SESSION IV

IFC International Finance Corporation
World Bank Group

Financing Urban Transport Infrastructure in Mega-cities

Towards Sustainable Urban Mobility

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Why is Urban Transportation Financing Challenging?

- Multiple government agencies involved
- Variety of direct and indirect fees
- Farebox revenues typically insufficient for project cost
- No clear mechanism for private sector participation
- Appropriate risk allocation between private and public sector

What do these Challenges Result in?

- Insufficient funds for both capital and O&M expenses
- Inadequate provision of services – both for private and public transport
- No clear mechanism for improvements
- Hesitancy from private sector to get involved

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Why Private Sector Participation?

- Not necessary to increase public expenditures for infrastructure
- Incentive for private firm for good construction quality
- Cost-based user fees easier to justify for private infrastructure
- Positive distributional impacts (those who benefit, pay)
- Market mechanisms guide project selection

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Generating Funds for Urban Transportation

- Property Development
- Advertising
- Services
  - At stations
  - On public transport
- Transferrable development rights
- Allied transportation services
- Entry toll
- Toll roads
- Leveraging lending

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Success at Implementation

- Think
- Plan
- List and manage risks
- Detailed scheduling

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Birmingham Street Maintenance

Objectives

- Provide for the future prosperity of the area
- Focus and manage travel to reduce impacts on the environment
- Provide greater transport choice
- Improve transport facilities and services

Implementation

- 2002 to 2010 for approval!
- $4 B – 25 year contract!!

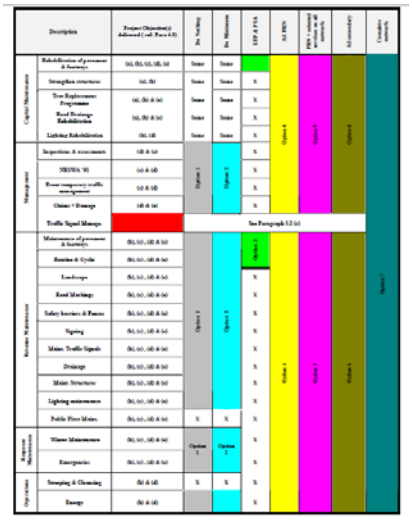

Table 5-1 : Appraisal of Long List to Develop Options Short List

Urban Transportation and IFC

- Making transport more inclusive - Improved access for poor
- Reduced GHG emissions – Transportation 13% of global GHG
- Increased engagement in urban transport sector

Table 6

Greenhouse Gas Emissions for Vehicles and Fuels in Delhi, CO_2-equivalent grams/vehicle-kilometer

	2000		2020	
	Fuel (km/liter)	GHG (g/vehicle-km)	Fuel (km/liter)	GHG (g/vehicle-km)
Gasoline Motor Scooter (2-stroke)	38.4	118	42.4	86
Gasoline Motor Scooter (4-stroke)	53.8	70	39.9	52
Electric Motor Scooter	N/A	51*	N/A	48*
Gasoline Minicar	24.9	140	28.7	119
Gasoline Car	13.6	293	14.5	265
Diesel Car	20.0	172	21.3	162
CNG Car	N/A	234	N/A	198
Electric Car	N/A	182*	N/A	155*
Diesel Bus	3.27	963	3.36	975
CNG Bus	N/A	1050	N/A	970
Fuel Cell Bus (methanol)	N/A	N/A	N/A	686

*The average electricity generating mix for India is used for calculating GHG emissions for battery electric vehicles as follows: 70 percent coal, 15 percent hydroelectric, 10 percent natural gas, and 5 percent other (mostly petroleum and biomass).

Source: Fuel consumption estimates are adjusted from Bose and Nesamani (2000) and GHG calculations are by M.A. Delucchi (see appendix).

Note: Diesel vehicles have better fuel economy than gasoline vehicles because diesel engines are more efficient and diesel fuel contains more energy per liter.

•Source: Transportation in Developing Countries – Greenhouse gas scenarios for Delhi, India, Institute of transportation studies, University of California, Davis, 2001

IFC Experience

- Bangkok Skytrain
- IAMSA/DTM Bus Operator
- Guatemala BRT
- Marcopolo Buses
- Istanbul Metro

Bangkok Skytrain

- $ 1.5 billion - 23 km elevated train
- Concession won by Tanayong Corporation (real estate developer)
  - Siemens (railway technology)
  - Ital-Thai (contractor)
- Completed in 1999 after significant delays
  - Initial schedule of 42 months unachievable
  - Utilities relocation in downtown - longer
  - Depot location change – environmental concerns
  - Automatic fare collection system
  - Asian financial crisis (1997-98)
- IFC - $ 100 million equity – key role in project financing

Issues Faced & Lessons Learned

Cost Overrun	• Provide for adequate cost overruns • Ensure promoter guarantee for cost overruns • Even in US, 36% of all projects face cost overruns
Opening ridership 200,000 against forecast of 570,000	• Thorough traffic demand modeling required • Extremely challenging for greenfield projects; few reach expectation
Project Design	• Proper emphasis to enviro/public concerns (Depot relocation -central public park) • Impossible schedule • Insufficient data (utilities)

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Guatemala - Municipality of Guatemala City

Risk-sharing agreement for single credit exposure

- Financed critical urban transport infrastructure that reduced travel times and congestion in one of the largest cities in Central America.
- Improved lives of 180,000 daily users, many of whom in poorest segments and depending on public transportation to reach their employment.
- Introduced a new source of commercial funding that does not rely on sovereign guarantee, for municipalities in Central America.
- Enhanced municipal financial management practices and diversified funding sources through WBG technical assistance.
- Created an entry point for a leading Guatemalan bank to participate in the municipal financing business.

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Guatemala BRT – Financial Structure

- 10-year syndicated loan for Q279 million (US$36.7 million) secured by a mechanism that aggregated property taxes and construction licenses in a separate trust account to service specific Municipality of Guatemala City debt.
- A local currency loan from Banco G&T Continental for Q72 million (US$9.5 million)
- Risk-sharing agreement for single credit exposure for 70 percent of the total bank exposure of Q72 million (US$9.5 million).

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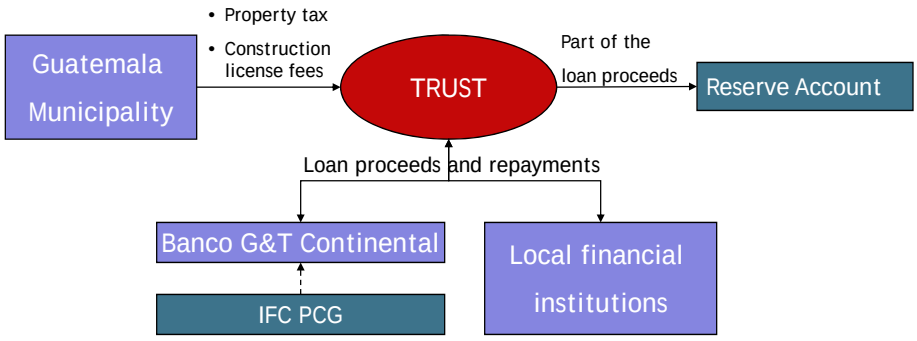
Guarantees – Risk-sharing on a loan + trust arrangement

- Risk sharing facility for 70% of the exposure to a local Bank to finance a municipal urban transport infrastructure project.



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10 Principles
for transport in urban Life

Shreya Gadepalli
INSTITUTE FOR TRANSPORT AND DEVELOPMENT POLICY

The Mother Principle

India is a DEMOCRACY

Constitution of India

WE, THE PEOPLE OF INDIA, having solemnly resolved to constitute India into a SOVEREIGN SOCIALIST SECULAR DEMOCRATIC REPUBLIC and to secure to all its citizens:

- ✓ **JUSTICE, social, economic and political;**
- ✓ **LIBERTY of thought, expression, belief, faith and worship;**
- ✓ **EQUALITY of status and of opportunity; and to promote among them all**
- ✓ **FRATERNITY assuring the dignity of the individual and the unity and integrity of the Nation;**

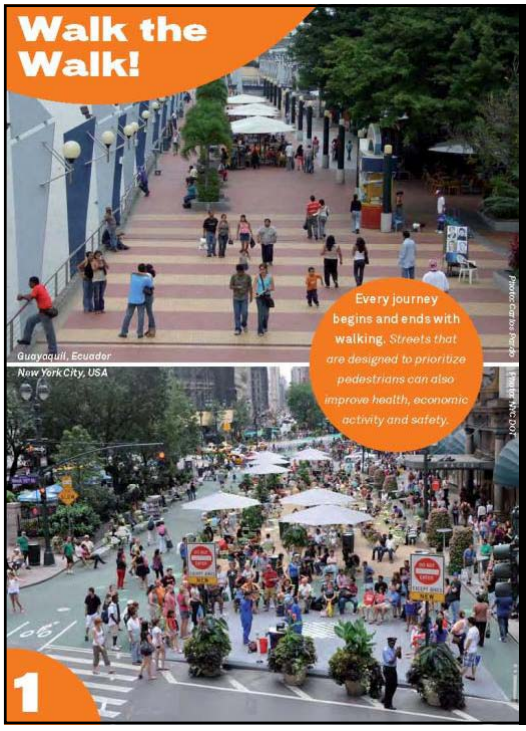
BIRDS = FLY

FISH = SWIM

MAN = ?

MAN
WAS BORN SO HE COULD
WALK!

WOMEN TOO!



1

Walk the walk!

Walking is the most universal form of transport. Great cities start with great pedestrian environments.

There is much more to walking -than walking!

A mode of transport - but with a potential for much more –
and the 'much more' is by far the more interesting part!

