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ABSTRACT
Transit villages could reduce automobile dependency and improve urban environments; however, there are few contemporary examples of such development, in part because of uncertainty about the market demand for transit-oriented living. This article assesses the market potential of transit villages using visual simulation techniques. Photoslide images were created to simulate a "walk" through four neighborhoods with different density and amenity mixes. Based on the survey responses of over 170 Bay Area residents, the lowest density neighborhood was the most preferred. However, far more respondents liked the simulated transit village designed at 36 dwellings per acre with nicer amenities than liked the village designed at 24 dwellings per acre but with fewer community services. The research suggests Americans will trade off higher residential densities for more amenities in transit village settings. Visual simulations, we believe, provide a richer context for probing the market potential for transit-oriented development than do traditional market research approaches because visual simulations convey a wider array of environmental choices.

INTRODUCTION
America's growing dependency on the private automobile is widely cited as a root cause of many of today's urban problems -- traffic congestion, air pollution, and faceless urban sprawl. During the 1980s, the national share of drive-alone commuters jumped from 64.4 percent to 73.2 percent, despite heavy subsidies to public transit systems (Pisarski, 1992). One strategy being suggested to help reverse, or at least stave off, this trend is to promote more intensive development, especially housing, around rail stops. Nationwide, around 12,000 multi-family housing units were built within a quartermile ring of rail stations in ten different metropolitan areas between 1988 and 1993, with nearly 500 units built on land owned by transit authorities (Bernick and Cervero, 1994). Research shows residents living near rail stations in California are around five times more likely to commute by transit than those living in the same city but away from rail stations (Cervero, 1994).

Much of the housing built to date around suburban rail stops in the U.S. are independent, stand-alone apartment structures with 30 to 50 units per acre (Bernick, 1993). Such environments fall short of what is often envisaged by proponents of transit villages and neo-traditional neighborhoods. Neighborhoods oriented toward transit should at minimum have a mixture of land uses, a commercial center near the train station, prominent public spaces, and a pleasant walking environment (Calthorpe, 1993; Katz, 1993; Audirac and Shermyen, 1994). Transit villages, of course, are hardly new ideas. They borrow from the visions of early city planners such as Ebenezer Howard, who in 1898 advanced the idea of building garden cities that would orbit London, separated by protected green belts and connected by inter-municipal railways. In the United States, the best examples of transit villages are the early streetcar communities like Back Bay in Boston, Forest Hills outside of New York, Riverside near Chicago, and Roland Park in Baltimore.

Relatively little is known about the market potential of contemporary transit village development, in large part because little has been built to date. Transit-oriented communities such as the celebrated Laguna West south of Sacramento, designed by architect Peter Calthorpe (1993), have struggled financially and for the most part incorporate modest transit provisions. Significant obstacles to building transit villages include questionable market viability, conservative lending practices by many banks today, and neighborhood opposition to multi-family housing proposals, especially in the suburbs.

Europe offers perhaps the best examples of transit-oriented communities anywhere, such as rail-served new towns outside of Stockholm and the pedestrian/transit-only cores of many German cities (Hass-Klau, 1990; Cervero, 1995); however, for historical and cultural reasons, experiences there are not easily transferable to the U.S.

Presently, the entire "transit village movement" seems caught in a catch-22: there are few examples, in part because of questionable market feasibility, and the market potential of transit villages is questionable because there are few examples. The purpose of this research is to investigate the market potential of transit villages. In the absence of good U.S. examples, we attempted to simulate them using computer-generated images. In particular, we sought to gauge the degree to which people might be willing to accept higher density transit-oriented neighborhoods in exchange for more amenities like open space and small retail plazas. Four village scenarios with varying blended housing densities [12, 24, 36, and 48 dwelling units per acre (dua)] were created. As densities increased, so did the amount and quality of neighborhood amenities. These densities span the minimum necessary to sustain rail transit services (12 dua), as established by Pushkarev and Zupan (1977), as well as the upper boundary (48 dua) of what can be built without going to more expensive steel-framed structures with elevators, lobby space, and structured parking.

