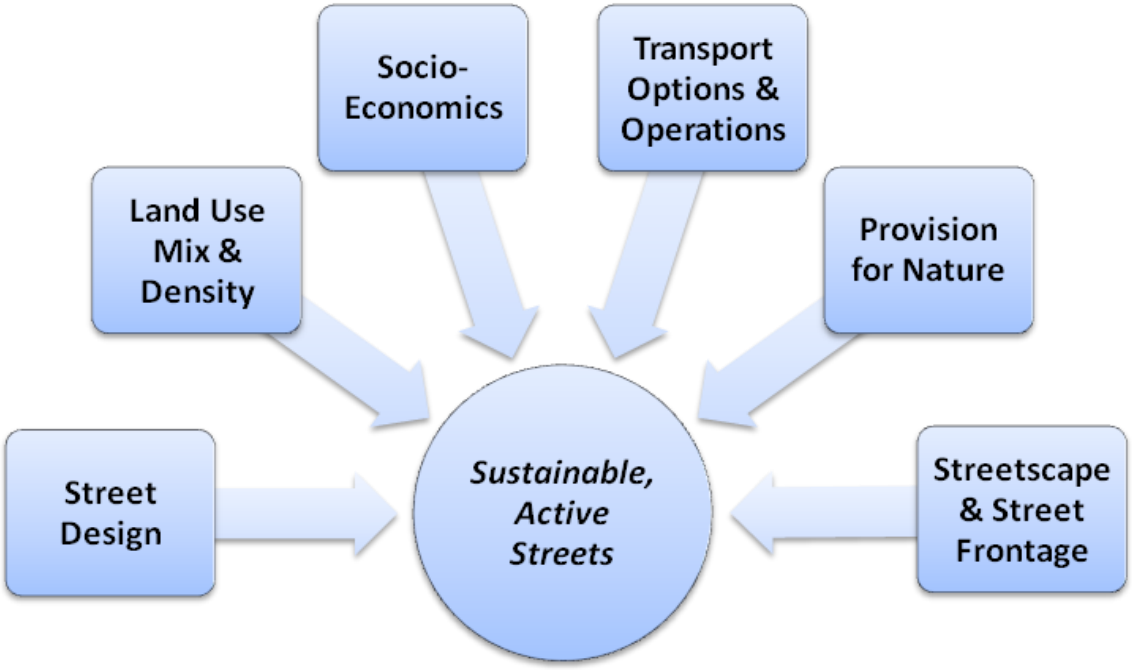


Figure 3: Influences on Active, Sustainable Streets

Assessing Arterial Streets for Activity, Sustainability

Marshall, Jones, & Plowright (2004) have defined the arterial street in comprehensive terms: "… a multifunctional urban street combining through movement and other urban functions, where the through movement function has relatively high strategic significance" (p. 28). As aspirations, if not always realities, Svennson (2005a) tasks arterial streets with being "multimodal", "multifunctional, "multi-dimensional", and as an "urban place, people-oriented, sustainable" (p. 18). D'Ieteren (2002) describes arterial streets as multifunctional in serving different types of users, pedestrians as well as vehicle occupants, cars and trucks as well as buses and bicycles. They have a transport role in connecting different parts or quarters of the city, an access role in connecting the street to the land uses it abuts, and an urban role as a public space "important to the city's economy" (D'Ieteren, 2002, p. 11). The street in all its complexity and however it is defined serves several core functions. Marshall (2003) expresses the teleology of the street in these terms: "The street essentially embodies three dimensions in a single package: … as a transport route or artery for through movement; … as a public space, where a variety of human activities take place; and … as a built frontage" (p. 771).

The research findings presented in this paper come from an analysis of data obtained in extensive fieldwork and from secondary sources. A mixed methods research strategy was employed to evaluate the activity on and sustainability of six street sections in five cities on the San Francisco Peninsula. The framework

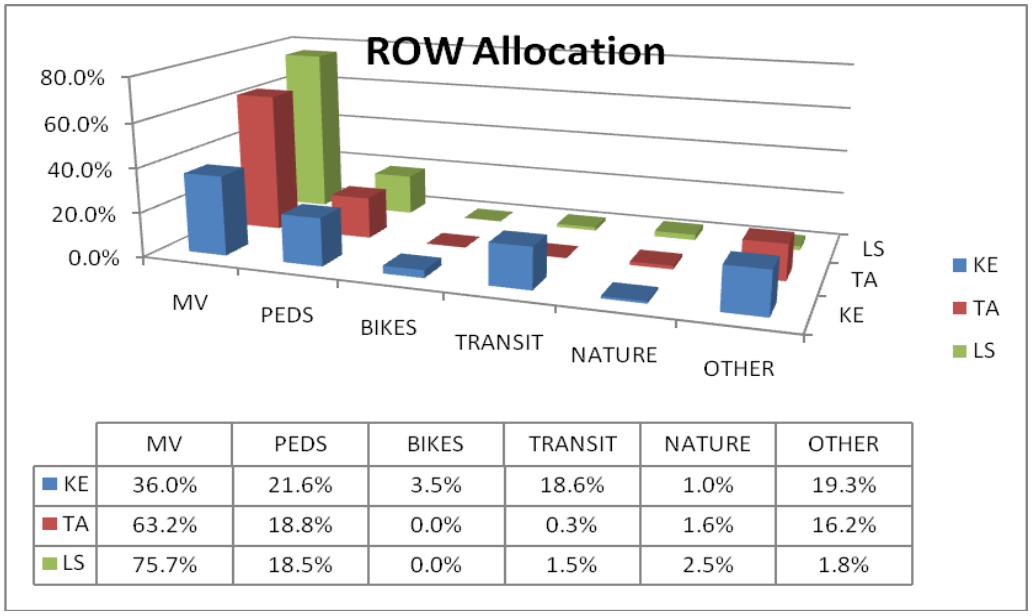
for the research is a 1:2, compare and contrast design, inspired by the Bosselman & MacDonald study of multi-way boulevards (1999). This design created the opportunity to examine in depth prototypes of two kinds of streets, the "complete" street and the "context sensitive" street, each in contrast to a pair of more conventional street sections. The criteria for selection of control streets, to be reported in a subsequent paper, required that they be broadly similar in function and located in a similar sized city, among other factors. This framework also made it possible to compare and contrast the larger and smaller city contexts for these streets. The economy of the 1:2 research design facilitated study in detail of a manageable number of street sections. The result was an illumination of many differences among streets that otherwise shared many common attributes. Reliance on both nonparametric statistics and qualitative methods was required in trading off breadth in sample size for depth in detail in this research design.