You can walk -and walk - and walk....

-but you could just as well ”walk`n-talk”

-or you can ”stop-n-talk”

-or you can ”stop-n-watch”

and watch-n-watch”

-or ” watch-n-learn”

You can
”play-n-laugh”

-or ”sit-on-top”

-or you can ”walk-n-dance”

-or you can ”stop-n-snooze”

-and whenever you feel like
you can even address your fellow citiziens!

Beyond survival needs, there are
HAPPINESS NEEDS.

We are pedestrians. We need to walk, and be outdoors, not in order to survive, but to be happy.

In terms of infrastructure what makes an advanced city are not highways or subways but great footpaths.

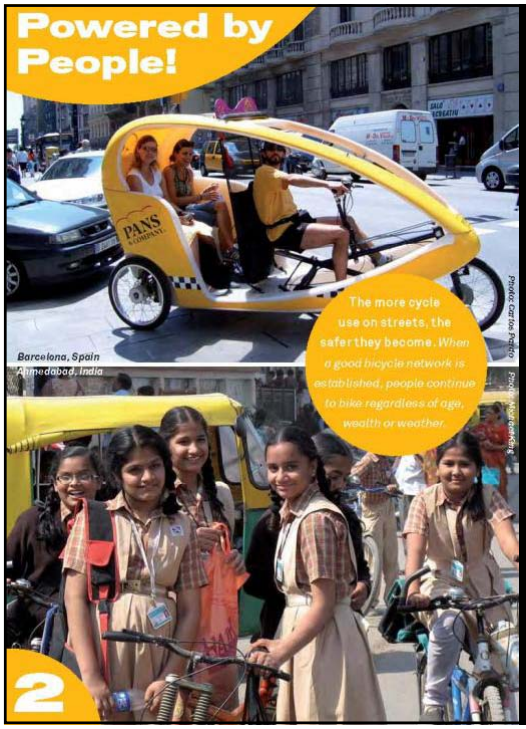

RAABOBS
RAABI
fabindia


OXFORD CIRCUS
LOOK RIGHT
LOOK LEFT


7
5000


400m relay race???


Pedestrians don’t get enough exercise???
PEDESTRIAN
WAY
STOP



2

Powered by people!

Bicycles and other means of people-powered transport, like rickshaws are great for short trips. Building bike lanes and slowing down traffic are key to making it safe.

Or has it really???

Why do Danes cycle?

1%	6%	19%	61%
state that it is because of the environment	state that it is because it is cheap	state that it is because of the exercise	state that it is because it is convenient, fast and easy

Copenhagen Bicycle Account 2006

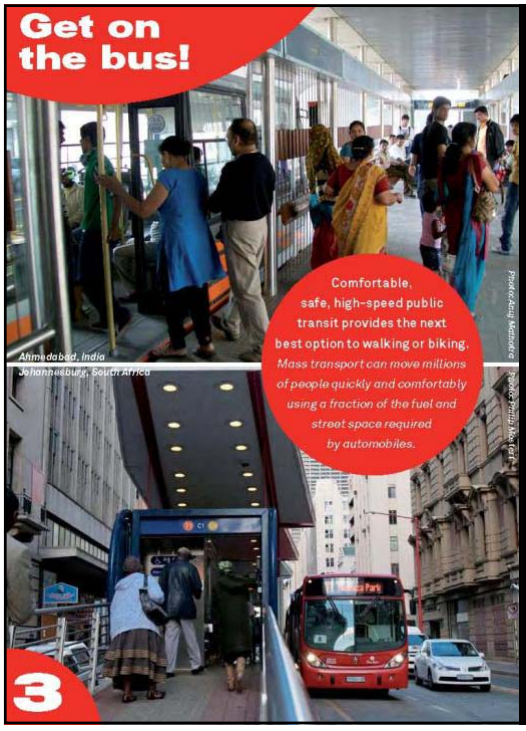
DEDICATED CYCLE TRACKS

PRIME PARKING FOR BICYCLES

EVEN MULTISTOREYED BICYCLE PARKING!

Simple interventions, like adding a ramp to stairs for people using cycles, make crossing more convenient. Changzhou, China.

RAMPS FOR BICYCLES



3

Get on the bus!

Mass transit can move millions of people quickly and comfortably using a fraction of the fuel and street space required by automobiles.

Cars are wonderful but they don't function well if we all decide to use them simultaneously at peak hours

The only solution is public transport, not just for those with lower incomes, but for everybody.

What is Bus Rapid Transit (BRT)?

Bus Rapid Transit is *high-quality, customer-orientated transit* that delivers *fast, comfortable and low-cost urban mobility.*

It is not business as usual.

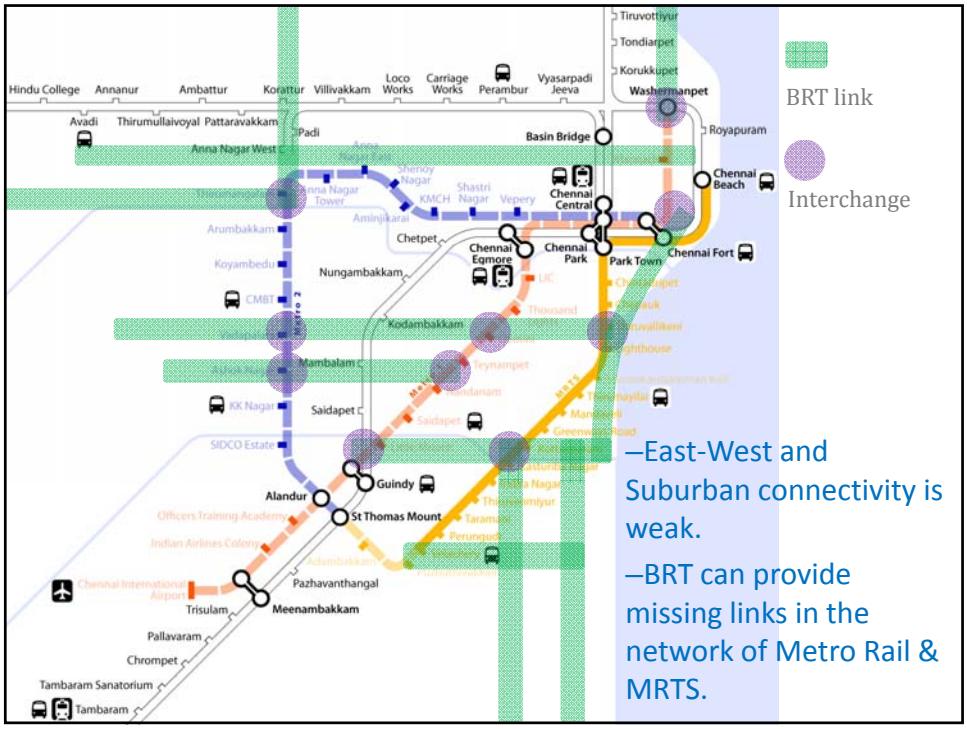
"Think rail, use buses!"

Bus Rapid Transit can give the same quality of service as Metro to a large number of citizens across the city at relatively low cost.

Our cities should have a few hundred kilometers of MRT in the form of BRT by itself of in addition to Metro

But BRT is only possible on wide roads?

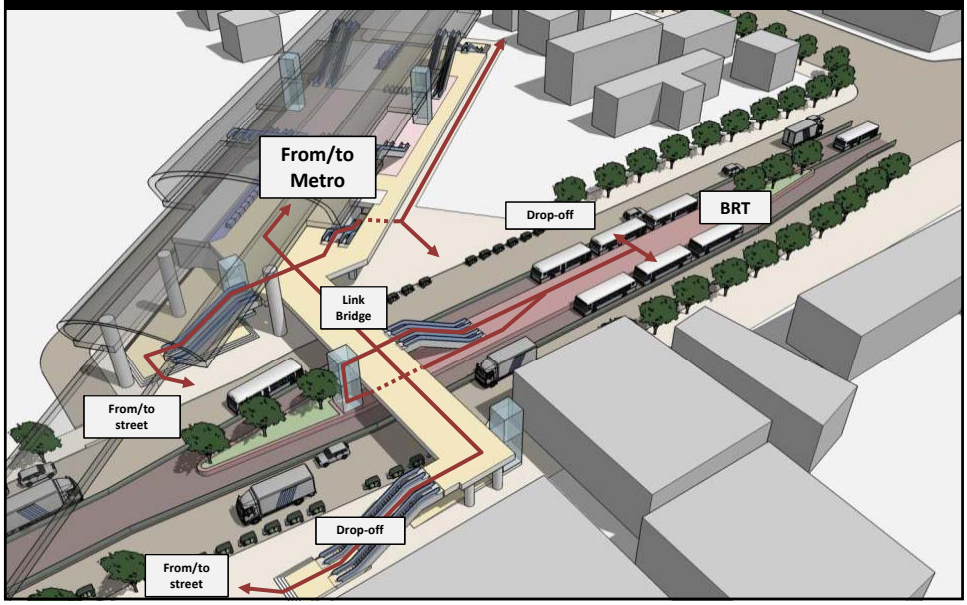
Not really. There are many examples of BRT on narrow streets.



–East-West and Suburban connectivity is weak.

–BRT can provide missing links in the network of Metro Rail & MRTS.

Modal integration METRO-BRT



Traffic jams without public transport are relatively useless;

So is public transport without traffic jams or some other form of automobile use restriction.

4

Cruise control

By managing private car use, cities can minimize problems while creating space for pedestrians, mass and non-motorized transit.

Quality public transport is necessary but not sufficient.

Private vehicle use must be restricted.

