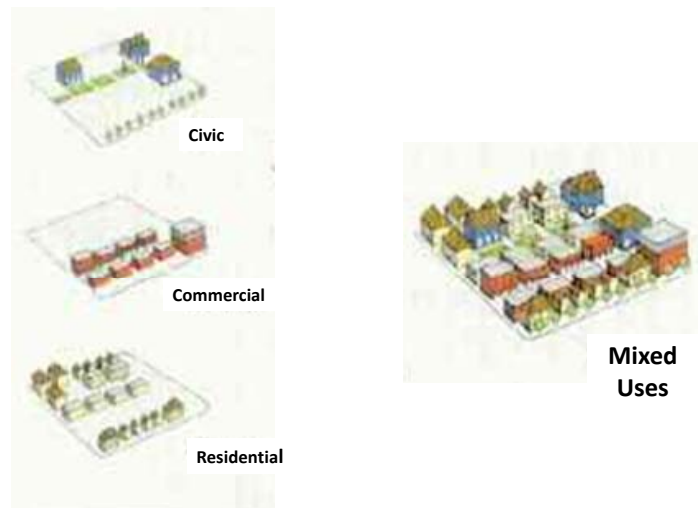


Mixed Uses & Sustainable Mobility

Distinguished Transport Lecture, University of Hong Kong
Robert Cervero, University of California, Berkeley



Car-Dependent Cities

- Equate with:
 - Air Pollution...Local & Global
 - Fossil fuel dependence
 - Inequality of Access
 - Neighborhood Disruption
 - Mounting Congestion -- Erodes Economic Growth & Quality of Life (*Time Pollution*)



Single-Use, Segregated Growth in China

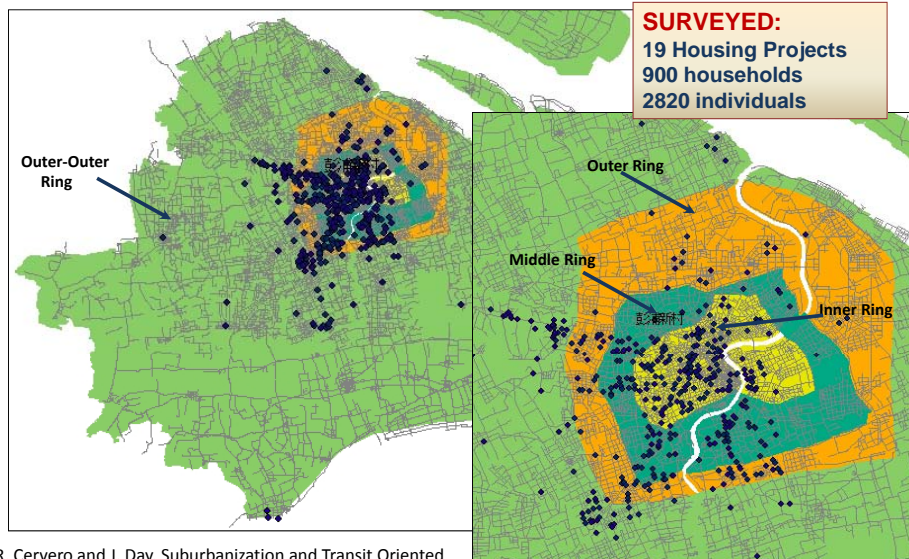
Gated Superblocks in Suburban China

Current suburban development is dominated by “gated super blocks” with arterial roads at approximately 2 km intervals: highly efficient at providing urban housing, but isolates & separates



2008 Study: Suburban Relocation & Travel in Shanghai

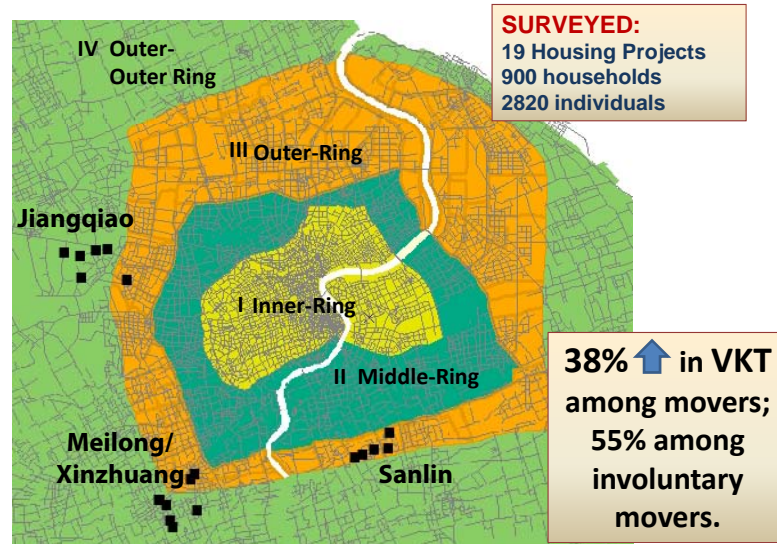
Previous residences (2002-2004)



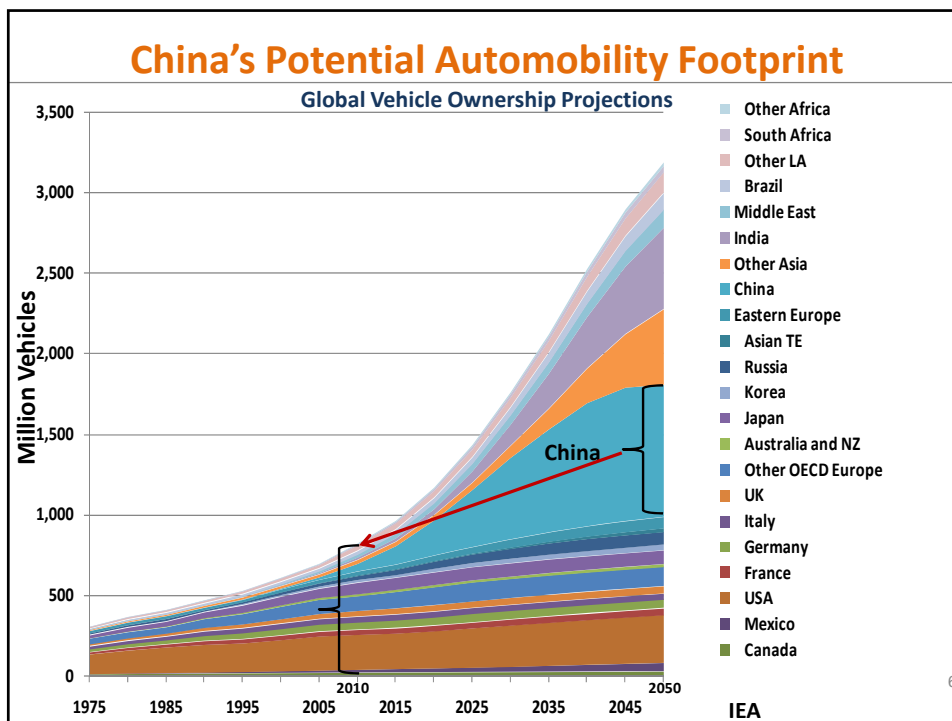
R. Cervero and J. Day. Suburbanization and Transit Oriented Development in China, *Transport Policy*, Vol. 15, 2008, pp. 315-323.

2008 Study: Suburban Relocation & Travel in Shanghai

Current Residences (2005-2007)



R. Cervero and J. Day. Suburbanization and Transit Oriented Development in China, *Transport Policy*, Vol. 15, 2008, pp. 315-323.