This endeavor entailed gathering of both quantitative and qualitative information on all the streets. There were clear differences among and between streets. More often than not, these differences reflected favorably on the two test or study streets in contrast to the four control streets. Since streets, like cities, are complex entities, the picture is not always clear and the distinctions are not always crisp. Nevertheless, there is a convincing pattern in the research findings that reveals the two test streets as more sustainable and more active than the control streets to which each was compared.

The first "test" or exemplary street was King Street – The Embarcadero (shown in Figure 4), an exemplar of a "complete street", built to replace the elevated Embarcadero Freeway along San Francisco's Bay front southeast of the Financial District. The second was Castro Street (shown in Figure 5), Mountain View, California's main street re-designed as a prototype of the "context sensitive" street. King Street – The Embarcadero was assessed in contrast to a comparable section of Lombard Street in San Francisco and The Alameda in San Jose. Castro Street was compared to two other small city main streets: California Avenue in Palo Alto, California and San Carlos Avenue in San Carlos, California. These two subsets constituted "Big City" and "Small City" arterial streets for purposes of this research study. Figure 6 and Figure 7 show right-of-way allocation across streets in each subset. The two test streets are both less generous to motorized traffic than are their companion control streets.

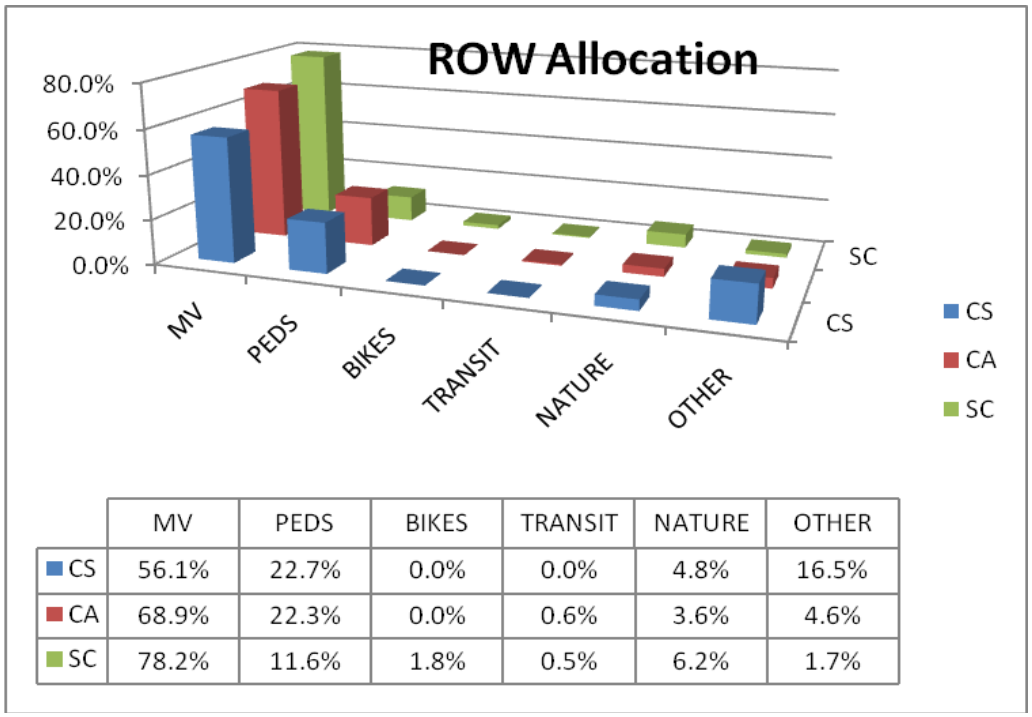
Figure 4: King Street – The Embarcadero

Figure 5: Castro Street



	MV	PEDS	BIKES	TRANSIT	NATURE	OTHER
KE	36.0%	21.6%	3.5%	18.6%	1.0%	19.3%
TA	63.2%	18.8%	0.0%	0.3%	1.6%	16.2%
LS	75.7%	18.5%	0.0%	1.5%	2.5%	1.8%

Figure 6: Right of Way Allocation – "Big City" Arterials

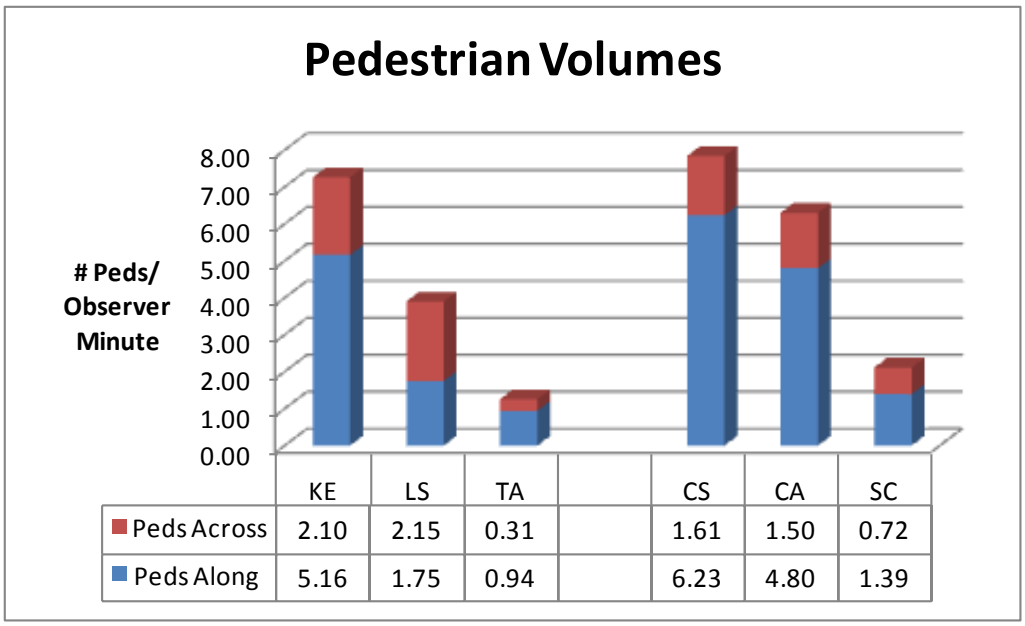


	MV	PEDS	BIKES	TRANSIT	NATURE	OTHER
CS	56.1%	22.7%	0.0%	0.0%	4.8%	16.5%
CA	68.9%	22.3%	0.0%	0.6%	3.6%	4.6%
SC	78.2%	11.6%	1.8%	0.5%	6.2%	1.7%