Parking
is not a constitutional right
in any country

The biggest threat
to green spaces and parks in our cities
is parking

DUMBO, Brooklyn

Before: Community leaders requested more open space for a burgeoning residential and commercial district.
After: DOT reclaimed road space to create a new public plaza.

NEW YORK CITY DOT

PARKING - MYTH vs REALITY

MYTH

On-street parking is a public right!

Government should provide it.

REALITY

- ✓Parking is private need of private individuals that should be dealt with in the private realm.
- ✓Vehicles are parked for 96% of the time. They often occupy 50% of street space. It's a wasteful use of streets and public space.

PARKING - MYTH vs REALITY

MYTH

Multi-storey parking will solve the problem

REALITY

- ✓Unless parking on streets is restricted, multi-storey parking doesn't work.
- ✓Parking fee should pay for the cost of creating multi-storey parking.

PARKING - MYTH vs REALITY

MYTH

The solution to parking problem is more parking

REALITY

✓More parking means more vehicles are attracted to use the road resulting in more congestion and poor mobility for all.

PARKING - MYTH vs REALITY

MYTH

Builders should provide necessary free parking

REALITY

✓Parking space in building complex has a cost. Builders charge it one way or the other.

✓Those households that do not want parking should have the opportunity to save money

One multi-storey car parking space = One Low Income Home

Who should get priority???

WHAT WILL HAPPEN WHEN YOU ARE OFFERED LAND FOR FREE???

Parking has a cost

Rs 5000-15000 per month per car parking

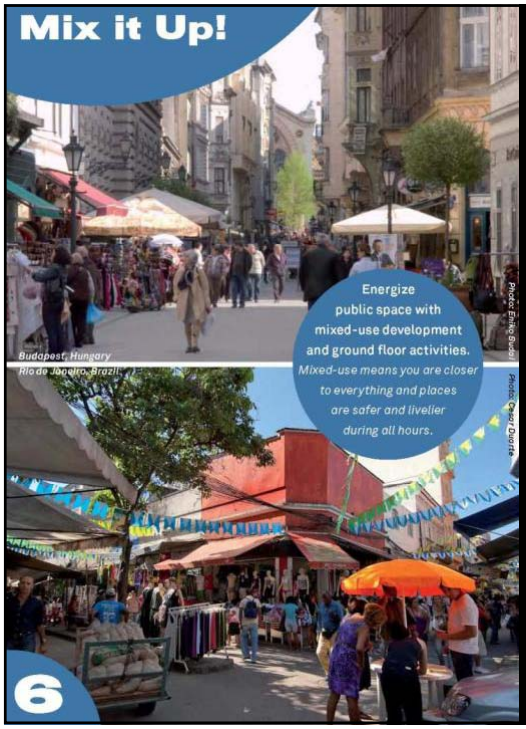
Rs 20-60 per hour!

Average space required per car in off-street multi storey parking is 250 sq ft.
Average occupancy of 80% during working hours on working days.
All costs are from Chennai city

5

Deliver the Goods!

Cities need to create incentives to use cleaner, smaller, quieter, slower and safer delivery vehicles.

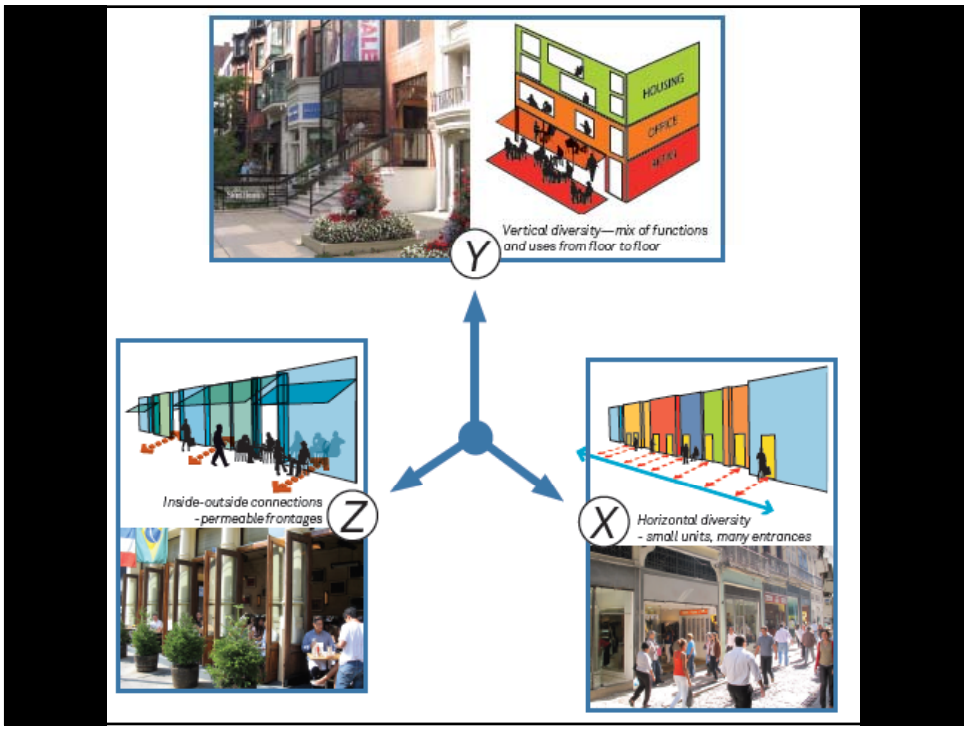


6

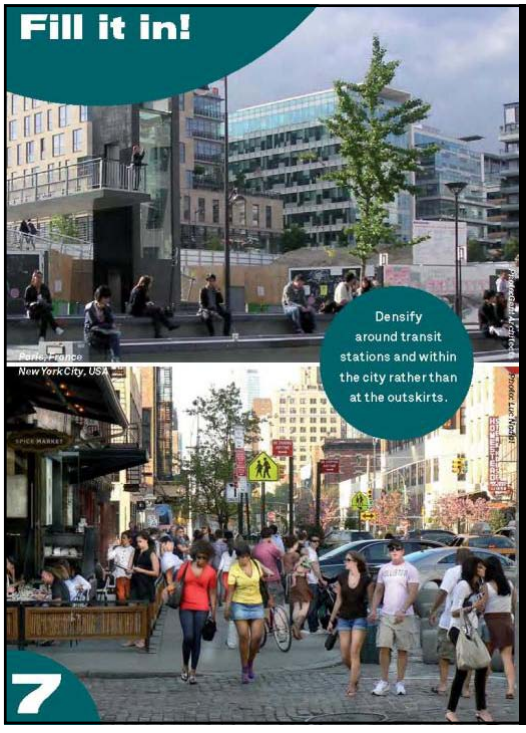
Mix it up!

Lively cities stack retail on the ground floor, with residences and offices above, so the streets are vibrant day and night.


4 storey apartments
10 storey apartment
2 storey row houses
Low income housing
Shops


HOUSING
OFFICE
Vertical diversity—mix of functions and uses from floor to floor
Y
Inside-outside connections - permeable frontages
Z
Horizontal diversity - small units, many entrances
X

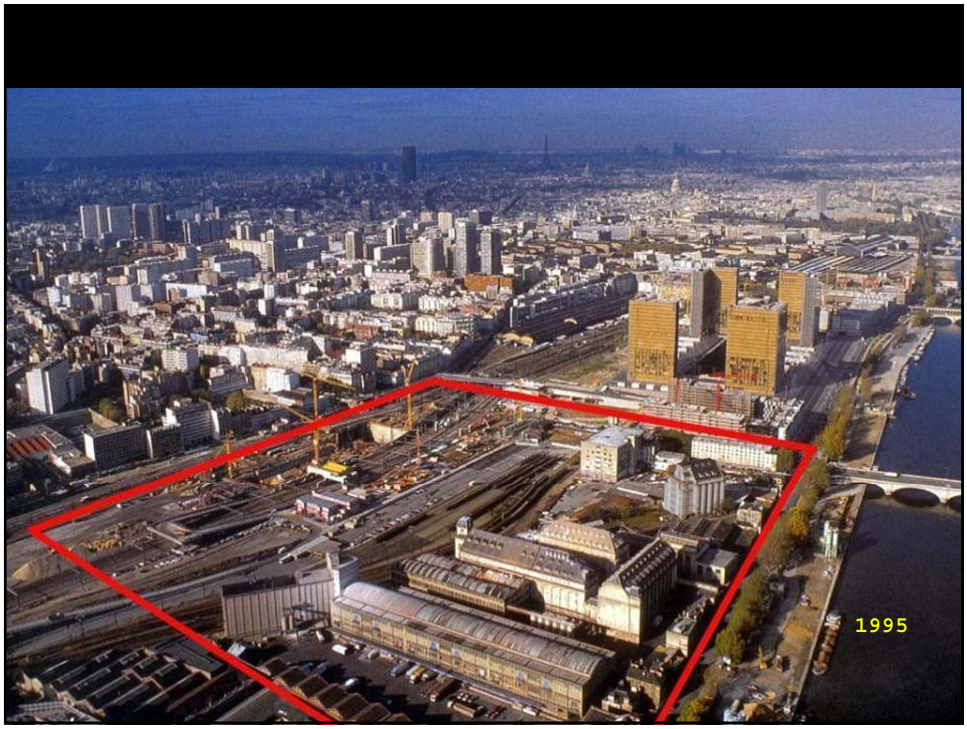

LADIES WEAR
GENTS WEAR
CHILDRENS WEAR



7

Fill it in!