DENSITY, MOBILITY, AND PLACE

Research shows residential densities to be one of the most important determinants of travel choice. Harvey (1990) found a doubling of residential densities in the San Francisco Bay Area was associated with a 30 percent decline in vehicle miles traveled (VMT) per household. Using data from smog check odometer readings and trip logs, Holtzclaw (1990) found that residents of a dense part of San Francisco drove, on average, only one-third as many miles each year as residents of Danville, an East Bay suburb with comparable incomes. In a more recent study of 28 California communities, Holtzclaw (1994) found that the number of automobiles and VMT per household fell by one-quarter as densities doubled, and by around 8 percent with a doubling of transit service levels, against controlling for potential confounding factors like household income. In a similar study of the greater Seattle area, Frank and Pivo (1994) found that higher population densities increased the share of shopping and work trips made by transit and on foot.

Research also shows that those living in higher density housing near rail stations not only commute more often by rail, but they also generally own fewer cars. Cervero (1994) found that one-third of employed adults living in apartments and condominiums near rail stations in the San Francisco Bay Area commuted by rail transit, compared to a regional average of 8 percent. Moreover, households near Bay Area rail stations averaged 1.40 vehicles, compared to an average of 1.67 vehicles per household for the region as a whole. Transit-based housing thus appears to hold the potential not only for reducing automobile commute trips, but also for reducing vehicle ownership, and thus the amount of land devoted to residential parking near rail stations.

Today's typical suburban planned unit developments (PUD) are designed at 5 to 6 dwelling units per residential acre (dua), well below the minimum of 12 dua necessary to support moderate levels of rail transit services.(FN1) Of course, communities are not designed for the purpose of shaping travel behavior, much less to lure people to mass transit. More important, according to Blumenfeld (1968) and Jacobs (1961), is to design places at a proper human scale -- to impart a sense of identity and belonging to a place. Hans Blumenfeld, with the assurance that comes from long practice, maintains the "right" residential densities are between 12 and 60 dua. Such a range, he contends, ensures that people can easily reach places by foot and have frequent face-to-face contact without being over-awed by a monumental scale. Jane Jacobs advocates even higher densities, more in the 50 to 150 dua range, to create a vibrant community and instill and attachment to place.

Many people wrongly equate density with high-rise buildings. Le Corbusier's Radiant City, the ultimate high-rise residential city, featured gross densities of only 120 to 150 dua (Blumenfeld, 1968). Since towers were separated by vast expanses of open space, Radiant City covered only 12 percent of ground. Four- to five-story residential buildings can produce average densities above those of Radiant City's -- in

the 140 to 220 dua range (Jensen, 1966).
Built environments are extremely malleable, able to accommodate a variety of spatial organizations and housing types. It is possible to build at 12 dua and still accommodate single-family detached units. Howard's garden cities, forerunners of today's transit village schemes, featured single-family homes built at 12 dua. Row houses (connected single-family homes with zero lot lines) can be developed as high as 6 dua. Mixing building types can nudge average densities up to the level where transit trips outnumber automobile trips. For instance, 50 dua can be achieved by designing a project where half of the units are single-family dwellings at 12 dua, 30 percent are row houses at 36 dua, and 20 percent are mid-rise apartments at 160 dua.

DENSITY AND DESIGN

Residential preference surveys consistently show upwards of 95 percent of Americans prefer single-family to multi-family dwellings (Michelson, 1968; Bookout, 1992). Many associate density with noise, overcrowdedness, urban blight, and stress. Preference for single-family living also reflects the strong North American value placed on home ownership (Foote, et al., 1960), secured tenancy (Michelson, 1977), and privacy (Cooper-Marcus and Sarkissian, 1986; Dillman and Dillman, 1987).
Only recently have designers begun to recognize that actual and perceived densities can vary widely. Rappaport (1976) argues that density is a perceived experience shaped by visual cues, some of which suggest crowdedness (e.g., busy sidewalks) and others that convey spaciousness (e.g., tree-lined streets). In a study of three San Francisco streets with similar densities (30-47 dua) lined with buildings of identical height but different architectural details, Bergdoll and Williams (1990) concluded that facades with greater articulation (e.g., visible roofs, individual bay windows, and recesses) were perceived as lower in density than streets with facades of a uniform appearance.
Bookout and Wentling (1988) contend people will trade off higher densities in return for more amenities and better quality living environments. Ways of making higher density projects acceptable include: extensive landscaping; adding parks, civic spaces, and small consumer services in neighborhoods; varying building heights to break the monotony of structures; detailing roof lines and varying building materials; designing mid-rise buildings on podiums with tuck-under, below-grade parking; replacing row apartments connected by exterior breezeways with eight-plex buildings (two-story stacked flats with four ground-level patios and second-level decks).
It is the prospect of designing attractive transit villages with plentiful amentities that reduce perceived densities that motivated this research. The views of one of the Bay Area's largest housing developers is cause for optimism:

> The market is beginning to put more value on the community than on the house itself. Developers need to do a better job of creating and selling community features -- variou recreational amenities, a pleasant ambiance (one perhaps harking back to traditional villages), pedestrian-friendly streets, and human building scales. (Bookout, 1992:16)

VISUAL SIMULATIONS AND RESIDENTIAL SATISFACTION

Past studies on residential satisfaction underscore Americans' preference for ownership of detached, single-family homes (Foote, et al., 1960; Baldassare, 1979; Shaw, 1994). Lansing, et al. (1970), surveyed attitudes of residents from several planned U.S. communities (such as Reston, Virginia, and Irvine, California). Most preferred low density neighborhoods, although only the highest density (above 12 dua) ones were strongly disliked. Residents of these planned communities reacted similarly to townhouses and single-family homes, except at higher densities. Studies also show that seniors and singles are usually most accepting of higher density living (Michelson, 1977; Shaw, 1994).
Not all attitudinal surveys of high-density settings have elicited negative responses. Visual Preference Surveys (VPS), wherein residents rate between 160 and 240 slides, have been used to build community consensus on urban design. As part of an infill plan for a New Jersey town, residents gave a negative rating to a recently approved multi-family project built according to local zoning requirements, but gave

highly positive ratings for several images of higher-density urban townhouses clustered around courtyards (Constantine, 1992). VPSs of several thousand people across the U.S. reveal a repeated preference for traditional communities over suburban PUD living.

Little work has been conducted to date on the attitudes of Americans on varying density in simulated neighborhoods. Two recent studies used overlays of slides to create photomontages that simulated housing development near northern California rail stations. Ketelsen-Johansson (1994) presented front- and rear-lot images of homes in neighborhoods varying from 10 to 36 dua. She found suburbanites disliked higher densities even after neighborhood amenities such as lakes and hillside landscapes were added. Shaw (1994) showed Bay Area and Sacramento residents photomontage images of neighborhoods close to both rail stations and freeway interchanges. Housing near transit was generally preferred to housing near freeways; however, the densest housing was preferred near highways instead of rail stops.

While these simulations confirmed what others have found, namely that Americans prefer lower density neighborhoods, the overlaying of separate images of dense housing projects and suburban rail stations failed to portray attractive or realistic-appearing neighborhoods. Also, these two studies were not able to control for the influence of other factors that likely influence responses, such as architectural style or illumination of the scene. Moreover, both projects used static slide presentations, showing single images of a street leading to a transit stop, as opposed to dynamically "walking" respondents through a simulated environment. Our research aims to overcome some of these shortcomings.

RESEARCH DESIGN AND METHODS

In order to elicit viewer responses to transit villages with varying density and amenity mixes, four different hypothetical neighborhood scenarios were simulated. For each neighborhood, nine color photoslide images simulated a "walk" from a house in the middle of the transit village to a rail station three blocks away. Over 170 residents from the San Francisco Bay Area were recruited to view the images and rate the neighborhoods.

To test the hypothesis that people will accept higher densities in return for more amenities in a transit village setting, our study was designed so that densities and amenity levels were the only factors that varied across the four simulated neighborhoods. Other factors, like architectural style, building colors and newness, the amount of sunlight, and street widths, remained constant. Without introducing such controls, we would not have been able to distinguish the influences of amenities like open space from the effects of building designs and other intervening factors on peoples' attitudes and preferences.

Decisions about many details of the simulated environments had to be made, including architectural style, articulation of facades, colors and textures of materials, orientation of entrances and windows, and the landscape design of private spaces. We decided to render building facades in a contemporary style. Other styles could have been chosen, such as a post-modern designs. The important decision was not the style per se, but rather maintaining a consistent style that would appear plausible at four very different density levels.