Figure 7: Right of Way Allocation – "Small City" Arterials

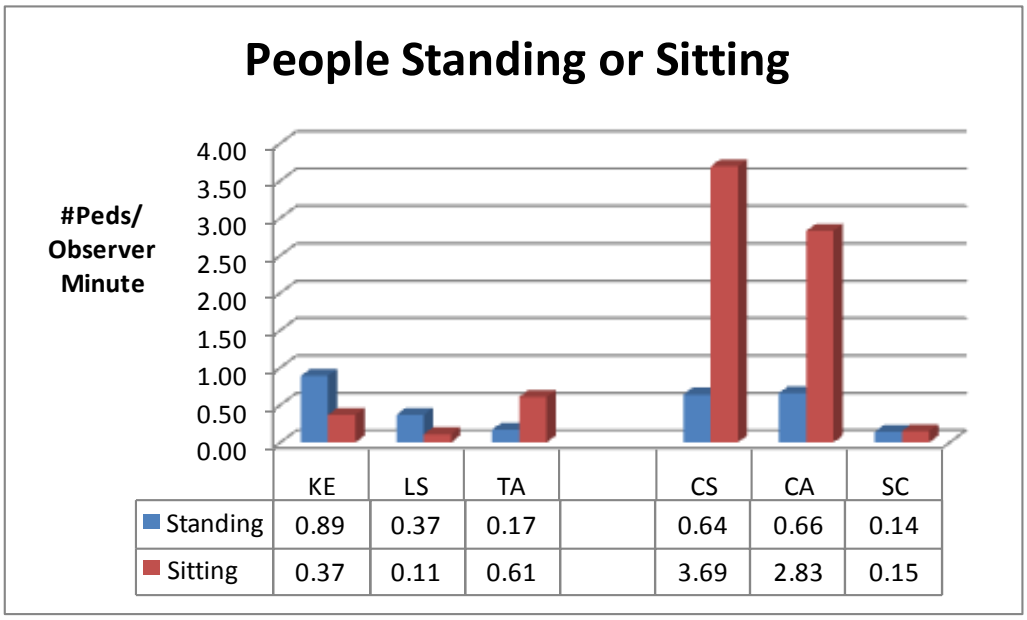
The test streets also had more pedestrian presence and activity than did their "big city" and "small city" counterparts. Figure 8 displays comparative pedestrian volumes, based on counts by observers at defined counting stations of pedestrians walking along and across each street. Figure 9 shows comparative data on pedestrians standing and sitting. The much greater

number of sitting pedestrians along Castro Street and California Avenue than other streets reflects the prevalence of café dining on both. Figure 10 combines moving and stationary pedestrians into a "pedestrian presence" metric. These data are normalized to observer minute.



	KE	LS	TA		CS	CA	SC
Peds Across	2.10	2.15	0.31		1.61	1.50	0.72
Peds Along	5.16	1.75	0.94		6.23	4.80	1.39

Figure 8: Pedestrian Volumes Along and Across the Street



	KE	LS	TA		CS	CA	SC
Standing	0.89	0.37	0.17		0.64	0.66	0.14
Sitting	0.37	0.11	0.61		3.69	2.83	0.15

Figure 9: People Standing and Sitting Along the Street

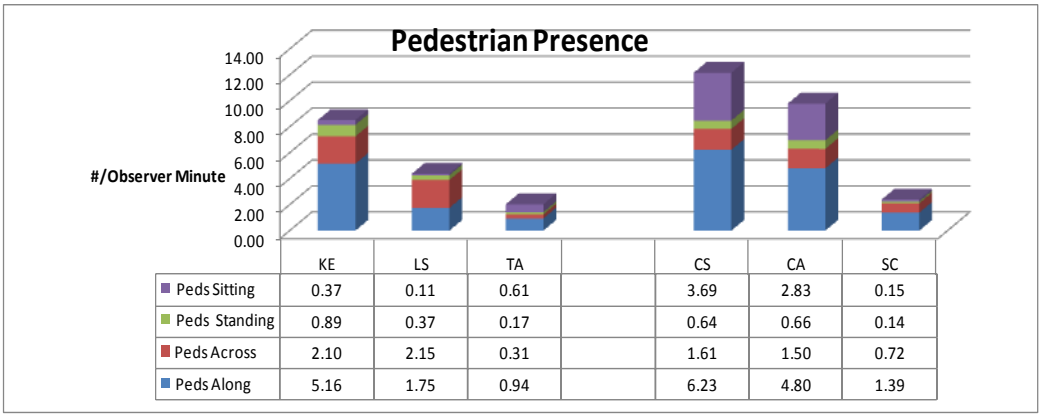


Figure 10- Pedestrian Presence - Number of Pedestrians Walking, Sitting, or Standing Along the Street

These pedestrians, whether moving, sitting, or standing interact with each other. Figure 11 shows how many of these pedestrians engage in interactions, by word or gesture, with one another.