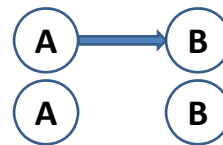
Mixed Uses & Sustainable Mobility

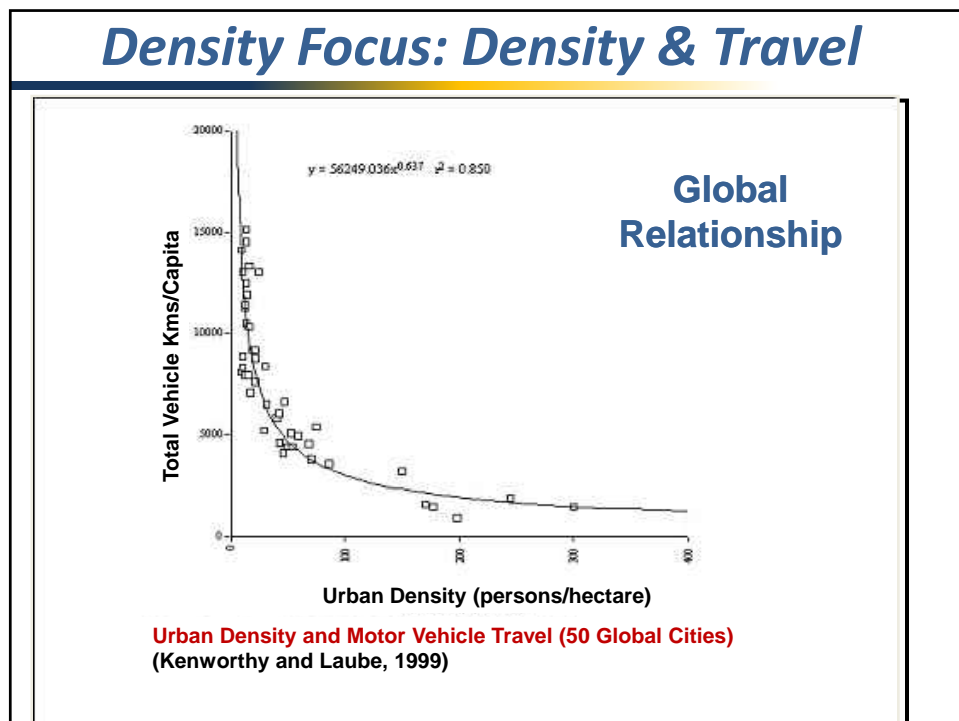
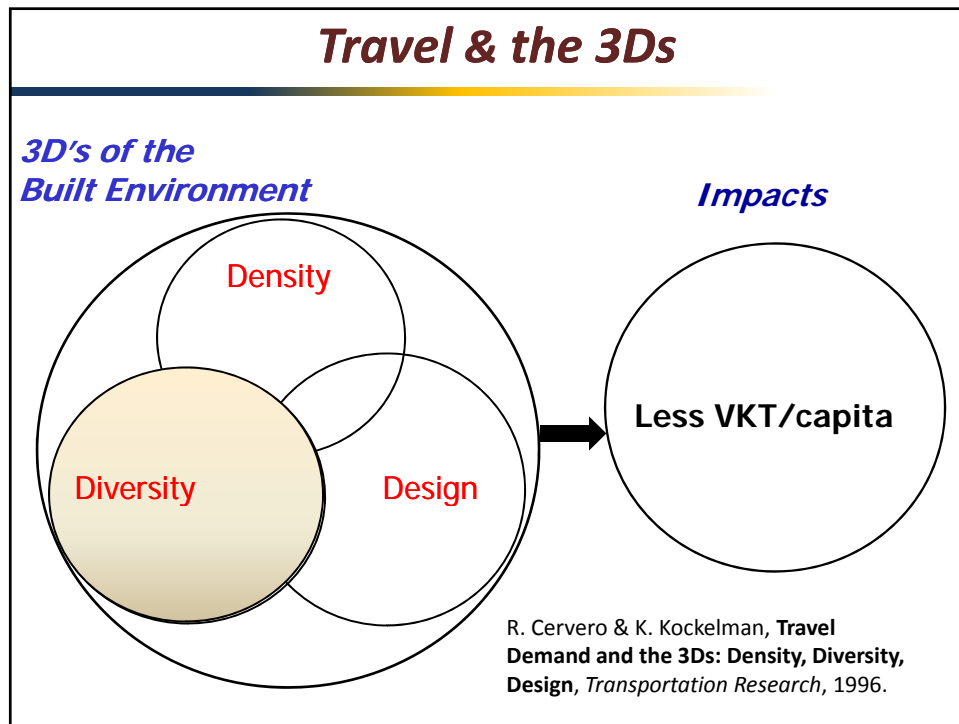
- **City of Short Distances**
 - More NMT (walking, cycling)
 - Less VKT per capita
 - Others: Physical Activity; Social Capital
- **Single-use, Segregated Land Development:**
 - Rooted in Euclidean Zoning – segregation of nuisances and non-compatible uses, for public health reasons
 - An undercurrent of exclusion and discrimination – class segregation?
 - Logic of separating residential & non-residential uses holds less in advanced service economies



Mixed Uses = Accessibility

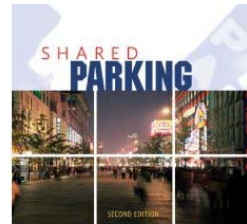
- **Accessibility:** Ability to efficiently & conveniently reach places you want to go
- **Enhanced by:**
 - **Mobility** (speed between pts. A & B)
 - **Proximity** (distance from pts. A & B)



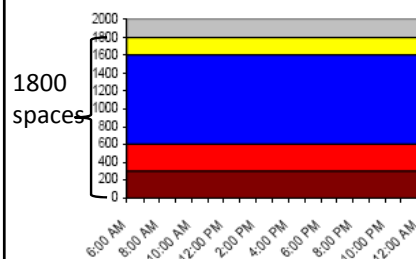


Mixing It Up

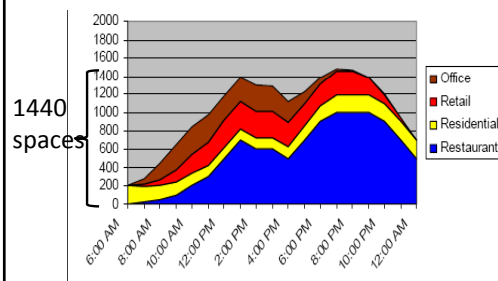
- **Diversity** = Greater Choice (uses, housing, work environments, travel)
- **Demand-side benefits**
 - Less VKT, especially in peak
 - Internal capture ... *e.g., retail in office parks*
 - Efficient trip-chaining – *e.g., child-care near transit or health clubs near office centers consolidate trips*
- **Supply-side benefits**
 - Shared parking
 - Spread demand/reduced infrastructure
 - Balanced, bi-directional flows



Shared Parking: Conserving Resources



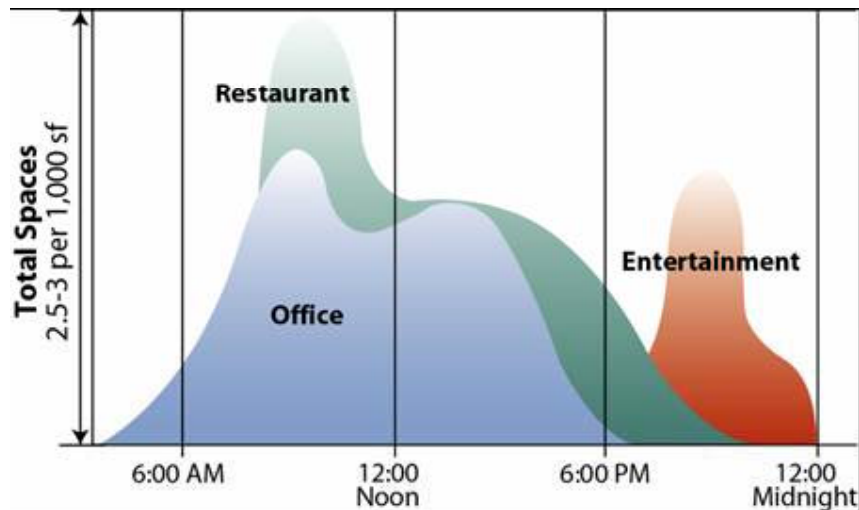
Most parking codes treat demand generically – requires developers to meet demand over the day.