SIMULATING TRANSIT VILLAGES

The four simulated neighborhoods had densities of 12, 24, 36, and 48 dua -- again, spanning the minimum necessary to support rail transit (12 dua) as well as the upper boundary (48 dua) of what can be built without going to four stories and incurring the costs of expensive steel-framed structures, elevators, lobby space, and structured parking. The South Hayward station on the Bay Area Rapid Transit (BART) system was selected as the site for modeling hypothetical transit villages. Each simulated neighborhood was designed according to the layout of blocks and streets in the vicinity of this station. The South Hayward station typifies many suburban rail stops -- it is surrounded by a large parking lot and vacant land, with single-family homes and a few apartments off in the distance. It thus has an important prerequisite for creating a transit village -- vacant, buildable land nearby, including a park-and-ride lot. BART is presently working with local governments to convert surface parking lots into mixed residential/retail projects at the El Cerrito del Norte and Pleasant Hill stations, and there have been discussions of doing likewise one day at South Hayward (Bernick and Cervero, 1994).

Images of the four simulated neighborhoods were generated using three-dimensional modeling and animation techniques. The model was designed like a kit of parts with exchangeable components depicting factors that varied (e.g., density, amenity levels) and permanent components depicting factors that remained constant (e.g., street widths, the presence of a BART station). The computer-generated kit of parts was created from digitized drawings. Each image was photorealistically rendered with trees, facade and surface texture, colors, people, and cars. The light sources were set consistently for each image, producing realistic shadows and shaded surfaces. The angle of views was also set consistently at 60 degrees. Images were stored in digital files and transferred in full color to photoslides via a film recorder.

An admitted weakness of simulation media is the "artificial" quality of the rendered views. State-of-the-art computer-generated renderings have a "stark" appearance, partly because objects in the view appear to be brand new, and partly because of the artificial light quality and reflectivity of surfaces and colors.

The simulated 12 dua neighborhood consisted of two-story, free-standing single-family homes on a 2,250 sq. ft. plot. The next lowest density neighborhood, 24 dua, consisted of two-story attached single-family rowhouses, constructed above individual garages, with 18 ft. frontages (1,260 sq. ft. land area per unit). The 12 and 24 dua neighborhoods had no park, only a convenience store near the rail station, and a fairly modest public square facing the station. Figure 1 shows the nine images created for the lowest density neighborhood. Figure 2 shows four of the images for the 24 dua neighborhood.

The rowhouse design with individual garages was again used for the 36 dua neighborhood but the frontage was reduced to 16 ft. (864 sq. ft. per unit). The highest density neighborhood, at 48 dua, was designed as a six-unit, three-story condominium (550 sq. ft. land area per unit). Parking extends under a podium into the rear yard. To compensate for higher densities, the 36 and 48 dua neighborhoods had more amenities -- a neighborhood park (at the end of the residential street), a neighborhood retail plaza with a bakery and outdoor cafe, and a more extensively landscaped public square facing the rail station, with additional commercial space and outdoor seating. Figure 3 shows four images for the 36 dua neighborhood and Figure 4 shows all nine images for the highest density neighborhood.(FN2)

In summary, each simulated "walk" began by showing a view out the rear and front windows of a house located three blocks from a hypothetical rail station, proceeded along two residential streets toward a neighborhood retail plaza, and ended at a nearby public square fronting a BART station. See Cervero and Bosselmann (1994) for further details on the research design.

FIELD PRESENTATIONS AND SURVEY RESPONSES

Over 170 Bay Area residents viewed the slides of simulated transit villages at eight different venues held in the spring of 1994.(FN3) Newspaper ads, telephone contacts, and passer-by solicitations were used to recruit individuals 18 years of age and over. Participants were screened to ensure that the sample was demographically representative of the Bay Area adult population. Before viewing the slides, respondents were told to imagine themselves visiting the neighborhoods for the purpose of possibly purchasing a home (i.e., we focused on attitudes toward owner-occupied units in transit villages). They were informed that houses in the neighborhoods were of identical size (1,100 sq. ft.), with two bedrooms, one and half baths, and a one car garage. In order to remove the influence of geographic location on how neighborhoods were rated, participants were to consider that the neighborhoods lie in a part of the San Francisco Bay Area similar to where they presently live and near a rail station like BART. This meant each person rated the four neighborhoods for the same assumed location, thus removing the influence of location on ratings.