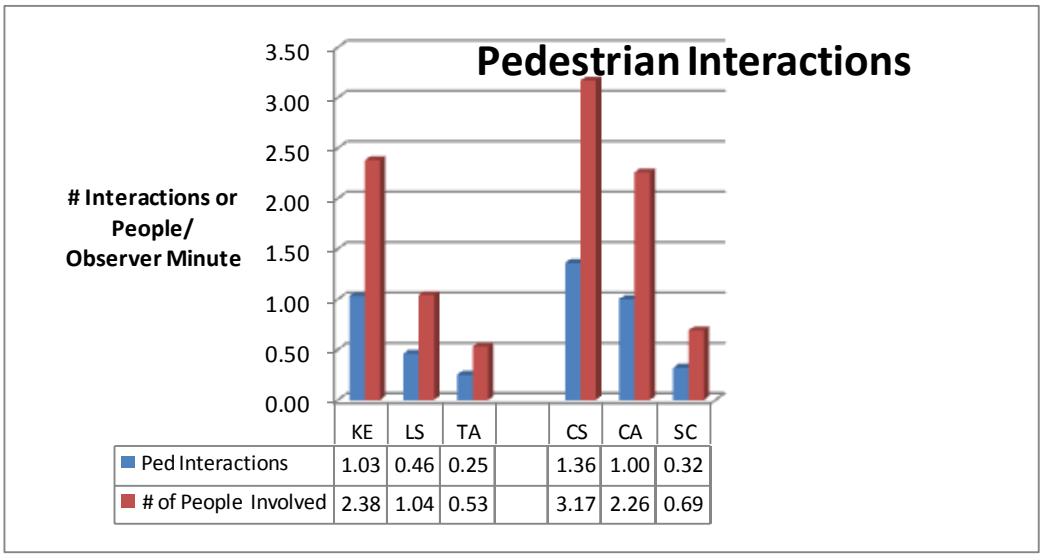


Figure 11- Pedestrian Interactions - Number of Pedestrians Walking, Sitting, or Standing Along the Street Who Interact with One Another

Figure 12 adds bicycle volumes to total pedestrian counts. The two test streets retain their primacy in each street cohort.

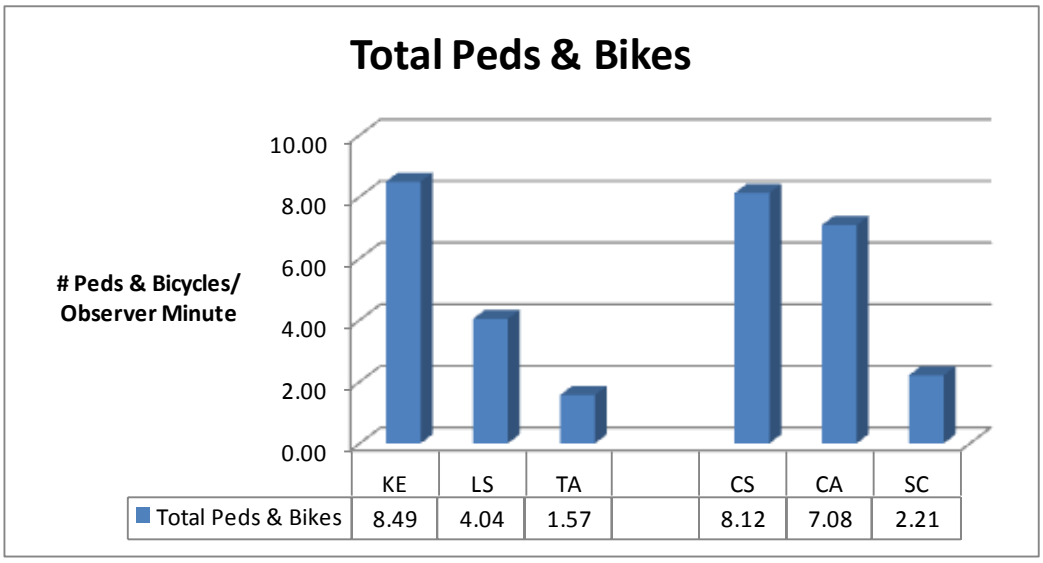


Figure 12- Total Pedestrian and Bicycle Presence

The rank order of streets within the "big city" and "small city" cohorts, respectively, in public transport boardings (Figure 13) mirrors that for pedestrian activity and presence. The generally much great public transport use on the "big city" arterial streets reflects their importance as urban travel links.

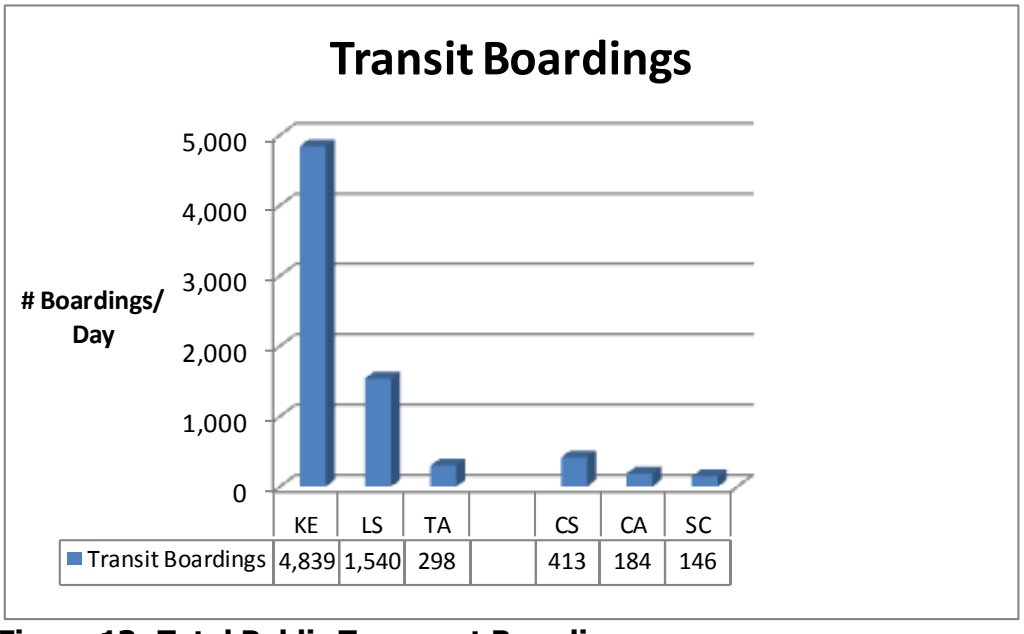


Figure 13- Total Public Transport Boardings

Table 1 summarizes results of non-parametric statistical significance testing on the difference between test and control streets for non-motorized modes and public transit boardings variables. While the small sample size of four streets compared to two virtually precludes the attainment of a .05 p-value for any given variable, the p-value of three (pedestrian interactions, stationary pedestrians, and total pedestrians) was less than .07, making the difference in each of these variables significant at the .10 level. P-values for public transit boardings, bicycles to/from/on, and pedestrians crossing, which ranged from approximately .13 to .27, were all above the .10 p-value significance threshold.