Shared parking – acknowledges peaks can dovetail

Sharing Reduces Parking from 1800 to 1440 spaces:
- 20%

Biggest Share Parking Benefits from Intermixing Office & Entertainment Uses



Hammarby Sjöstad: Mixed-Use Eco-Community

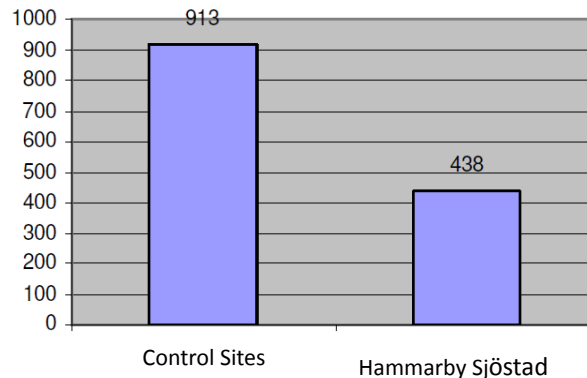
- Residents produce 50 percent of the power they need — by turning recycled wastewater and domestic waste into heating, cooling and electricity; also use excess bio-fuels from commercial uses
- Waste treatment: all garbage is separated and much of it goes to produce energy.

Green roofs hold rainwater so that it evaporates. Solar cells convert solar energy into electricity. Solar panels heat water. All biodegradable and recycling materials are from heavy metals. Low-Rushing fountains and low-velocity water consumption by half. Compostable waste is used to produce district heating and electricity in the waste-to-energy system. Organic waste is turned into biogas. Heat exchangers in water treatment. Farmer's Market: encourages residents to buy local produce. Ecological lessons for the environmentally aware. Connected to water features.

Smaller Carbon Footprint

Hammarby Sjöstad

Kg CO₂ equivalents/apartment/year



Source:
Grontmij, AB. 2008.
Environmental
Impact in Hammarby
Sjöstad, Stockholm.

Mixed –Use Effects on Land Values per M²

Land Use, Zoning, Mix, & Balance

Single-Family Residential: Proportion of dwelling units within one-mile radius of parcel that are single-family

-

Jobs-Housing Balance: $1 - \{[ABS (ER - E)] / (ER + E)\}$, where: ER = employed-residents within 5 mile radius of parcel;
E = employment within 5 mile radius of parcel

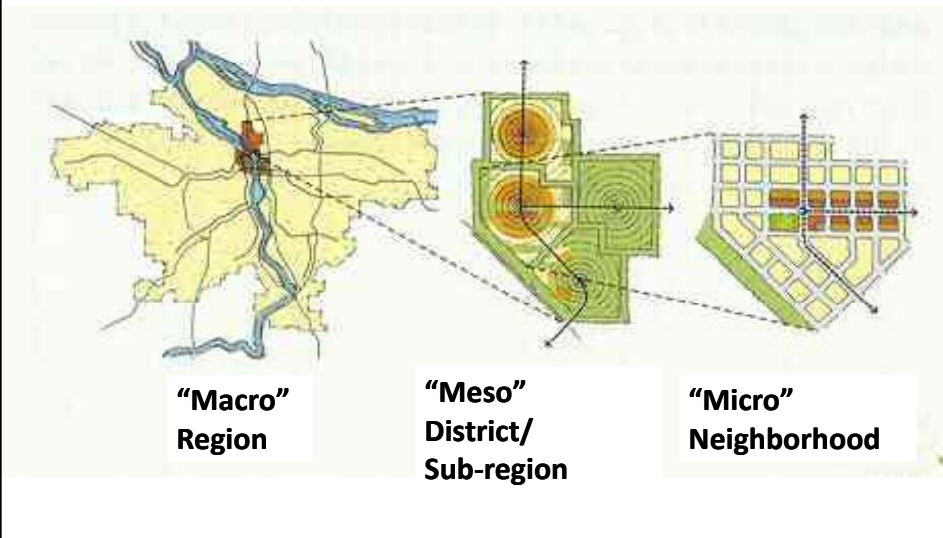
+

Land-Use Mix: Normalized Entropy = $\{ - \sum_k [(p_i) (\ln p_i)] / (\ln k) \}$, where: p_i = proportion of total land-use activities in category i for 1-mile radius of parcel (where land-use activities are defined in terms of numbers of: employed-residents in single-family housing; employed-residents in multi-family housing; employees in retail; employees in services; employees in manufacturing; employees in trade; employees in agriculture; and employees in other (including office sector); and k = 8 (number of land-use categories).

+

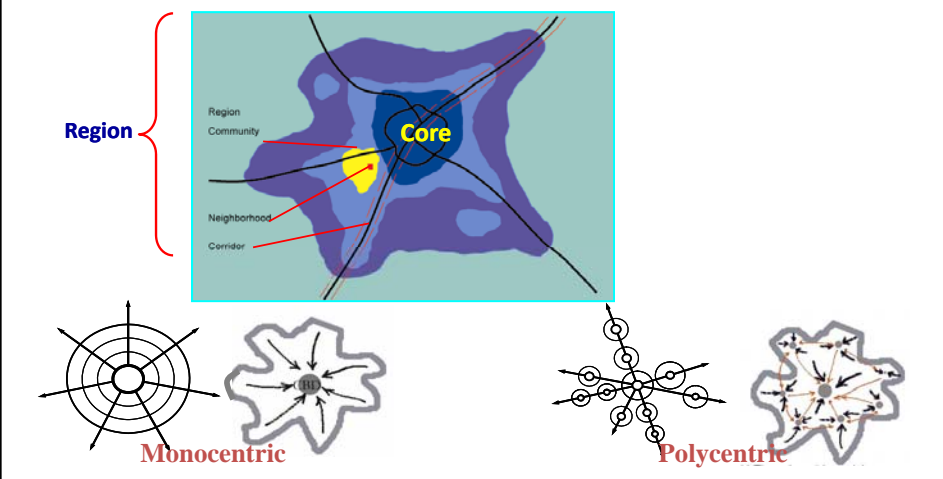
MXD: Significant marginal influences across more than a dozen studies of Transport & Land Use

Mixing Uses at Multiple Scales



I. Macro...Regions as Ecological Units

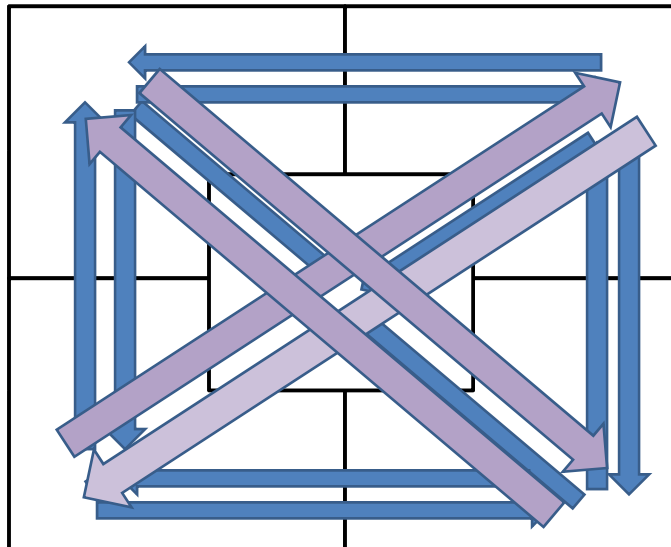
- Water-sheds, air-sheds, commuter-sheds, labour-sheds