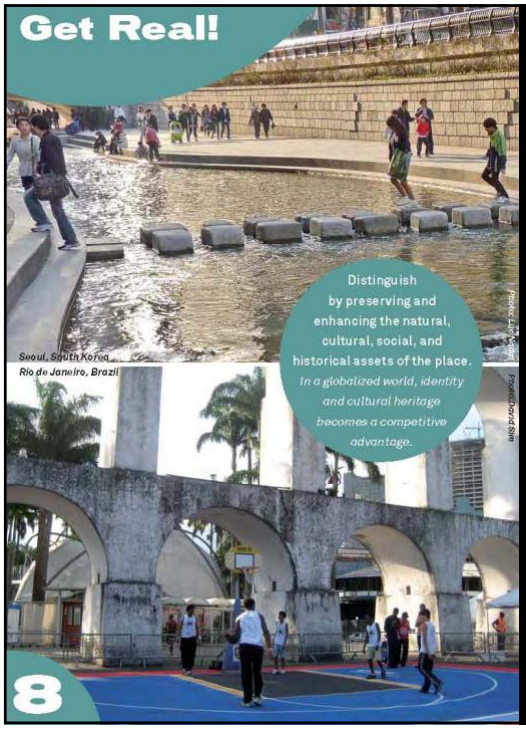
Building on vacant lots and brown-fields prevents urban sprawl and makes urban neighbourhoods more vibrant.


1995


2005


Quai Panhard et Levassor
Les Grands Moulins
La Halle aux Farines
Rue des Frigos
Rue Marguerite Duras
Jardin des Ecoles
Jardin des Grands Moulins
Rue Olivier Messiaen
Rue Marie Andrée Lagroua Weill Hallée
Jardin de l'avenue de France
Avenue de France
Jardin privé
Jardin public
ENVELOPPES THEORIQUES
RDC - R+1
R+2 - R+4
R+5 - R+8
> R+8


RESTO' RAPIDE



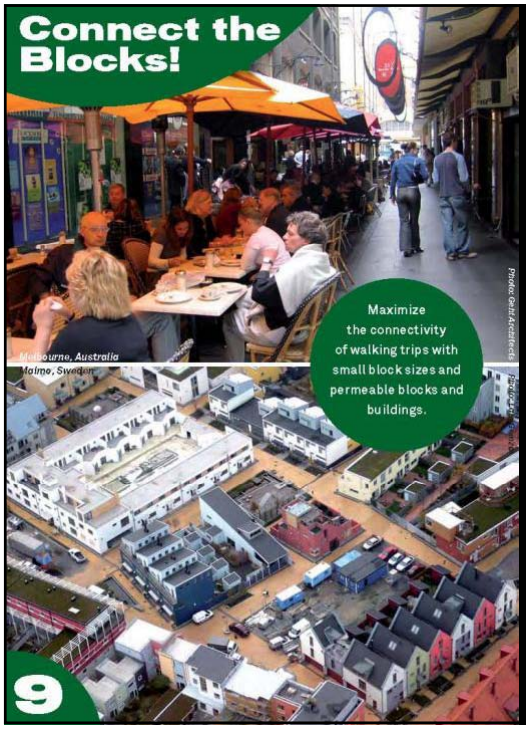
8

Get real!

A community's history, natural environment and ethnic traditions all contribute meaningfully to what makes a place unique. Finding these elements and enhancing them is critical to distinguishing one place from another.

Local markets reduce need for transport, while creating local jobs and a social forum. Ahmedabad, India.

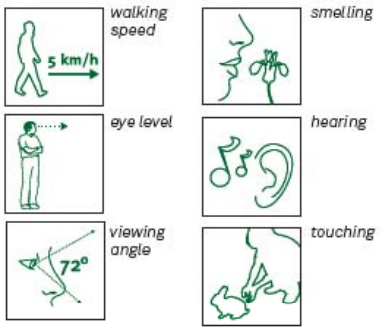
Architectural heritage under restoration, Historic Center. Mexico City, Mexico.



9

Connect the Blocks!

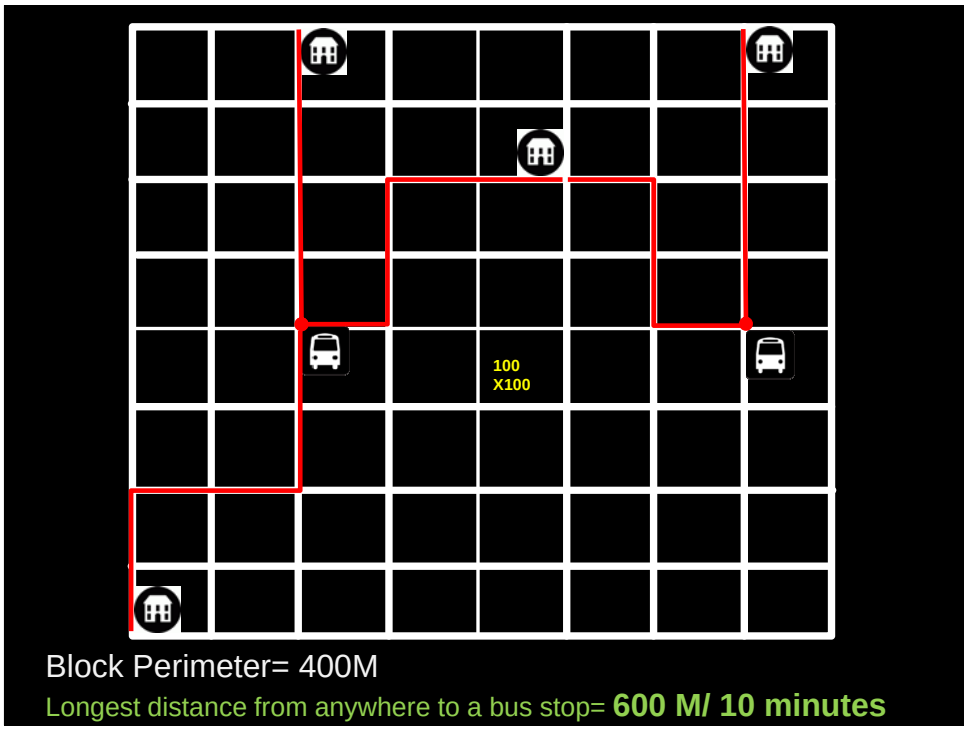
The more connected the blocks, the shorter the distance between destinations, making walking and biking more appealing.



In an environment well scaled to the physical size of the human body, all senses can engage.

Fine grain area filled with restaurants and small shops. Istanbul, Turkey.


Sarjapur Attibele Rd
Image © 2010 GeoEye
© 2010 Google


100
X100
Block Perimeter= 400M
Longest distance from anywhere to a bus stop= 600 M/ 10 minutes

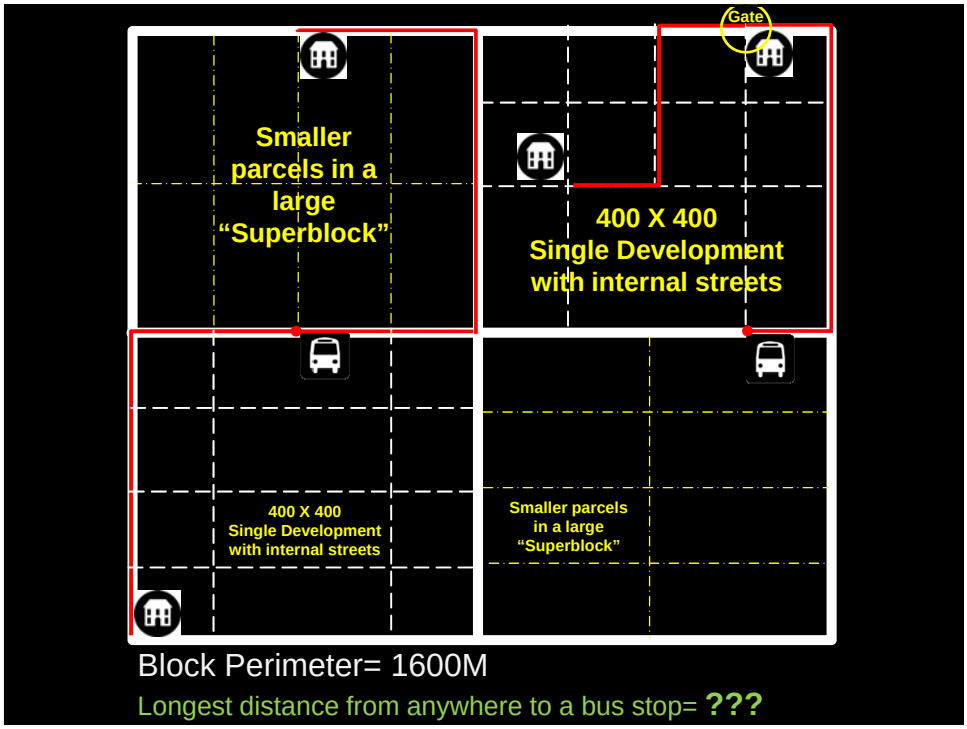
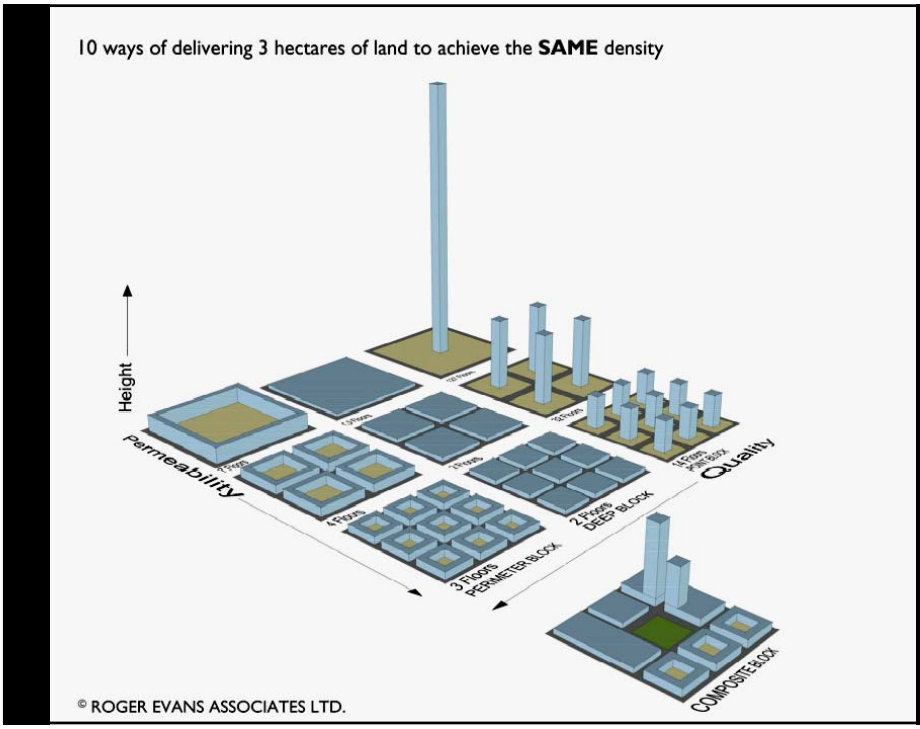