Dependent Variable	1-sided Wilcoxon Exact p-value
BIKEON2FR	0.2667
PEDINT	0.0667
PEDSSTAY	0.0667
PEDX	0.2667
PTBOARD	0.1333
TOTPED	0.0667

Table 1- P-Values for Non-motorized Modes Activity and Presence

The difference between the four control streets and two test streets, including location of the median value for each cohort, for the variables of total pedestrians, stationary pedestrians, and pedestrian interactions is shown on Figures 14 through 16.

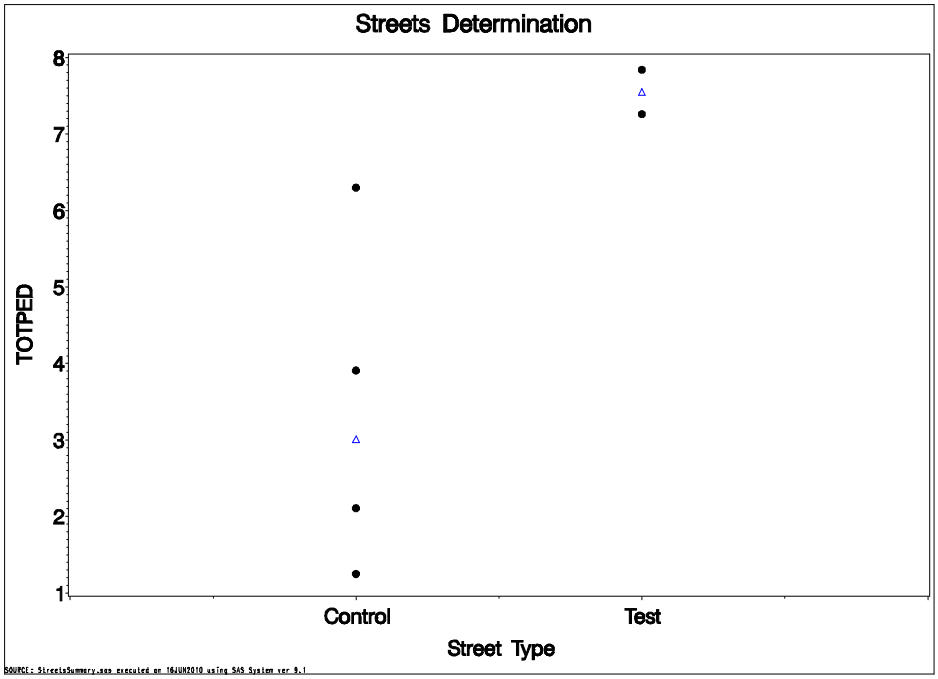


Figure 14- Values for Total Pedestrians, Arrayed by Street Cohort

Figure 15: Values for Pedestrian Interactions, Arrayed by Street

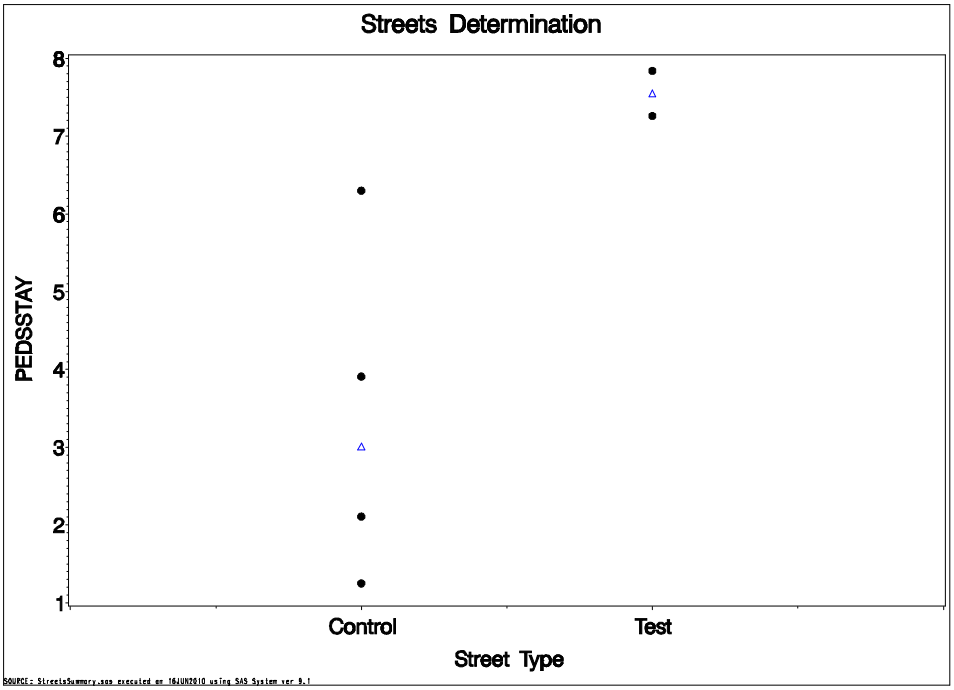
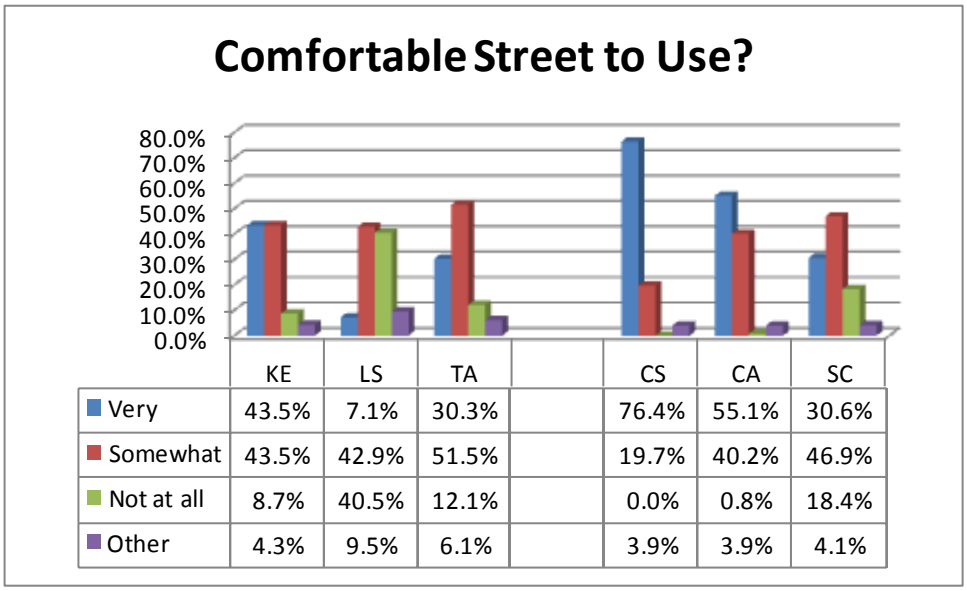