Participants viewed each neighborhood slide sequence twice, and then responded to a series of questions that asked them to rate and evaluate the neighborhood. (We pre-tested and, based on the pretest results, modified the final survey instrument and presentation format.) Simulated neighborhoods were shown in different random orders at each venue in order to remove any biasing influences of sequencing. We suspected ratings might be higher for the initial sequence because of the novelty factor. Ratings for latter sequences might then fall off because some respondents might begin to tire from viewing many images.

Random ordering of sequences reduced the likelihood of such biases. Viewing the slides and answering questions took around 45 minutes, and each participant received $20 for his or her time.

Participants were fairly representative of the Bay Area population at-large. From the survey results, the mean age was 38 years, compared to 41 years for residents 18 years and above for Alameda, Contra Costa, and San Francisco counties combined.(FN4) Around 60 percent of the respondents were single -- either living alone, with other singles, or raising children by themselves. This share is slightly above the 53 percent of adults from the three BART-served counties who were single in 1990. Twenty percent of the repondents lived in households with children, compared to 28 percent of adults from the three counties. Forty percent lived in single-family homes versus 46 percent of households in the three BART counties.

EVALUATIONS OF SIMULATED TRANSIT VILLAGES

OVERALL RATINGS AND RANKINGS

After viewing the slides for each simulated neighborhood, participants were asked to rate each on a -3 to +3 scale in terms of "overall desirability," with -3 representing highly undesirable, +3 representing highly desirable, and 0 signifying indifference. While none of the neighborhoods were viewed as overwhelmingly the most desirable, the lowest density one received the highest average rating: 0.24. The average ratings for the other neighborhoods were: 24 dua: -0.45; 36 dua: 0.03; and 48 dua: -0.1. Thus, the least desired neighborhood had the second lowest densities (and few amenities). It was preferred, on average, even less than the neighborhood with twice the density (48 dua).

Matched-pair comparisons were conducted to test whether differences in overall desirability ratings were statistically significant. Taking differences in ratings for neighborhood pairs for each respondent effectively removed the influence of all factors other than the variable of interest -- desirability rating. Based on t-statistics, ratings were significantly different for all neighborhood pairs at the .05 probability level except for two: 12 versus 36 dua and 36 versus 48 dua. Thus, while respondents preferred living in a 12 versus a 36 dua neighborhood, mean ratings were not significantly different. Nor were they between the two highest density neighborhoods. The paired difference in ratings of the 24 dua versus 36 dua neighborhoods was 0.460, yielding a t-statistic of 4.40 with a probability of 0.000.

Figure 5 summarizes rankings by the percent of respondents who liked each neighborhood the most and each the least. Fifty-eight percent of the respondents liked the lowest density neighborhood the most. However, far more respondents liked the transit village designed at 36 dua and nicer public amenities than the village designed at 24 dua with few amenities. Notably, people preferred tightly spaced two-and-a-half story rowhouses with modest backyards located near a public park and small retail plaza to similar rowhouses with larger rear yards and more street frontage, but with no neighborhood park and fewer local services. Overall, a moderately dense neighborhood without a large park (24 dua) or a very dense neighborhood with a park (48 dua) were disliked by many. The neighborhood which fell in between these two in terms of density and park features (i.e., the one with 36 dua) provoked less of a strong reaction -- it was generally liked more and disliked less than the other two neighborhoods.

After respondents initially ranked neighborhoods (having viewed all of them in sequence), they were told specifically what distinguished the neighborhoods. They were then asked to rank the neighborhoods again one last time. The intent of the second ranking was to ferret out how perceptions might have changed once participants were informed about how the neighborhoods differed. Overall, the second rankings were very similar to the first. Verbal descriptions increased the rankings of the two highest density neighborhoods slightly, and lowered those of the two low-density ones just a bit.