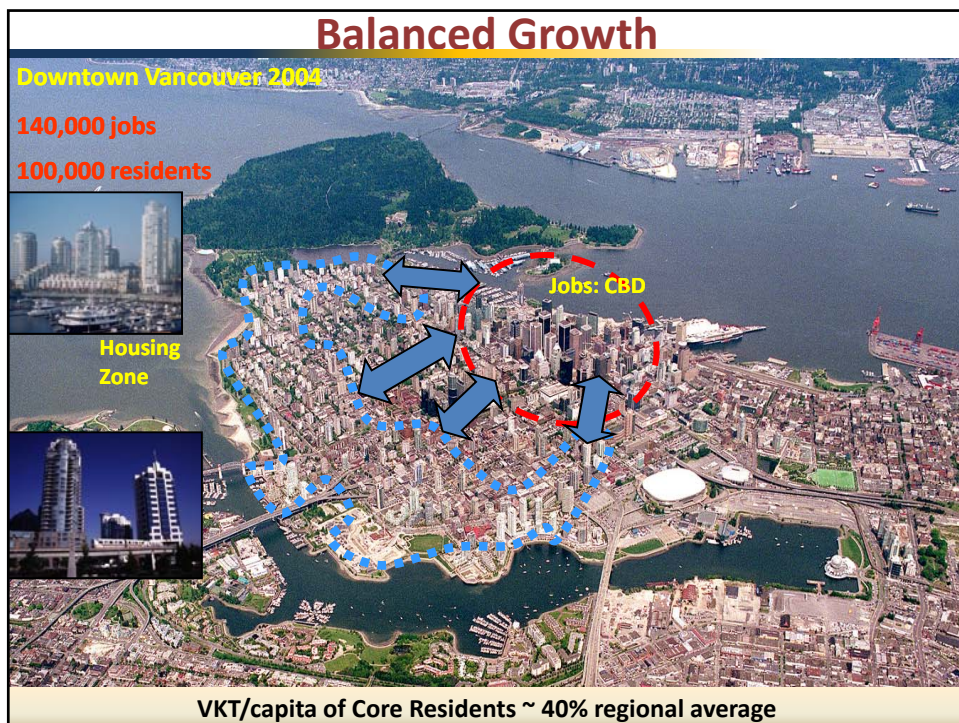
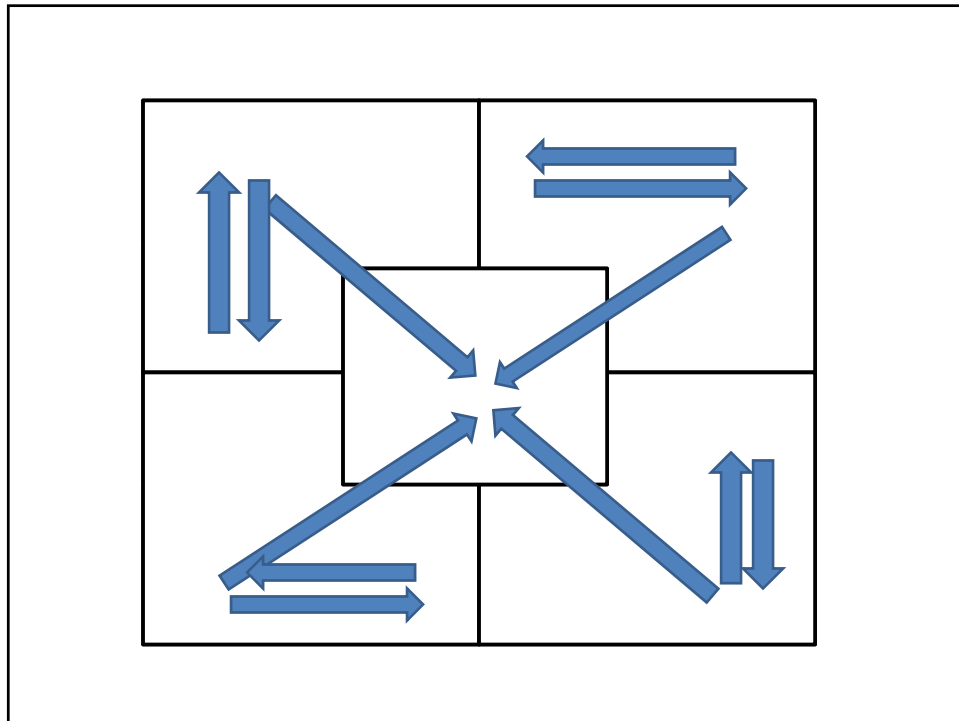


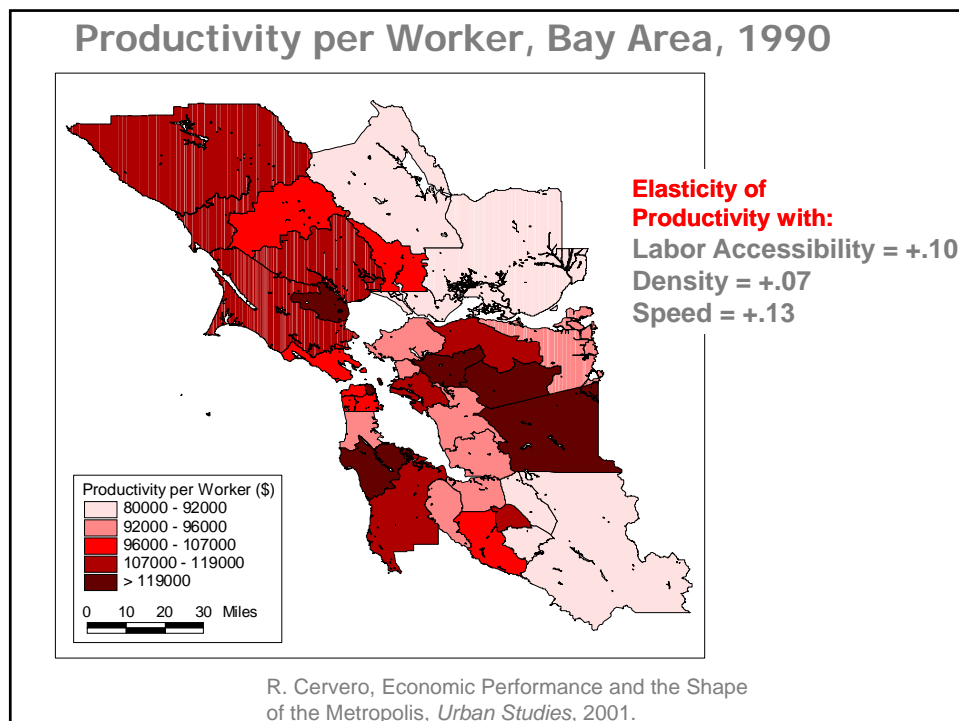
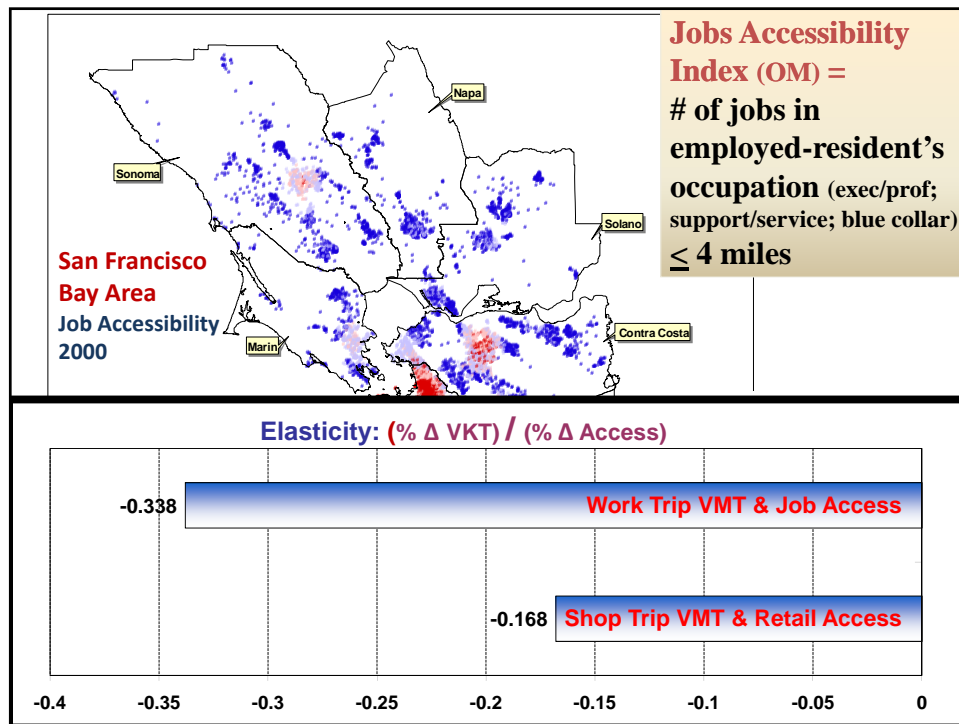
Balanced Regional Growth