Figure 16: Values for Stationary Pedestrians, Arrayed by Street

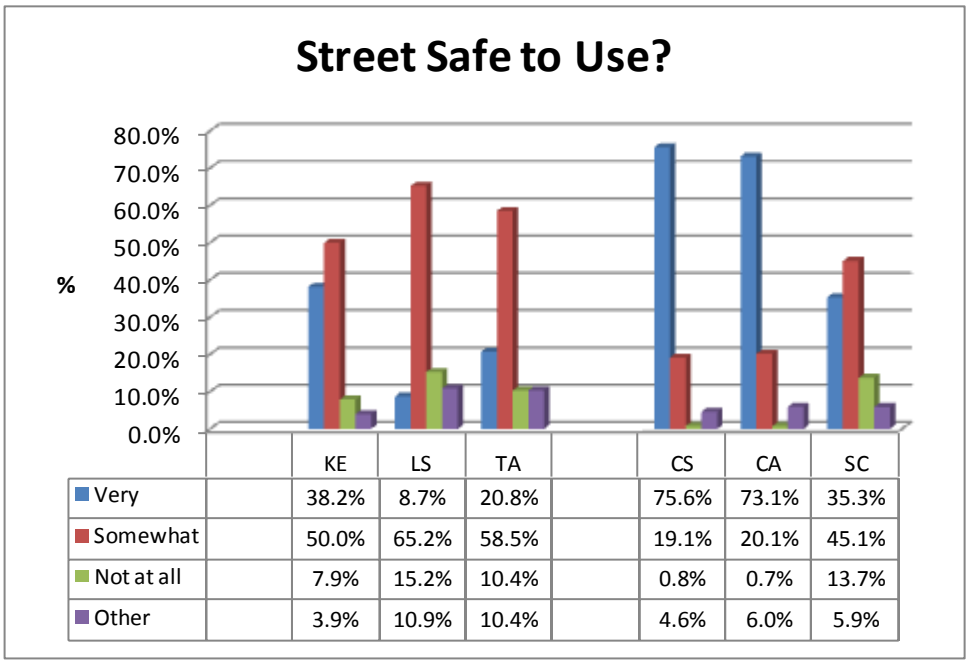
Street User Assessments

Street user survey results give clues as to why the text streets out-perform the control streets in pedestrian activity and presence. Figures 17 through 19 show the advantage that the two test streets have over their respective pairs of control streets on the key attributes of comfort, safety, and attractiveness.



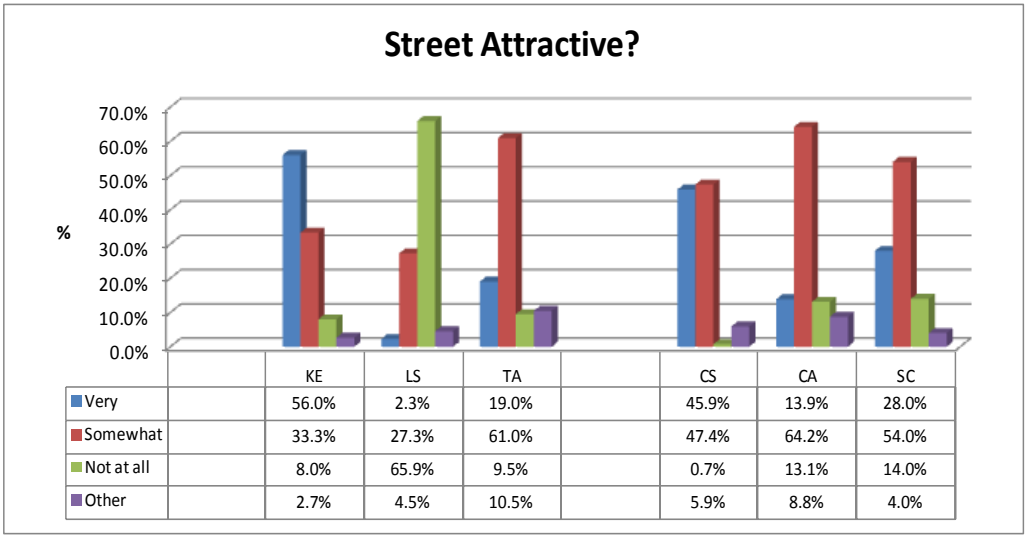
	KE	LS	TA		CS	CA	SC
Very	43.5%	7.1%	30.3%		76.4%	55.1%	30.6%
Somewhat	43.5%	42.9%	51.5%		19.7%	40.2%	46.9%
Not at all	8.7%	40.5%	12.1%		0.0%	0.8%	18.4%
Other	4.3%	9.5%	6.1%		3.9%	3.9%	4.1%

Figure 17- Street User Survey Results for Street Comfort



	KE	LS	TA	CS	CA	SC
Very	38.2%	8.7%	20.8%	75.6%	73.1%	35.3%
Somewhat	50.0%	65.2%	58.5%	19.1%	20.1%	45.1%
Not at all	7.9%	15.2%	10.4%	0.8%	0.7%	13.7%
Other	3.9%	10.9%	10.4%	4.6%	6.0%	5.9%