Gate
Smaller parcels in a large "Superblock"
400 X 400 Single Development with internal streets
400 X 400 Single Development with internal streets
Smaller parcels in a large "Superblock"
Block Perimeter= 1600M
Longest distance from anywhere to a bus stop= ???

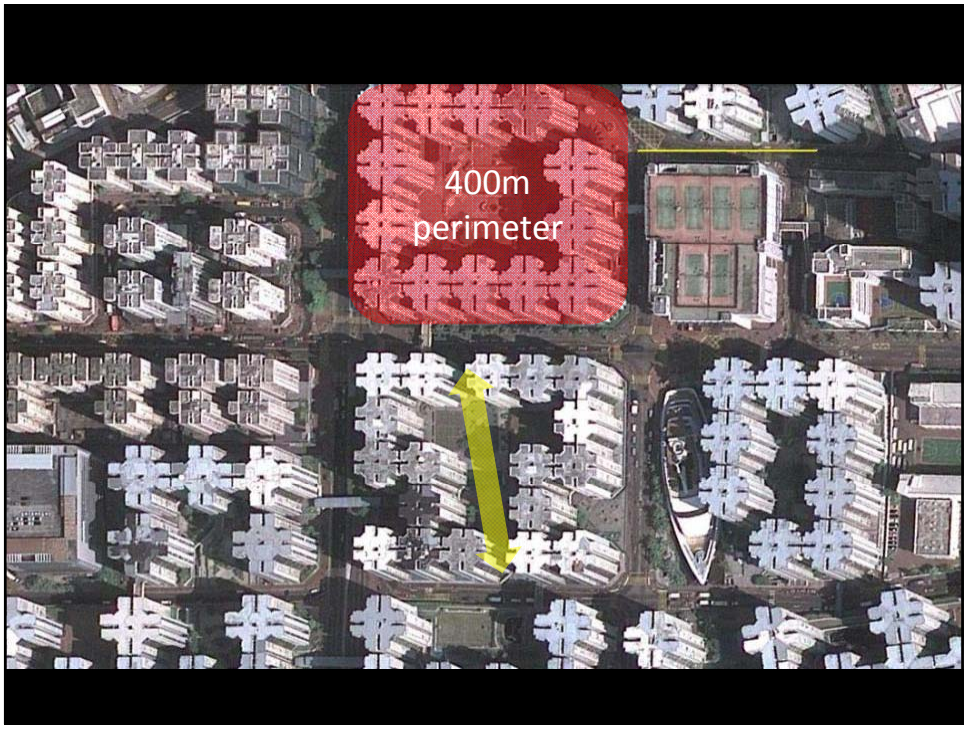

Image © 2011 GeoEye


AURORA

Density is necessary for efficient use of urban infrastructure.

Low density reduces opportunities, increases cost of services, stifles economy.




400m
perimeter

Pedestrian cut through encourage walking

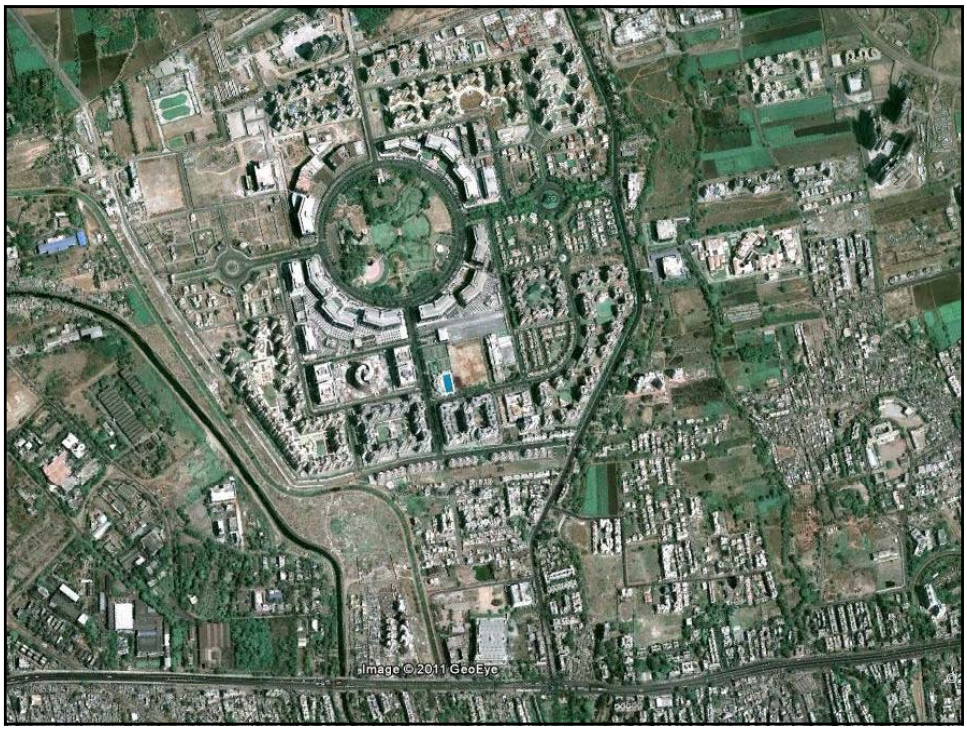
Buildings do not end at the ground. Any new building must IMPROVE public pedestrian space quality around it.

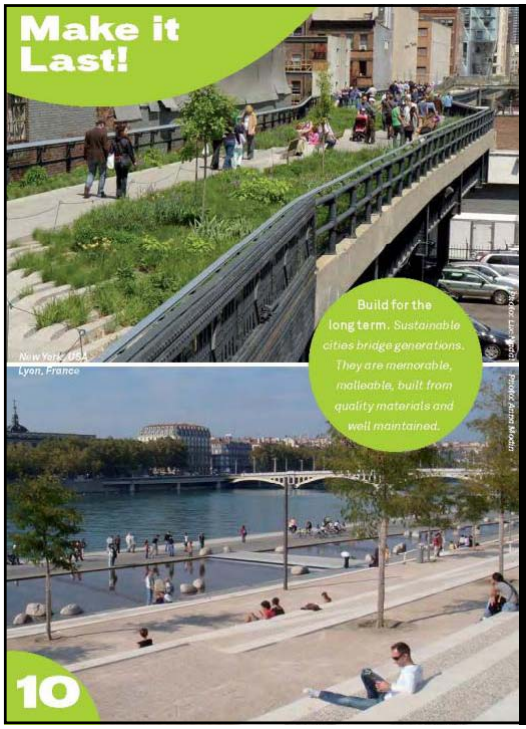
Especially the big ones.


RMZ

A self sustained township within a city is a fantasy.

Over time, they make life difficult for people and value starts degrading.

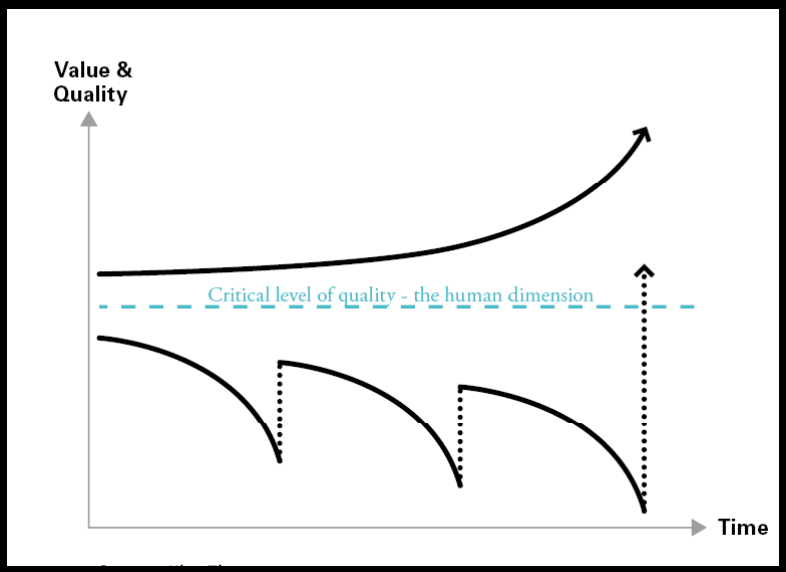




10

Make it last!