- **AIMS:**

- *Reduce VKT*
- *Rationalize Travelsheds*
- *Protect & Conserve Land*
- *Reduce travel costs/
increase housing
affordability
(location efficiency)*

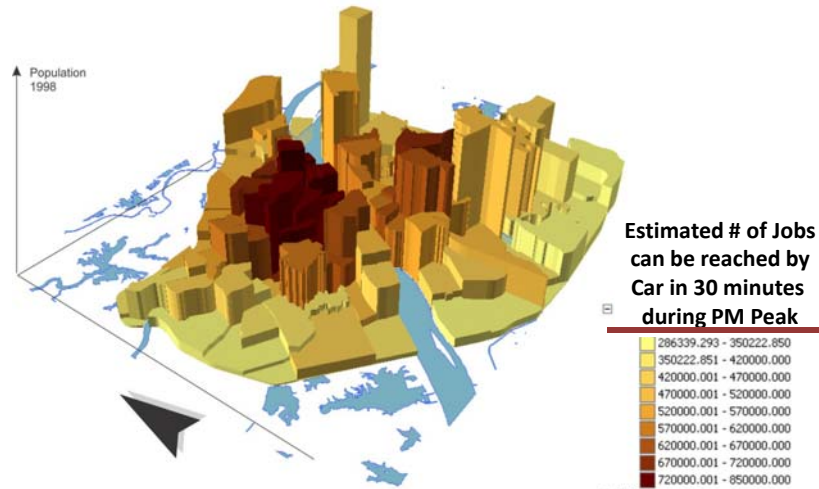






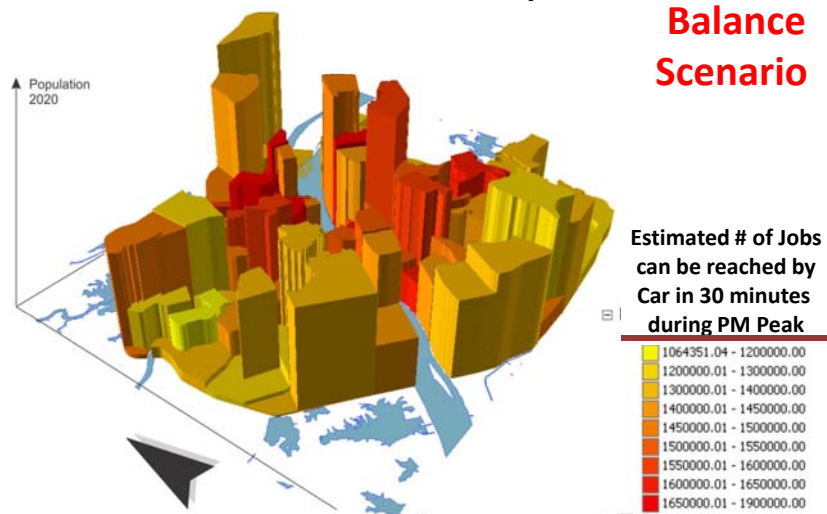
Wuhan, China

Access to Jobs overlaid with Population **1998**



Jobs-Housing Balance Scenario for Wuhan, China

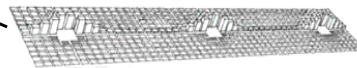
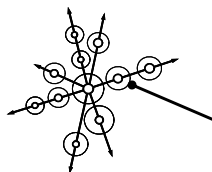
Access to Jobs overlaid with Population **2020** **Balance** **Scenario**



II. Meso-scale: *Corridors* (the amorphous zone)

- **Natural Travelsheds** – In U.S., 55%-70% of motorized travel within 10-15 Km axial corridors
- **Public Transport's "Natural Habitat"**

TOC
Transit Oriented
Corridors

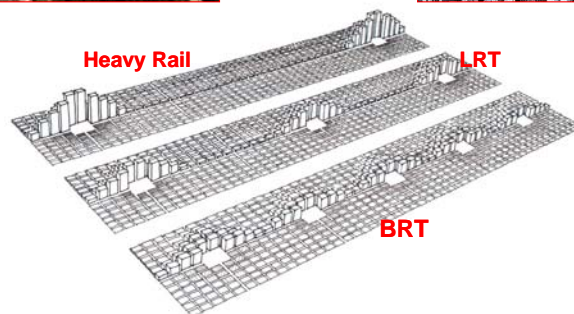


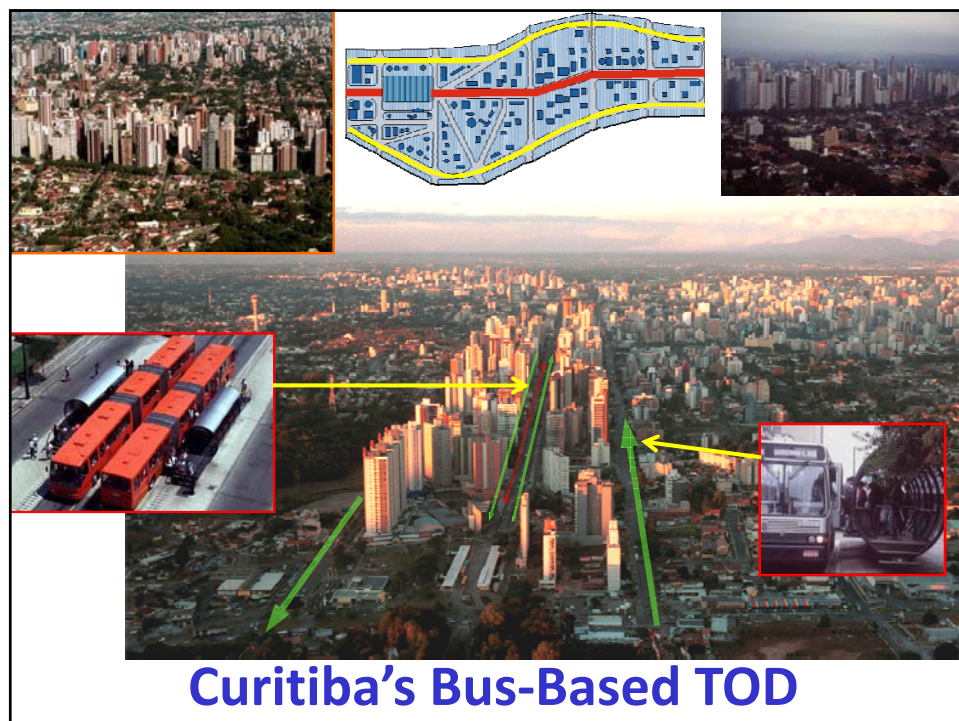
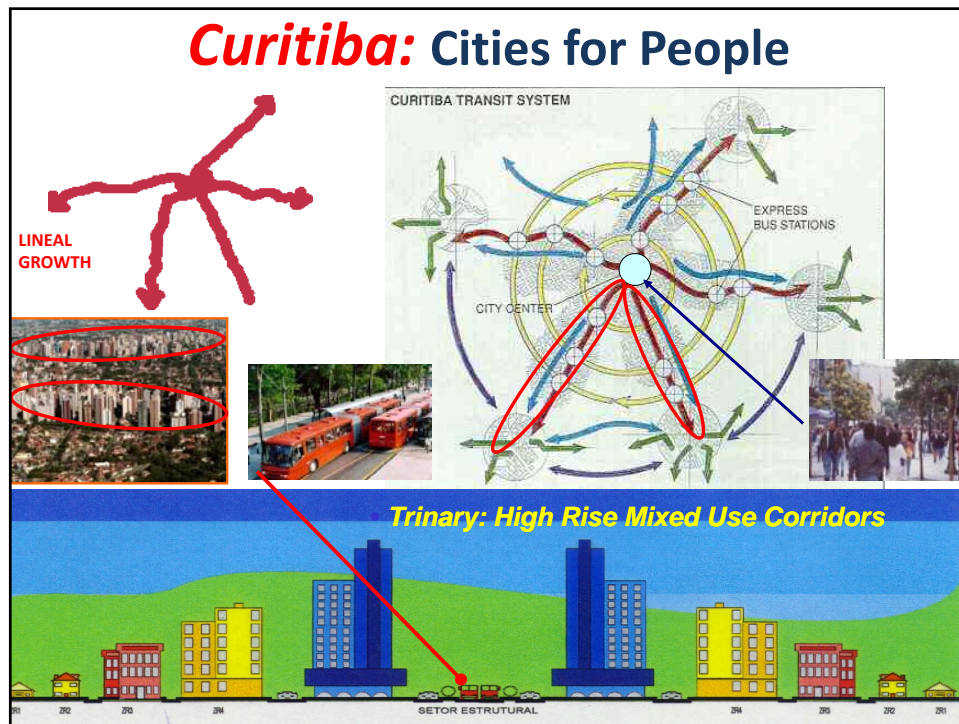
TOCs = "String of Pearls"