Overall, these findings confirm the central hypothesis of this research: people are willing to accept higher densities in transit-oriented neighborhoods as long as various amenities, perhaps most noticeably a neighborhood park, are provided. As expected, people's preferences of neighborhoods fell as densities increased -- that is, among the two simulated neighborhoods without a park, they generally preferred the lowest-density one (12 dua), and among the two neighborhoods with a park, the lowest-density one (36 dua) was also liked most. Also, the finding that amenities can compensate for densities that are 50 percent higher (36 versus 24 dua) in a transit village setting confirms our belief of a wide gulf between perceived and actual densities.(FN5)

RATINGS OF NEIGHBORHOOD AMENITIES

Among the neighborhood features shown, having a rail station close by was consistently liked the most (Figure 6). The second most liked feature of the denser neighborhoods was the open space; this was the neighborhood attribute that differed the most, visually, between the two lower and two higher density neighborhoods. Without a neighborhood park, the two lower density neighborhoods were rated poorly on open space features. The addition of more services in the two higher density neighborhoods -- specifically, a bakery and outdoor cafe in the retail plaza, and more commercial stalls and outdoor seating in the public square near the station -- was well-received by the respondents. People were fairly indifferent or slightly negative toward community services in the 12 and 24 dua neighborhoods. With regard to building architecture, respondents were fairly neutral toward the 12 dua neighborhood and disliked the three higher density ones. Some were likely responding more to perceived density than to building design. Based on open-ended survey responses, some participants mentioned they did not like the architectural designs of the buildings shown. We might have been able to elicit more positive responses to higher density neighborhoods if the architecture and perhaps quality of buildings "improved" as density rose; however, this would have confounded the research design (since building architecture would no longer have been a control variable).

RATINGS BY RESPONDENT CHARACTERISTICS

Cross-tabulating neighborhood ratings by characteristics of respondents might suggest which demographic groups are potential markets for transit village living. Those who were most receptive to higher density transit neighborhoods were young adults with moderate incomes who currently reside in apartment complexes.(FN6) Half of the respondents who were between 18 and 28 years of age, for instance, gave the 48 dua neighborhood an overall rating of +2 or +3; fewer than a third of respondents from other age groups rated the neighborhood this high. Those who currently commute to work by transit were also slightly more accepting of denser neighborhoods.

We expected that those who work in cities that are well-served by BART would have been more receptive to denser, transit-oriented neighborhoods (since, in theory, living near rail stops should lower average commuting costs). However, no meaningful associations were found between where people currently work and neighborhood preference. More surprising was the finding that existing household type had little bearing on neighborhood preferences. The presence of children in someone's household had no discernible influence on ratings. Also, retirees and empty-nesters were fairly netural towards all four neighborhoods -- half gave both the 12 and 48 dua neighborhoods a zero score on the "overall desirability" rating.

CONCLUSION

This research provides some encouragement about the prospects of creating transit villages in large metropolises like the San Francisco Bay Area. The general public seems willing to accept residential densities necessary to sustain rail transit services in return for public parks, in-neighborhood shops, and easy access to rail stops. Notably, rowhouses with narrow front lots and modest backyards that are near a neighborhood park and retail plaza are preferred to rowhouses with bigger backyards and more frontage, but with no nearby park and fewer local services.

Being near stores and services was particularly important to those who reacted positively to the denser simulated neighborhoods. Having a central park increased the average ratings of the densest neighborhoods, and not having a park slightly lowered the ratings of the less dense ones. While large open space was clearly perceived as a positive amenity, its ability to compensate for density seemed to hold only up to a certain density threshold -- around 36 dua.

Overall, this research suggests there is a potential market for moderately dense housing projects near rail stations that feature nice amenities and neighborhood attractions. For this market to materialize, various stakeholders -- builders, lenders, local governments, transit boards, and neighborhood groups -- need to work together to create a receptive policy environment. Permissive land use regulations, like density bonuses and inclusionary zoning, could encourage denser housing and mixed-use projects near major rail stops. Parking standards might also be relaxed to allow one off-street space per unit at transit-based complexes instead of the two normally enforced in the suburbs. This would lower construction costs by an estimated $12,000 per unit in the Bay Area (the typical cost of tuck-under, podium parking space). Joint development opportunities might also be pursued, such as converting portions of park-and-ride lots to housing, as currently being pursued in the Bay Area. Credits against exactions, impact fee obligations, and local taxes might also be granted to builders of transit villages, in recognition of the transportation benefits of such projects, such as obviating the need to expand roads. In redevelopment zones, fiscal tools like tax increment financing might be used to attract housing development to station areas. In California, the Transit Village Act, AB 3152, was recently passed for this very purpose. Such federal initiatives as the formation of empowerment zones and enterprise communities that aim to attract private capital to inner-city areas might also be used as leverage for transit-based housing projects.