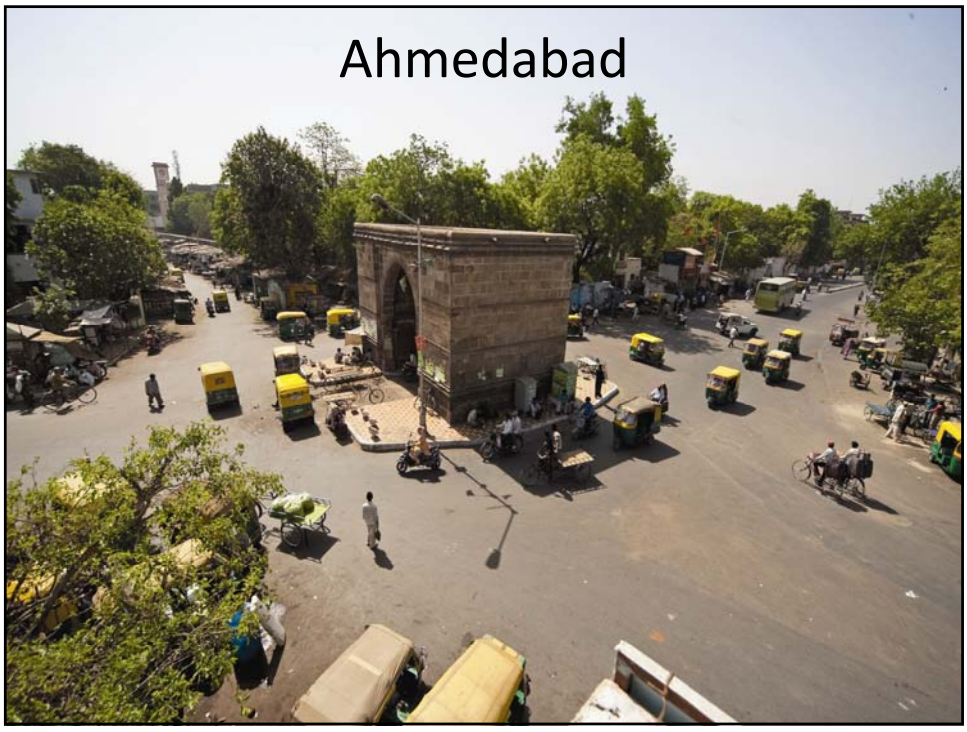
Streets and public spaces, if built with quality materials and are well-designed, well-maintained, and well-managed, can last for decades



WE CANNOT DESIGN AN URBAN TRANSPORT SYSTEM UNLESS WE KNOW WHAT KIND OF A CITY WE WANT.

THE VISION OF OUR CITY


"Airplane - planning (from
Brand New Towns???


Ahmedabad

Ahmedabad

Ar. Bimal Patel visualization for Our Cities Ourselves

Life - Spaces - Buildings -and in this order, Please

Think BIG

- but always remember to make people places small

When we stop being experts and start acting using common sense, we will have better cities.

Modern, desirable, sustainable walking cities require

- Mixed uses – in all forms
- Active, people-oriented design
- Small blocks & human scale streets
- High density & good public transit access

ITDP
Institute for Transportation & Development Policy

Institute for Transportation and Development Policy
is an international not-for-profit organization
that is a leader in promoting environmentally sustainable
and socially equitable transportation worldwide.

www.itdp.org
www.ourcitiesourselves.org
www.twitter.com/#!/itdpindia

ITDP key program areas are

Public transit:
Investing in modern, attractive public transit systems, specifically bus rapid transit, to provide a higher quality of life in cities

Non-Motorized Transport:
Making streets safer and more convenient for cyclists and pedestrians, improving the quality of affordable non-motorized vehicles, and promoting bike use

Travel Demand Management:
Reducing air pollution, congestion, and CO2 emissions by reducing private car use through parking regulations, access management, and road user charging

Urban Accessibility:
Reinforcing urban centers by encouraging pedestrian-oriented real estate development, urban design, and public space management

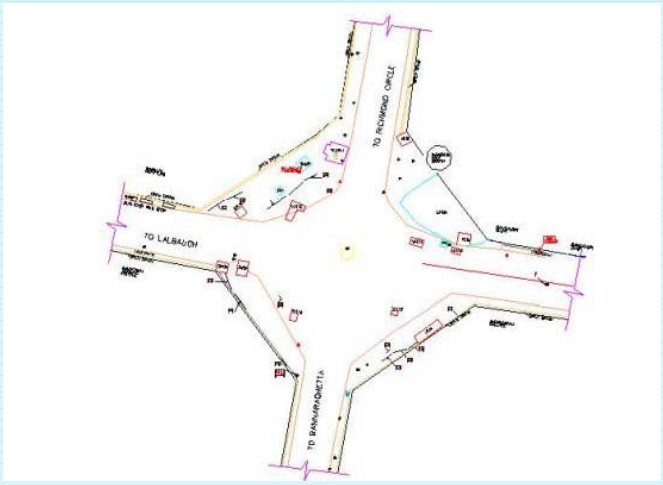
Sustainable Transportation Investment:
Ensuring necessary funding is available for sustainable transport projects.

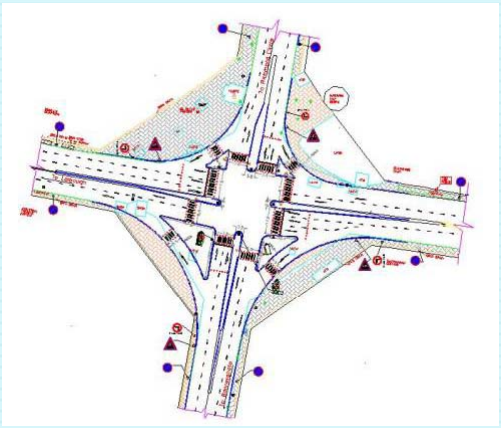
IMPORTANCE OF TRAFFIC ENGINEERING IN URBAN MOBILITY

Vinoba Sunder Singh - Senior Vice President
Urban Mass Transit Company Limited

Components that make up a city street

- The physical elements of the pavement
- The user
- The traffic Police
- The control elements
- Signage
- Road markings
- Footpaths
- Street furniture


TO RAJAMAHENDRAVARAM
TO LALBAUGH
TO RAJAMAHENDRAVARAM



One Signboard too many

Hide and Seek

The Urban Scenario

GDP increased 4 fold in the period 1985 to 2005

Has 10 of 30 fastest growing cities in the world

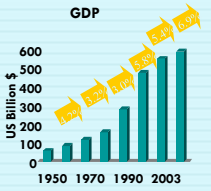
700 million will urbanise by 2020

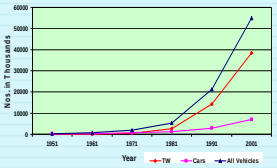
140 million rural will enter to urban by 2020

100 million people will enter labour force by 2020

Number of Metro Cities with Pop > 1 Mill - 51 by 2021

Growth of Vehicles at double digits

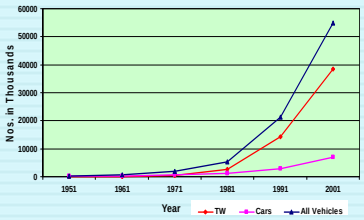




All this leads to a huge demand for Traffic

Urban Transport Scenario

Car ownership is still very low when compared to Developed countries - 10 times lower



Speed Trend - No network development (in KMPH)

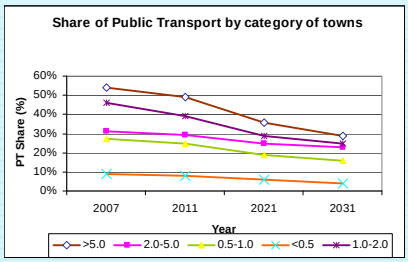
Category	City Population (In Millions)	2007	2011	2021	2031
1	<0.5	26	22	15	8
2	0.5-1.0	22	18	13	9
3	1.0-2.0	18	13	10	7
4	2.0-5.0	22	18	12	9
5	>5.0	17	12	9	6

Source: Study on traffic and transportation policies and strategies in urban areas – Ministry of Urban Development

- Road Network speeds will be at walking speeds!!
- Cities will experience economic decay

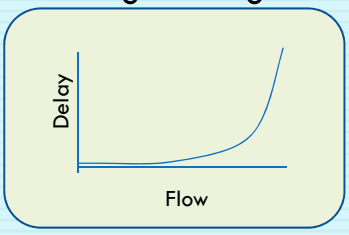
Share of Public Transport

Share of PT is fast declining and has dropped by about 10% per decade - and will continue to decline in the future



Talking Traffic

- How many junctions are working at optimal conditions?
- Is the traffic policeman equipped to do traffic engineering
- How many traffic engineers are there in the city
- Can all traffic engineering works be outsourced



Traffic Management

- Junction Improvements
- One way streets
- Tidal flow operations
- Parking
- NMT
- Goods Vehicles Management
- IPT Management

ITS

- Level 1 : Traffic Policeman
- Level 2 : Traffic Signal
- Level 3 : Video Camera's
- Level 4 : Controller control from OCC
- Level 5 : Traffic Feeds to OCC
- Level 6 : Software optimisation

Traffic Engineering and Mobility

- Optimise our Resources
- Improved Bus Operations
- Safety
- Convenience for Walking
- An overall pleasing look
- Lesser air and noise pollution

- Lets get our Traffic Engineering in order
- Lets get the institutions that are responsible for traffic engineering setup/strenghtened.
- Lets invest in ITS and optimise our resources
- Lets live better – live safer

- Thank You

TRAVEL DEMAND MANAGEMENT IN URBAN TRANSPORTATION

Dr. Sanjay Gupta
SPA, Delhi
Seminar Chennai

25th Feb 2011 CMDA

NEED FOR TRAVEL DEMAND MANAGEMENT

- Growth in population, number of vehicles and travelers, freight, and development has affected travel demand and reshaped travel patterns.
- The inability to add new infrastructure in time has led to the need for planners to pay more attention to managing demands.
- Demand-oriented approaches are needed to address the transportation issues created by growth and the variability in demand for use of the systems.
- TDM is the use of policies, programs, services and products to influence whether, why, when, where and how people travel.