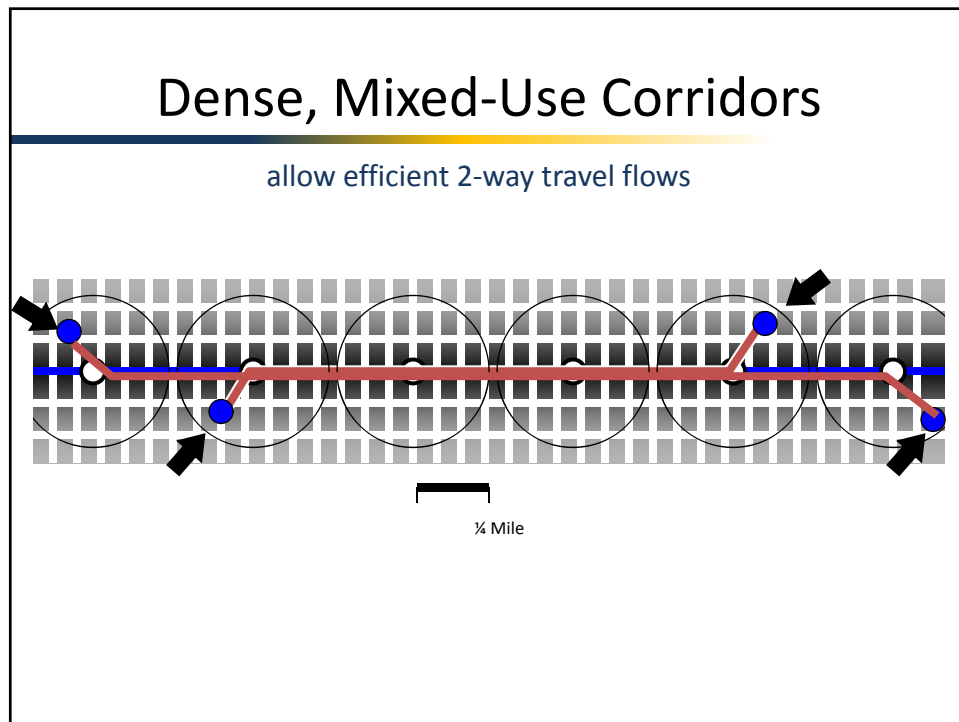
How Densities Are Organized Matters!



| Population | |
|--------------------------|----------|
| 3 mill. | 16 mill. |
| Transit Trips/ Capita | |
| 355 | 330 |







| | Curitiba | Brasília |
|---------------------------|----------|----------|
| Persons/km ² | 3,470 | 420 |
| Transit trips/capita/year | 355 | 97 |
| VKT/capita/year | 7,900 | 16,700 |