Figure 18- Street User Survey Results for Street Safety



	KE	LS	TA	CS	CA	SC
Very	56.0%	2.3%	19.0%	45.9%	13.9%	28.0%
Somewhat	33.3%	27.3%	61.0%	47.4%	64.2%	54.0%
Not at all	8.0%	65.9%	9.5%	0.7%	13.1%	14.0%
Other	2.7%	4.5%	10.5%	5.9%	8.8%	4.0%

Figure 19: Street User Survey Results for Street Attractiveness

The two text streets together also out-performed the four control streets collectively in the street user survey results for street convenience, activity, and importance. Table 2 summarizes non-parametric statistical significance testing of the difference in results between the two test streets and four control streets for all six attributes. P-values for four attributes (safety, comfort, attractiveness, and convenience) were all well below .01 and p-values for one other attribute (how active) below .03.

The focus groups echoed, to a large degree, the judgments pronounced in the answers to survey questions. Lombard Street and San Carlos Avenue were deemed in both focus group dialogs and survey responses to be uncomfortable, unsafe, and unattractive. In comparison, King Street – The Embarcadero and Castro Street were judged, in the terminology proposed by Jones, Boujenko & Marshall (2007), to be good places as well as good links. The middle cases in each street cohort, The Alameda and California Avenue, were each seen as flawed but with great potential. Residents and business people expressed affection for as well as exasperation with these two streets. The question for these streets was whether they would fulfill their potential or slide into shabbier versions of their present selves. Implicitly and sometimes explicitly, street re-design was seen as an avenue to take for attainment of the more hopeful future.

Street user survey and focus group comments about the two test streets amplify these results. For King Street – The Embarcadero, for example:

> "(There is) a lot going on; people running, people mingling. That all feels pretty good" and "the traffic moves on the Embarcadero; at the same time you don't feel menaced by all that traffic."

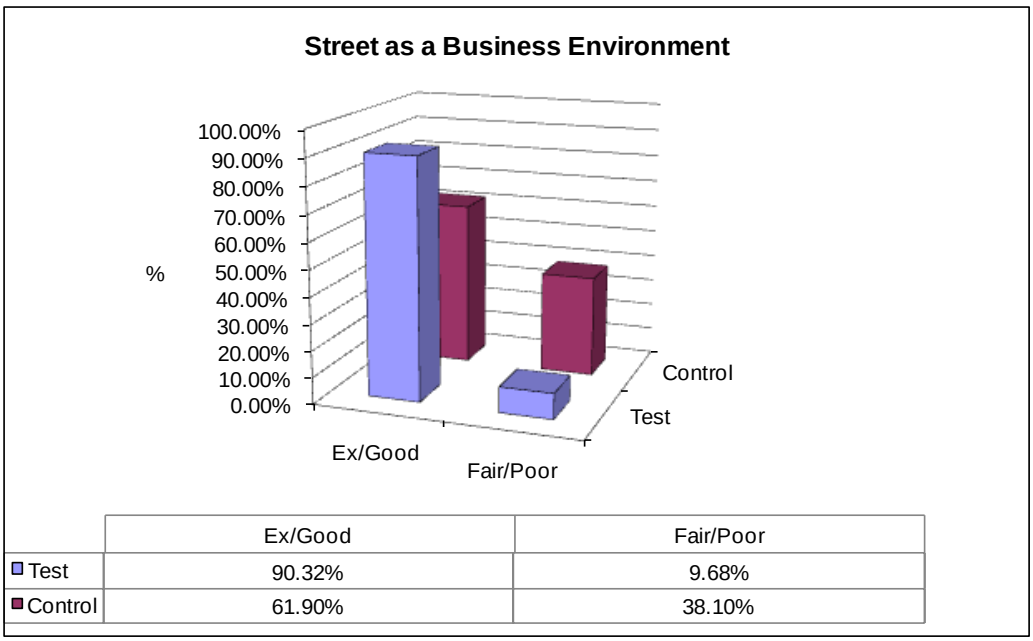
Regarding Castro Street:

> "The sidewalks are wide and there is just one lane of traffic each way, there are easy places to cross it, and there are quite a few trees and other plants there. There is an interesting mix of people on the street at different times of day, and a reasonable range of stores."
>
> "It's a pedestrian-oriented street -- quite rare in the South Bay. It has a variety of restaurant choices, and they're not big national chain restaurants. The fine grain of the buildings; the variety of architectural styles; buildings that come right to the sidewalk and have windows giving a view to what's inside; all of that makes it interesting to stroll along Castro."

Business person survey results also put the two test streets in a better light than their control counterparts. As shown on Figure 20, nine-tenths of the business people surveyed on the test streets assessed the business environment as either excellent or good, compared to three-fifths of businesses on the control streets. Business survey sample sizes ranged from 12 to 19 respondents, depending on the street. Non-parametric statistical significance difference test results were significant at α=.05 (Fisher's Exact).

		N (%) of Respondents		
Street Attribute	**Level of Agreement with Statement**	**Test Streets (KE and CS)**	**Control Streets (LS, TA, SC, CA)**	**Fishers 1-tailed p-value**
Convenient	Very	136 (69.0 %)	170 (54.7 %)	< .001
	Somewhat/Not at All	61 (31.0)	141 (45.3)	
Safe	Very	128 (64.6)	142 (45.8)	< .001
	Somewhat/Not at All	70 (35.4)	168 (54.2)	
Comfortable	Very	127 (67.2)	118 (39.3)	< .001
	Somewhat/Not at All	62 (32.8)	182 (60.7)	
Attractive	Very	100 (50.0)	54 (17.5)	< .001
	Somewhat/Not at All	100 (50.0)	255 (82.5)	
Active	Very	100 (50.5)	123 (39.9)	0.0219
	Somewhat/Not at All	98 (49.5)	185 (60.1)	
Important	Very	95 (47.7)	170 (55.0)	0.1221
	Somewhat/Not at All	104 (52.3)	139 (45.0)	