CONCEPT OF TRAVEL DEMAND MANAGEMENT

Travel Demand Management (TDM) is the implementation of programmes of measures which seek to change travel demand patterns by:

- **Trip reduction**
- **Reduction in vehicle use**
- **Increase in vehicle occupancy**
- **Increased travel by alternative modes**
- **Trip retiming**
- **Offering alternative destinations**
- **Reduction in trip length**

CONTRIBUTION OF TDM

- **Greater community well-being through improved public health and road safety**
- **Increased use of public transport, cycling, and walking modes of travel**
- **Reduced transport-related greenhouse emissions and non-renewable energy use**
- **Community connectedness**
- **Improved access to key destinations via the transport network**
- **Reduced expenditure by private and commercial vehicle owners on fuel and vehicle maintenance**
- **Improved cost-effectiveness, capacity and efficiency of the transport network.**

CATEGORIES OF TDM STRATEGIES

- **Parking Management**
  - Parking cash-out programs
  - Priority parking for carpools, vanpools, and short-term parkers
- **Land Use Management**
  - Mixed-use development
  - Increased densities in transit corridors
  - Infill and brown field development

CATEGORIES OF TDM STRATEGIES

- **Improved Transportation Options**
  - Biking and walking
  - Transit
- **Incentives to Use Alternative Modes and Reduce Driving**
  - Telework and flexible work schedules
  - Road and parking pricing
  - Road space allocation (bike lanes, transit-only lanes)
  - Carpool incentives

IMPACT OF SELECTED TDM STRATEGIES

Strategy	Modal Share Impact
Congestion pricing	London: 37% vehicle speed increase, 30% decrease in peak period delays; 50% decrease in bus delay.[1] 14-30% increase in transit ridership (London, Stuttgart, Singapore)[2]
High capacity transit	20-72% of new riders shifted mode from auto[3]
Parking management (includes pricing and availability stratigies)	40-50% reduction in parking demand under peak period and long-term parking pricing increases; SOV mode share 16%- 25% lower when employees paid for parking [4]
Transportation-efficient development	15-24% SOV reduction[5]

PARKING MANAGEMENT

- **Strategies that encourage more efficient use of existing parking facilities, reduce parking demand and shift travel to other modes resulting in enhanced community liveability, access to retail businesses and neighbourhood vitality.**
- **Effective Parking Management Practices**
  - **Variable Market Rate On-Street Pricing**
  - **Unbundling Parking Costs**
  - **Parking Tax**
  - **Parking Cash-Out**
  - **Electronic Parking Guidance Systems**
  - **Park-and-Ride**

TRANSIT USE AND CARPOOLING

Proven strategies include:

- **Put more transit service**
- **Build compact communities with sufficient density to support high-frequency transit service.**
- **Get low cost or free transit passes**
- **Improve and distribute transit and carpool rider information**
- **Build park-and-rides and HOV lanes**
- **Support car-sharing**

TRADITIONAL CAR POOL OD

Morning

Evening

Morning

Evening

Origin

Location: XX Society
Time: 8:00 AM

Destination

Location: YY Limited
Time: 6:00 PM

10

LAND USE MANAGEMENT

New dense housing development in downtown Vancouver increases walk trips.

Vancouver, Canada

Increased housing capacity in the downtown area "living-first strategy".

From 1991 to 2002, the number of residents living downtown increased by 62%, to 76,000, but car trips into downtown remained essentially constant.

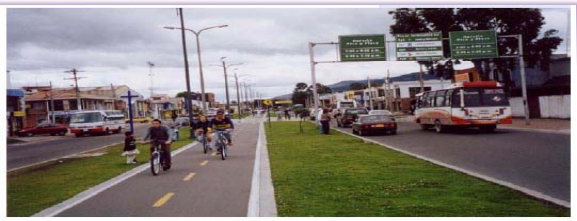
TRANSIT ORIENTED DEVELOPMENT

Transit-oriented development (TOD) creates mixed-use, higher density communities that encourage people to live, work and shop near transit services and decrease their dependence on

CHARACTERISTICS OF TOD

- Compact, higher density land development
- Mixed uses
- Good pedestrian environmen
- Public amenities
- Parking management
- Good transit service
- Strong connectivity between transit and development

BIKE PATHS AND PEDESTRIAN FACILITIES



EMPLOYER-BASED TDM STRATEGIES

- **Financial Incentives** – makes non-SOV options relatively cheaper for the employee to use.
- **Facilities and Services** –services to make non-SOV commute options more appealing
- **Flexible Scheduling** –employees to reduce their number of weekly commute trips and shift work trips to nonpeak hour times of day.
- **User Information** – The employer provides information on available alternatives to driving alone,

IMPACT OF SELECTED EMPLOYER-BASED TDM STRATEGIES

Strategy	Details	Employee Vehicle Trip Reduction Impact
Parking Charges[1]	Previously Free Parking	20-30%
Information Alone[2]	Information on Available SOV-Alternatives	1.4%
Services Alone[3]	Ridematching, Shuttles, Guaranteed Ride Home	8.50%
Monetary Incentives Alone[4]	Subsidies for carpool, vanpool, transit	8-18%
Services + Monetary Incentives[5]	Example: Transit vouchers and Guaranteed Ride Home	24.50%
Cash Out[6]	Cash benefit offered in lieu of accepting free parking	17%

CONGESTION PRICING

The "C" symbol indicates the Congestion Pricing Area in London.

- **Techniques that use variable charges to provide disincentives to drive vehicles in certain areas or on particular roadways during periods of peak congestion.**
- **Examples include:**

- Variably priced lanes

- Variable tolls on entire roadways

- Cordon charges

- Area-wide charges

- Variably priced ramps

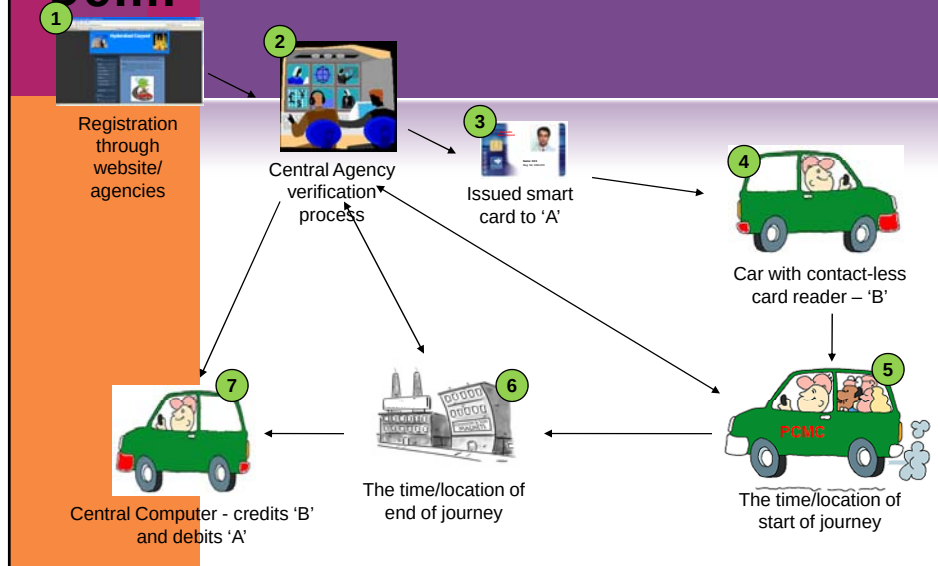
CONGESTION PRICING CASE STUDY: LONDON

Map showing London's expanding congestion zone.

Cameras capture license plates of cars entering the zone.

- **Since 2003, London has charged a congestion fee to most motorists entering or leaving its central area between 7 AM and 6:30 PM weekdays; residents receive a 90% discount, and motorcycles, taxis and some other vehicles are exempted.**
- **In 2004/2005, the program generated £190 million in total revenues (£118 million in fees and £72 million in fines), of which £97 million was invested in improvements to public transportation.**
- **Within three years, average car speeds within the zone had increased 37%, and peak period delays had decreased 30%.**

Pan-City Mega Carpool Scheme in Delhi



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CAR POOLING - RESEARCH EXPERIENCES IN DELHI

- Propensity to car pool is positively correlated with journey length and time.
- 30 to 50 yrs age group are more inclined towards car pool.
- Males are more inclined than Females for car pooling
- Estimated Economic and Environmental Benefits due to car pooling in Delhi estimated Rs 28.5 lakh/day (1991).

ACTIVITY RESCHEDULING – RESEARCH EXPERIENCES IN DELHI WHOLESALE MARKETS

Market	Commodity	Establishment No.	Direct employment in the establishment *
M1	Food grains	1100	9240
M2	Spices/Dry Fruits	2180	10940
M3	Hardware, Paper	4636	12980
M4	Textiles	4385	9428
M5	Electricals, Electronics, Pharma	4418	9277
M6	Miscellaneous	-	-

* In addition indirect employment @ 3 – 9 persons/direct employee.