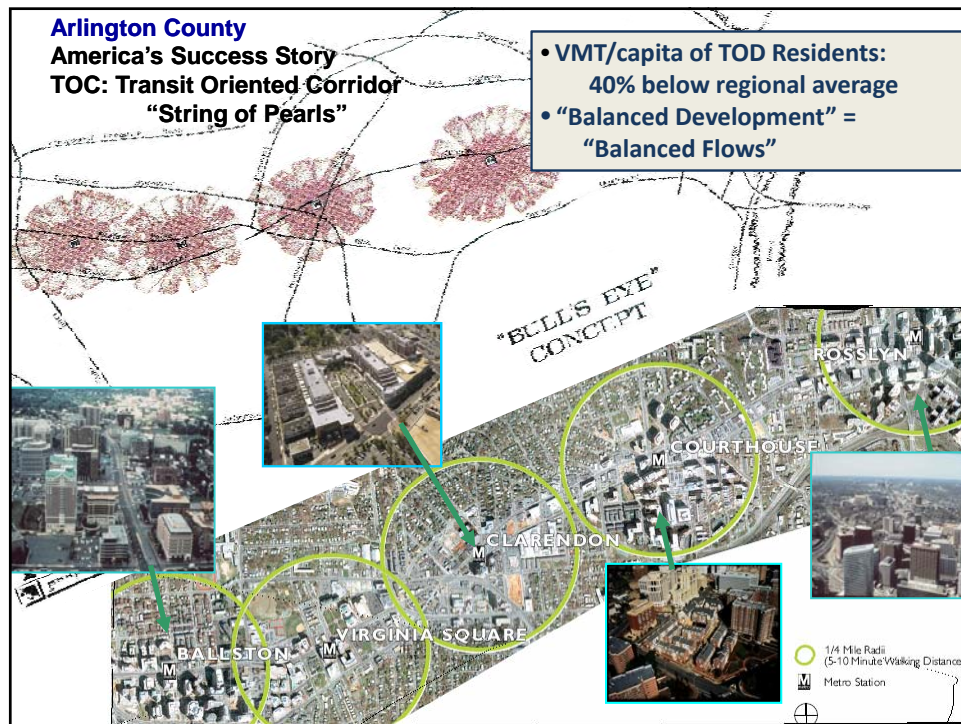
Curitiba



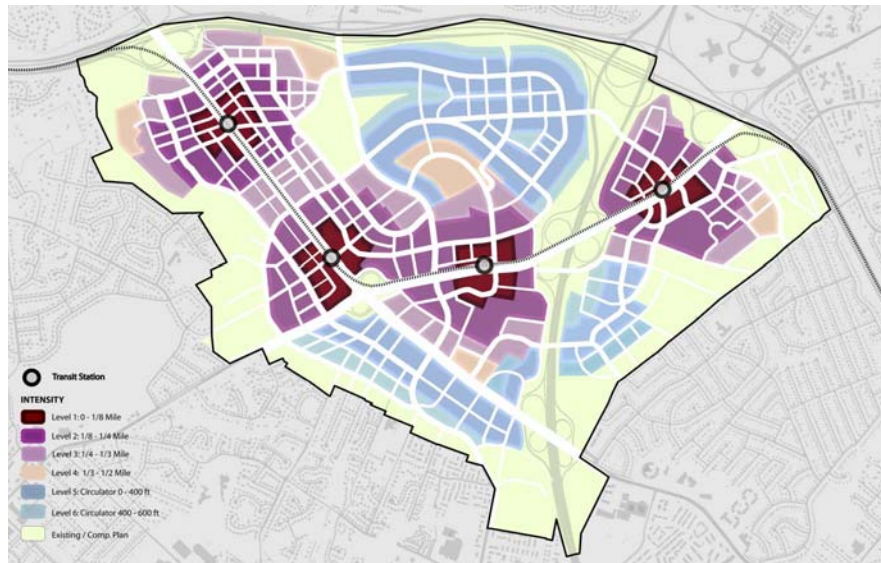
Brasília



4/29/2011



DENSITY: Intensity Around Transit



95% of growth within a 3 minute walk of transit

8 Unique Districts

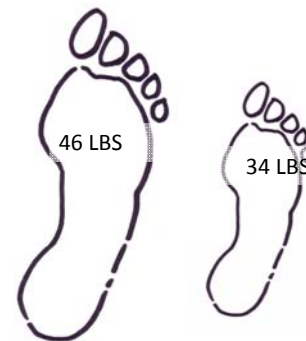


Tysons Central 7

Lower Carbon Footprint

- Greenhouse Gas emissions
16% less per capita
- 2.5 billion lb reduction
annually

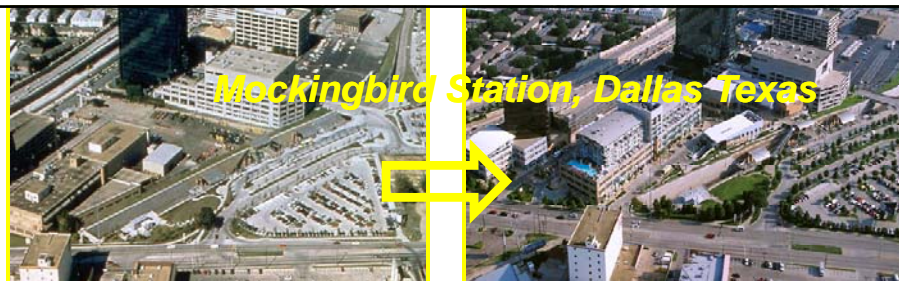
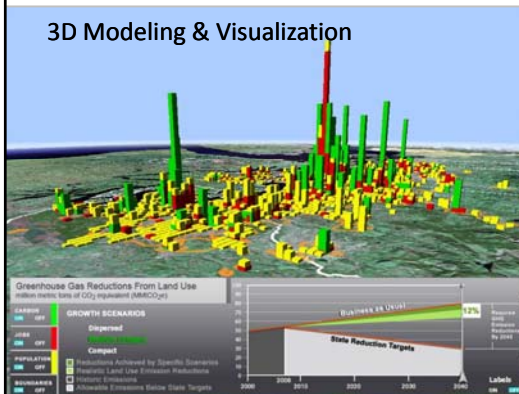
Daily CO₂E Per Capita



Base Case

TOD

3D Modeling & Visualization



**MXDs generate far less traffic than
single-use suburban development**

Experiences of 6 large-scale US Suburban MXDs:

- 30% Internal Capture
- On average, 15% of external trips
by foot, bike, transit
- Thus “45% of trips put no strain on external road
network”



Recommend 20% to 25% “Internal Capture” adjustments to ITE Trip Generation Rates for Mixed-Use Activity Centers , accounting for “induced travel” impacts

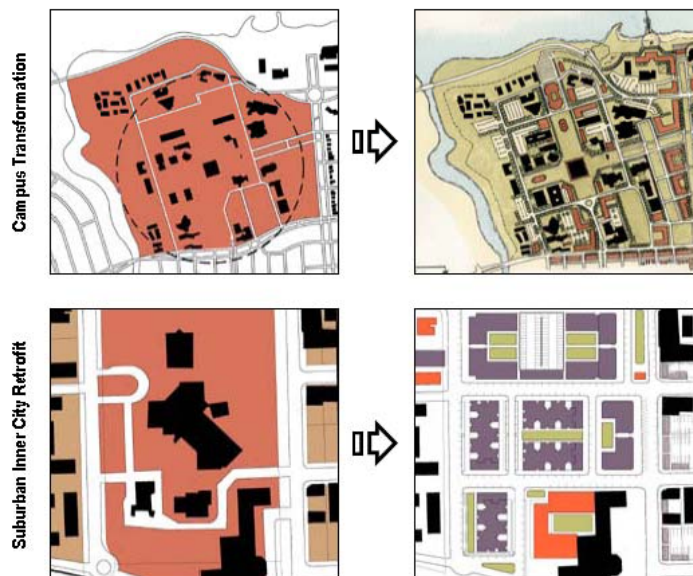
R. Ewing, R. Cervero, et al. 2011. Traffic Generated by Mixed-Use Developments. *Journal of Urban Planning and Development* (forthcoming);.

MXDs generate far less traffic than single-use suburban development

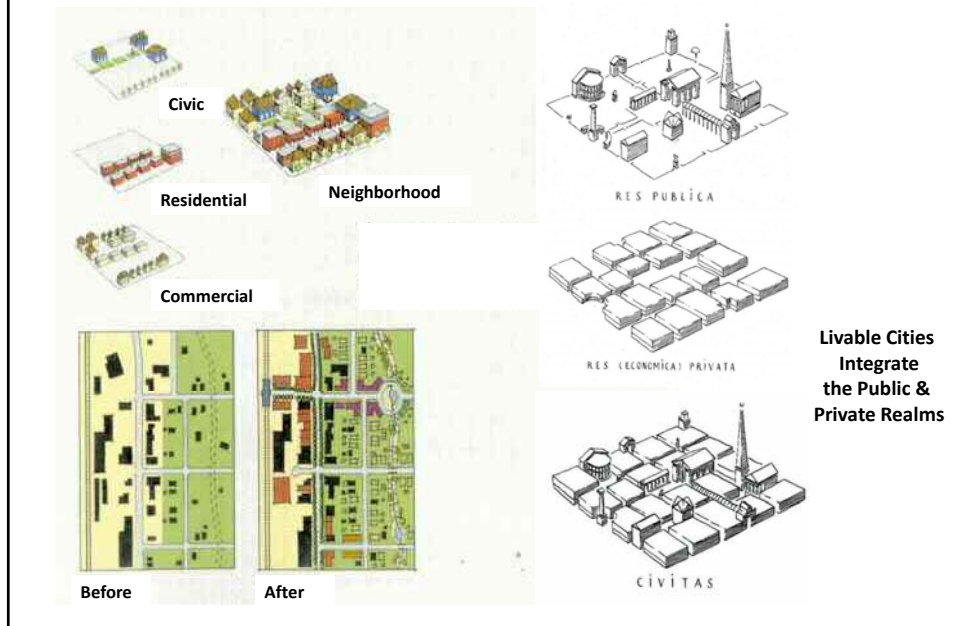
Experiences of 6 large-scale US Suburban MXDs:

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Suburban Retrofits



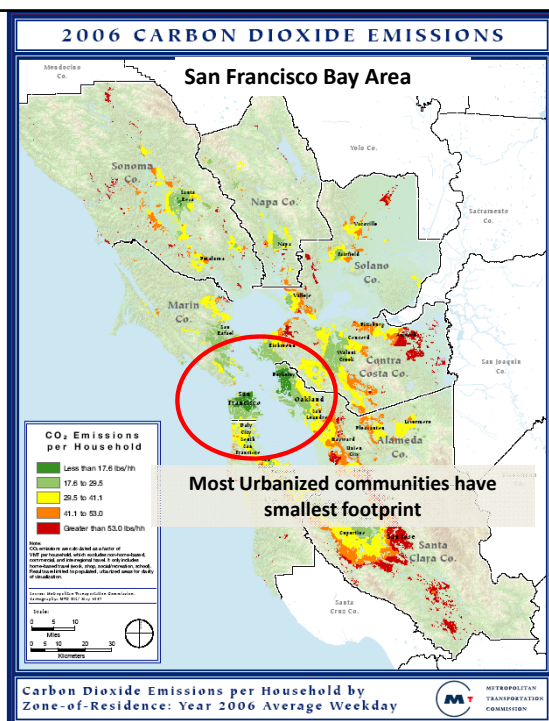
III. Micro-scale: *Neighborhoods (mix it up)*