Another novel idea suggested by Holtzclaw (1994) would have banks adjust the calculated mortgage qualifications of prospective home buyers in transit villages by the amount of automobile costs saved. Holtzclaw maintains the automobile-cost savings of living in a transit-oriented, pedestrian-friendly environment can be substantial: according to his calculations, a family in San Francisco's Nob Hill spends an average of $6,000 less a year on automobile expenses than a family of similar size and income living in San Ramon, a newer East Bay suburb. Lower transportation costs free up more money for housing consumption. Reflecting this in mortgage qualification calculations could attract more home buyers to transit village locations. Collectively, such initiatives as creating financing, zoning incentives, and innovative mortgage programs would provide the kind of supportive policy environment that would allow transit villages to take form.

Visual simulations provide a new approach for assessing the market potential of different built forms, like transit villages. The use of tightly-controlled simulations allowed us to test and confirm the hypothesis that people are willing to trade off higher densities for more neighborhood amenities, up to a limit. Future research on consumer responses to simulated transit villages might consider enlivening architecture in addition to increasing neighborhood amenities as a means of compensating for higher densities. From a research standpoint, this introduces statistical challenges in separating out the unique and joint influences of design and amenities on people's attitudes. Measuring interactive effects, however, may very well be moot if indeed better design and more amenities are both viewed by the public as necessary, co-dependent features of attractive neighborhoods.

The somewhat contradictory findings of this research with those of other marketing studies on attitudes toward higher residential densities might very well be attributed to differences in research methods. Traditionally, housing marketing studies rely on verbal descriptions and written inquiries. Visual images, we believe, provide a much richer context for probing the market potential for transit village development, not only because they are concrete and graphic, but also because they allow for a much wider array of choices to be conveyed. Notes Constantine:

> ... it should not be surprising that surveys of consumers' visual preferences often contradict conventional marketing studies. By gauging people's preferences for various types of architecture, streetscapes, commercial centers, and even landscaping, visual surveys can become the basis for creating a more successful image for new development. (1992:1)

ADDED MATERIAL

AUTOBIOGRAPHICAL SKETCHES

Robert Cervero is Professor of City and Regional Planning at the University of California at Berkeley. Professor Cervero has written extensively on urban transportation and land-use relationships, is co-director of the National Transit Access Center, and has recently published two books, one on transit

villages and one on paratransit systems.
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Additional information may be obtained by writing directly to Professor Cervero at the Department of City and Regional Planning, 228 Wurster Hall, University of California, Berkeley, 94720, USA.
FIGURE 1. Nine images for simulated neighborhood at 12 dwelling units per acre.
FIGURE 2. Four images for simulated neighborhood at 24 dwelling units per acre.
FIGURE 3. Four images for simulated neighborhood at 36 dwelling units per acre.
FIGURE 4. Nine images for simulated neighborhood at 48 dwelling units per acre.
FIGURE 5. Percent of respondents who liked neighborhoods the most and least.
FIGURE 6. Average rating of features of simulated neighborhoods.

FOOTNOTES

1. To support light rail services, Pushkarev and Zupan (1977) maintain that a minimum of 12 du per acre is necessary over a 50 square mile area in a region with a central business district with at least 25 million square feet of non-residential floor space.
2. The number of people and parked cars in each viewscape increased with density, though not exactly proportionally (to reflect the likelihood that denser transit villages would encourage more walking and lower automobile dependency).
3. Field presentations took place in San Francisco, Berkeley, Hayard, El Cerrito, Dublin, Walnut Creek, and Ashland. These venues represent different levels of urbanization in the region. Most participants were drawn from residences in the immediate areas.
4. These are the three Bay Area counties in which field presentations were held, where most of the participants live and are served by BART. All statistics presented for the three counties were obtained from the 1990 U.S. Census, Summary Tape File 3A.
5. Responses were also tabulated by levels of respondent "attentiveness." In the questionnaire, respondents were asked to rank the four neighborhoods in terms of density. Those who correctly identified the relative densities of all four neighborhoods were considered the "most attentive" and those who got at least two of the relative neighborhood density rankings correct were considered "reasonably attentive." In general, respondents seemed to be more sensitive to density as their level of attentiveness increased. Overall, however, neighborhoods were similarly evaluated regardless of levels of attentiveness.
6. The Pearson product-moment correlation between age and overall desirability for each neighborhood (with significance levels in parentheses) were: 12 dua: -.150 (.046); 24 dua: -.154 (.055); 36 dua: -.098 (.223); and 48 dua: -.080 (.321). The negative association between age and rating fell as the density of a neighborhood increased.