Table 2- P-Values for Difference in Street User Assessment of Street Attributes



	Ex/Good	Fair/Poor
Test	90.32%	9.68%
Control	61.90%	38.10%

Figure 20: Business Survey Results for Business Environment

Summary and Conclusion

The findings discussed in this paper were derived through use of a mixed methods research strategy, which has been described as using "qualitative and quantitative date collection and analysis techniques in either parallel or sequential phases" (Tashakkori & Teddlie, 2003, p. 11). The advantage of mixed methods is that, just as in navigation, they provide a kind of triangulation using "multiple reference points to locate an object's exact position" (Jick, 1979, p. 602). The framework for the research is a 1:2, compare and contrast design, inspired by the Bosselman & MacDonald study of multi-way boulevards (1999). This design created the opportunity to examine in depth prototypes of two kinds of streets, the "complete" street and the "context sensitive" street, each in contrast to a pair of more conventional street sections. This framework also made it possible to compare and contrast the larger and smaller city contexts for these streets. The economy of the 1:2 research design facilitated study in detail of a manageable number of street sections. The result was an illumination of many differences among streets that otherwise shared many common attributes. Reliance on both nonparametric statistics and qualitative methods was required in trading off breadth in sample size for depth in detail in this research design.

The research strategy pursued was informed by the author's own insights as street user, transport planning practitioner, and urban planning scholar. There is no substitute for spending a lot of time actually using streets that one is also studying. This is especially true if the street use is by all the available modes of travel and includes taking time for "outdoor stays", for example people

watching from a sidewalk café or counting those pedestrian interactions that are so integral to lively streets (Gehl, 2006).

The researcher's expectations were that the study or test streets would be more active and more sustainable environmentally, economically, and socially than the control streets. In other words, that King Street – The Embarcadero and Castro Street would have more pedestrian activity, transit use, and commercial appeal, as well as being safer to use, than the pair of control streets to which they were being compared. A further expectation was that the two test streets together as a sub-set would be more successful than the four control streets as a sub-set. A singularly important expectation in this research effort was that re-allocation of street right of way from private motor vehicles to pedestrians, cyclists, public transport, and "nature" would contribute to making streets both more active and more sustainable.

A signal and expected result was that street right of way allocation matters. The two test street sections that had the highest proportion of right of way given over to uses other than the movement of private motor vehicle were also the most active. Both streets featured allocation of a substantial proportion of right of way to sidewalks, those mundane facilities, often taken for granted, that have been described as "multiuse environments" rather than "pure pedestrian thoroughfares" (Loukaitou-Sideris & Ehrenfeucht, 2010, p .22). In the case of King Street – The Embarcadero, wide sidewalks served commuting pedestrians and cyclists as well as recreational walkers and joggers. Along Castro Street, sidewalks afforded room for café patrons, strollers, window shoppers, and people waiting to board a bus.

Another research expectation was that restaurants along a street front activate the street. The finding, to be reported in a subsequent paper, that the rank order correlation between the amount of pedestrian presence and the extent of street front in restaurant use was nearly perfect met that expectation. In the course of many visits to each of the six streets studied in this dissertation, the researcher was struck by just how much activity these businesses can generate. A lively scene is created by prospective patrons scanning menus posted on restaurant windows or walls, others queued up on the sidewalk waiting to be seated inside or out, and still more eating and chatting at sidewalk cafes.

This research also began with the idea that public transport, especially rail transit, can activate a street and support street sustainability. This expectation too was met. The test streets each had the most public transit service as well as the most pedestrian presence in their respective cohorts. Both King Street – The Embarcadero and Castro Street benefit from the proximity of light rail as well as commuter rail services. Many appreciative focus group and open-ended survey comments about transit availability on and near each street described just how important this was to street users. The researcher was impressed by the contribution that people walking to and from and waiting at transit stops make to street activity levels. Prospective public transport patrons waiting for a train or bus interact with others at the stop or on the platform. The stream of transit users walking to and from transit stops animates the scene on the

sidewalks and crosswalks they use. Some of these patrons stop to patronize stores and restaurants, or enter offices to begin or resume work, after de-boarding.

There is some evidence that street design itself appears to matter as well. As also will be reported in a subsequent paper, both test streets had far fewer commercial driveways that any of the four other street sections studied. Castro Street had the fewest through lanes for motor vehicle travel and King Street – The Embarcadero tied for the fewest in their respective street cohorts. Notably, while there were street user comments in focus groups and on-line surveys in praise of easier pedestrian navigation on both test streets, there was little if any such praise for the control streets. This testifies to the importance of street design for some users of these exemplary streets.

If perceptions of comfort and safety for walking or bicycling on a street are necessary, though not sufficient, conditions for actually doing so, King Street – The Embarcadero and Castro Street meet those conditions. Each street segment was viewed favorably for both qualities in street user survey ratings as well as in comments made in both surveys and focus groups.

Business survey respondents provided evidence that the two test streets combined provided a better business environment than did the control streets combined. The advantage given King Street – The Embarcadero over Lombard Street, the big city arterial street with the second most favorable assessment by business people, was not statistically significant at the .05 level, however. In contrast, Castro Street's advantage over San Carlos Avenue was statistically significant at this level...

One hoped-for and largely realized expectation was that a "context sensitive" main street (Castro Street) can be more active and more sustainable than a low motor vehicle traffic volume, low motor vehicle speed, but conventionally designed main street (California Avenue). Another largely realized expectation was that an urban arterial designed as a "complete street" (King Street – The Embarcadero), although tasked with being the surface street extension of an urban freeway, can be more active and sustainable than an urban arterial similarly tasked but conventionally designed. The two test streets had more pedestrian presence and pedestrian interactions as well as more public transport use than did each pair of the street sections to which they were compared. Street user surveys and focus group assessment results also clearly favored King Street – The Embarcadero and Castro Street over their companion street sections.

An important policy implication is that street right of way allocation makes a difference in the link and place performance of arterial streets. Communities need not pursue, as if on automatic pilot mode, the pattern of adapting streets and cities to the needs of motor vehicles, as has been the case from the early days of mass ownership of private cars (Mc Shane, 1994). Instead, street rights of way can be shaped and re-shaped like clay. In this way, streets can become instruments for creating sustainable cities and suburbs, links and places for active, sustainable community life.

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