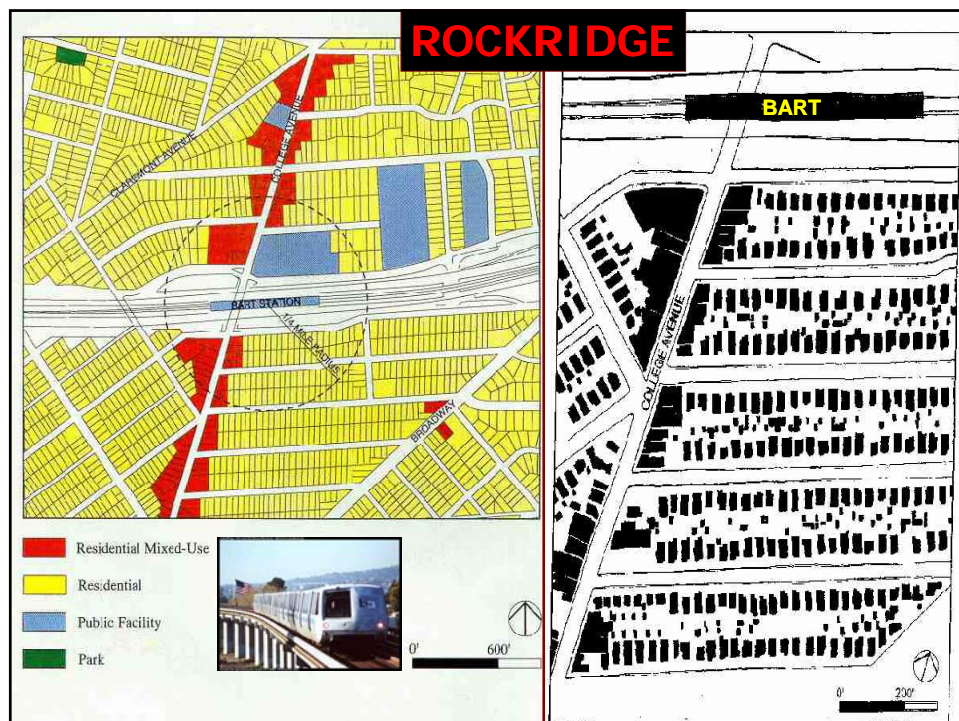
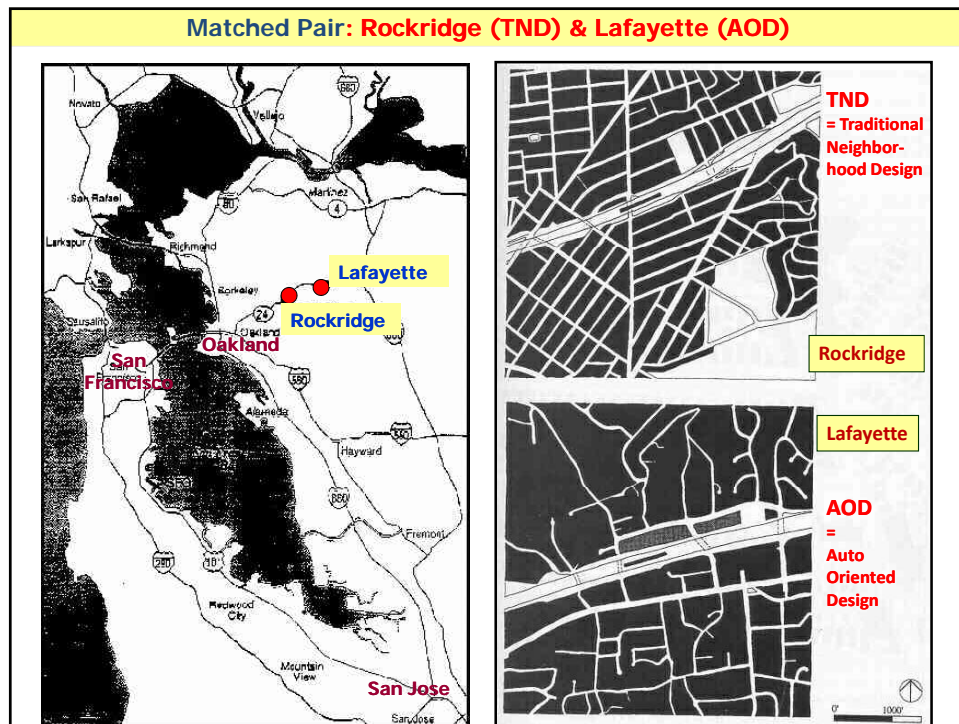
Built Environments Matter

- **Compact, mixed-use, ped-friendly development:** 30%-40% less VKT & CO₂ than **sprawl**


42



4/29/2011



Two Different Environments



Rockridge: TND

Lafayette: AOD

| | <u>Community Type</u> <u>TND</u> | <u>AOD</u> |
|--|-------------------------------------|------------|
| ■ VMT/person/day | 14.5 | 27.7 |
| ■ % Rail | 23% | 7% |
| ■ % Walk/Bike | 14% | 3% |
| ■ Out of Neighborhood Shop Vehicle Trips/Day | 0.5 | 2.1 |

R. Cervero and C. Radisch. Travel Choices in Pedestrian Versus Automobile Oriented Neighborhoods, *Transportation Policy*, Vol. 3, 1996, pp. 127-141.

Meta-Evidence from Predictive Models

Elasticities from Regressions & Logits

| | Vehicle Trips (VT) | Vehicle Miles Traveled (VMT) |
|-----------------------------|--------------------|------------------------------|
| Density | -.05 | -.05 |
| Diversity (mix) | -.03 | -.05 |
| Design (walkability) | -.05 | -.03 |
| Destination (accessibility) | -- | -.20 |

Source: R. Ewing & R. Cervero, Travel and the Built Environment: A Synthesis, *Transportation Research Record* 1780, 2001; Confirmed in Ewing & Cervero, *Journal of the American Planning Association* 2010.

Elasticity = (% Δ Travel Demand) / (% Δ in Land Use)

Effects of MXD at multiple scales: *Neighborhood Diversity* & *Regional Destination Accessibility* ≈ **-.25**

Mixed Uses, TOD & Public Policies

Santa Clara County: Trip Rate Adjustments for Mixed Uses and TOD

| Trip Reduction Strategy | Maximum Trip Reduction |
|---|---|
| Mixed-Use Development Project | |
| with housing and retail components | 13.0% off the smaller trip generator ³ |
| with hotel and retail components | 10.0% off the smaller trip generator ⁴ |
| with housing and employment | 3% off the smaller trip generator ⁵ |
| with employment and employee-serving retail | 3% off employment component ⁶ |
| Effective TDM Program⁷ | |
| Financial Incentives | up to 5.0% ⁸ |
| Shuttle Programs ⁹ | |
| - Project-funded dedicated shuttle | 3.0% |
| - Partially-funded multi-site shuttle | 2.0% |
| Location Within 2,000-Foot Walk of Transit Facility¹⁰ | |
| Housing near LRT or Caltrain Station | 9.0%* |
| Housing near a Major Bus Stop ¹¹ | 2.0%* |
| Employment near LRT or Caltrain Station | 3.0%* |
| Employment near a Major Bus Stop ¹¹ | 2.0%* |

Balance, Variety, Choice

Sustainable Mobility



*It's easier to get pollution,
than people, out of cars*



Sustainable Urbanism



*Also need sustainable Cities &
Regions...broadly defined*

....

*Conservation must be part of the
equation*