REFERENCES

Audirac I, Shermyen A (1994) An evaluation of neo-traditional design's social prescription: Postmodern placebo or remedy for suburban malaise? Journal of Planning Education and Research 13(3):161-173.
Baldassare M (1979) Residential crowding in urban America. Berkeley: University of California Press.
Bergdall J, Williams R (1990) Perception of density. Berkeley Planning Journal 5:15-38.

Bernick M (1993) The Bay Area's emerging transit-based housing. Urban Land 52(7):38-41.
Bernick M, Cervero R (1994) Transit-based development in the United States. Passenger Transport 12 (2):7-8.
Blumenfeld H (1968) The modern metropolis: Its origins, growth, characteristics, and planning. Cambridge: MIT Press.
Bookout L (1992) The future of higher-density housing. Urban Land 51(9):14-18.
Bookout L, Wentling J (1988) Density by design. Urban Land 47:10-15.
Calthorpe P (1993) The next American metropolis. Princeton: Princeton Architectural Press.
Cervero R (1994) Transit-based housing in California: Evidence of ridership impacts. Transport Policy 1 (3):174-183.
Cervero R (1995) Sustainable new towns: Stockholm's rail-served satellites. Cities 12(1):41-51.
Cervero R, Bosselmann P (1994) An evaluation of the market potential for transit-oriented development using visual simulation techniques. Berkeley: Institute for Urban and Regional Development, Monograph 47.
Constantine J (1992) Design by democracy. Land Development 17(Spring-Summer):11-15.
Cooper Marcus C, Sarkissian W (1986) Housing as if people mattered. Berkeley: University of California Press.
Dillman J, Dillman D (1987) Private outside space as a factor in housing acceptability. Housing and Society 14(1):20-29.
Foote N, Agu-Lughod J, Foley M, Winnick L (1960) Housing choices and housing constraints. New York: McGraw-Hill.
Frank L, Pivo G (1994) The impacts of mixed use and density on the utilization of three modes of travel: The single occupant vehicle, transit, and walking. Transportation Research Record 1466:44-52.
Harvey G (1990) Relation of residential density to VMT per resident. Oakland: Metropolitan Transportation Commission, mimeo.
Hass-Klau C (199) The pedestrian and city traffic. London: Belhaven Press.
Holtzclaw J (1990) Manhattanization versus sprawl: How density impacts auto use comparing five Bay Area communities. Proceedings of the Eleventh International Pedestrian Conference. Boulder, CO: City of Boulder, pp. 99-106.
Holtzclaw J (1994) Residential patterns and transit, auto dependence, and costs. San Francisco: Resources Defense Council.
Jacobs J (1961) The death and life of great American cities. New York: Vintage Books.
Jensen R (1966) High density living. New York: Praeger.
Ketelsen-Johansson J (1994) Perception of housing densities that are transit-supportive and maintain the appeal of single family home ownership. Unpublished master's thesis, University of California, Berkeley.
Lansing J. Marans R, Zehner R (1970) Residential location and urban mobility. Ann Arbor: Survey Research Center, Institute for Social Research, University of Michigan.
Michelson W (1968) Most people don't want what architects want. Transaction 5(8):37-43.
Michelson W (1977) Environmental choice, human behavior, and residential satisfaction. New York: Oxford University Press.
Pisarski A (1992) New perspectives in commuting. Washington, D.C.: Federal Highway Administration, U.S. Department of Transportation.
Pushkarev B, Zupan J (1977) Public transportation and land use. Bloomington: Indiana University Press.
Rappaport A (1976) Toward a reflection of density. In S Saegert (Ed.), Crowding in Real Environments. Beverly Hills, CA: Sage Publications, pp. 7-32.
Shaw J (1994) Transit-based housing and residential satisfaction. Unpublished doctoral dissertation, University of California, Berkeley.