ACTIVITY RESCHEDULING – RESEARCH EXPERIENCES IN DELHI WHOLESALE MARKETS

…..

- Characteristics:
  - Total Vehicles in the study area – 3.60.000
  - Destined Trips – 2,48,085
  - Shared Destined trips
    - Textile = 34.2%
    - Hardware =20.4%
- Impact
  - Percentage reduction in the travel demand
  - Varies between (electrical)to 24.3% (textile)
  - Percentage reduction in vehicle km varies between 3% to 50%

IMPACT ASSESSMENT OF ACTIVITY RESCHEDULING ….

Market	Reduction ('000)			% age Reduction		
	Trips	Vehicle km	Vehicle Hr	Trips	Vehicle km	Vehicle hrs
M1	40	54	597	16.2	16.8	13.9
M2	24	31	551	9.5	9.7	12.8
M3	51	24	1931	20.4	7.5	45.1
M4	85	163	586	34.2	51.2	13.7
M5	16	8	66	6.2	2.6	1.6
M6	33	38	548	13.1	12.2	12.9

SUMMING UP

- Develop a TDM strategy and action plan.
- Integrate TDM into land use and transportation plans
- Support TDM through the development approval process.
- Build TDM into infrastructure plans

Agenda for Action

- Undertake pilot studies on TDM to check their effectiveness
- Develop planning tools and guidelines for TDM implementation
- Develop real time traveler information system on priority
- Encourage stakeholder participation, public awareness on TDM

ITS for Sustainable Urban Mobility

Dr. R. Sivanandan

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Transportation Engg. Division
Dept. of Civil Engineering
IIT Madras, Chennai

Towards Sustainable Urban Mobility (Seminar)
February 25, 2011, Chennai

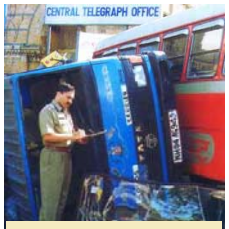
Today's Traffic Problems in Urban India

Low peak-period speeds – Longer travel times

Excessive intersection delays

Severe congestion (Capacity deficiencies)

Increased fuel consumption and pollution



Safety issues

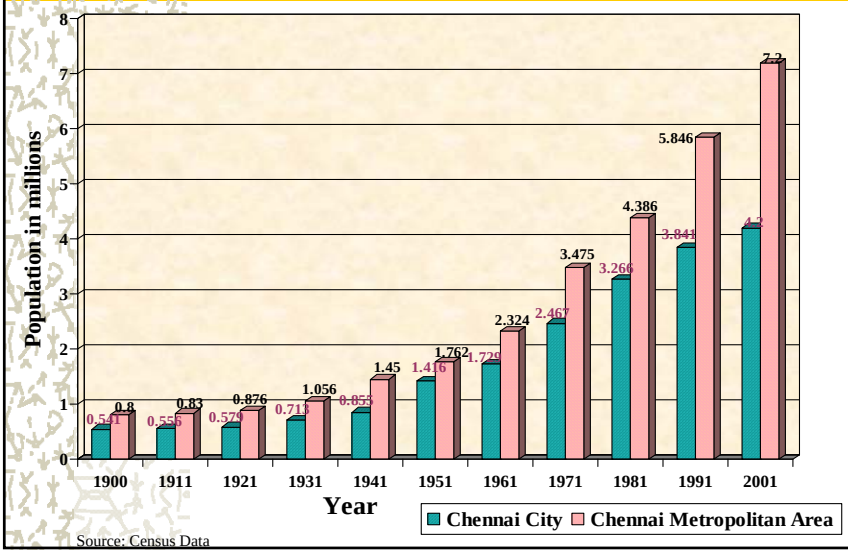
Causes of Urban Traffic Problems

(Chennai as a Case Study)

- Population growth
- Increase in per capita trip rate
- Modal shift (towards personal vehicles)
- Steep rise in vehicular population
- Less than commensurate growth in road network
- Inadequacy of public transport
- Others …

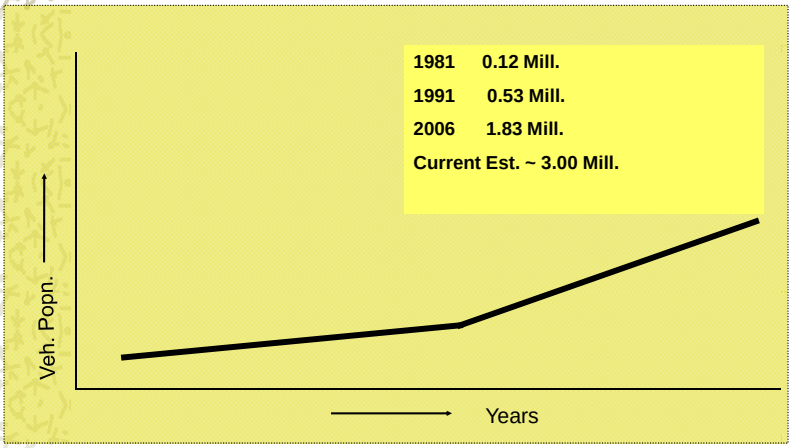
Growth of Population

(Chennai)



Source: Census Data

Steep Growth in Vehicle Popn.
(Chennai)



Growth in Per Capita Trip Rate
(Chennai Metropolitan Area)

Year/Study	Per Capita Mechanised Vehicular Trip	Per Capita Total Trips
1971-MATSU	0.39	0.866
1984-Kirloskar Study	0.70	1.146
1992-HHI Survey	0.73	1.282
2011-Projected	0.93	1.500

MATSU- Madras Area Transportation Study Unit (MATSU, 1974)

Kirloskar Study - Transportation Study by Kirloskar Consultants Ltd. (Kirloskar Consultants, 1986)

HHI Survey-Household Interview Survey (PTCS, 1993)

Changing Trend in Modal Split
(Chennai)

Mode	% of Total Trips Shared by Various Modes		
	1970[a]	1984[b]	1992[c]
Bus	41.50	45.53	37.90
Train	11.50	9.03	4.10
Car, Van, Jeep	3.20	1.45	1.50
Two Wheelers	1.70	3.24	7.00
Bicycle	21.30	10.70	14.20
Walk	20.70	28.07	29.50
Others	0.10	1.98	1.00
IPT (Auto Rickshaw, Cycle rickshaw)	NA	NA	4.80

% of Total Trips by Modes	
2007[d]	
Public Transport	31
Car	10
Two Wheelers	20
Bicycle	9
Walk	22
Auto	8

Sources: a. MATSU, 1974
b. Kirloskar Consultants, 1986
c. PTCS, 1993
d. Wilbur Smith Assoc. for MoUD

What can be done?

- Travel Demand Management
- Transportation System Management (TSM) Measures
- Building New Infrastructure
- Advanced Technology Applications (ITS)

Advanced Technology Applications

- Intelligent Transportation Systems (ITS)
- ITS are applications of advanced technologies to transportation systems to:
  - enhance their efficiency
  - promote safety

Potential Applications for Urban Areas

- Advanced Traffic Management System (ATMS)
- Advanced Traveller Information Systems (ATIS)
- Advanced Public Transportation Systems (APTS)

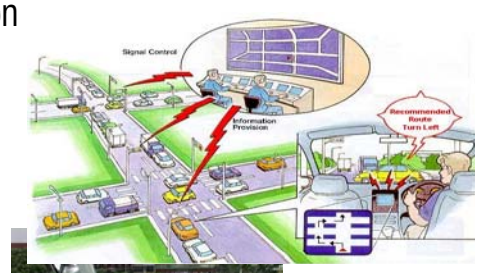
(Based on ITS America's Classification)

Advanced Traffic Management Systems (ATMS)

- To monitor, control and manage traffic and to ultimately predict and prevent congestion

Elements

- Surveillance
  - Sensors (Examples)
    - Loop Detectors
    - Infrared Sensors
    - CCTVs
    - Image Processing Sensors
- Traffic Control
  - Area-wide, Adaptive
- Advisory
  - VMS, In-vehicle Displays, etc.



Cameras/Image Processing Sensors

TRAFFIC CONTROL CENTRE

Source: *ITS World, Sep./Oct. 98*

Advanced Traveller Information Systems (ATIS)

- Provide up-to-the-minute information on road and weather conditions, detours, construction zones, bus schedules and parking
- Available before trip and en route
- Examples
  - Pre-trip Travel Information
  - In-vehicle Dynamic Navigation
  - Driver Advisory
- Media
  - VMS
  - In-vehicle
  - Others

Source: *Rockwell / ITS International, Sep. 96*

Advanced Public Transportation Systems (APTS)

- Improvements to mass transit to make it more efficient and attractive to users
- Examples
  - Real-time Passenger Information
  - Fleet Management
  - "Smart" Cards
- Superior transit service with APTS technologies

ITS Application Issues and Challenges

- ATMS Issues
  - Functional Requirements
  - Data Needs
  - Specifications for Components
  - Architecture
  - Traffic Data Collection technologies
    - Assessment and Identification of Appropriate Technologies in the Context of:
      - Heterogeneous Traffic
      - Indisciplined Flow
    - Performance Evaluation

ITS Application Issues and Challenges (contd.)

- ATIS Issues
  - User Needs
  - Functional requirements
  - Specifications of Components
  - Data Needs and Collection
  - Integration with ATMS Components
  - Architecture
  - Others
    - Role of ICT in Information Dissemination
    - Driver Compliance
- APTS Issues
  - Bus Transit Information System
    - User Perception
    - Location Technologies
    - Information Displays
  - Cost Effectiveness

ITS Application Issues and Challenges (contd.)

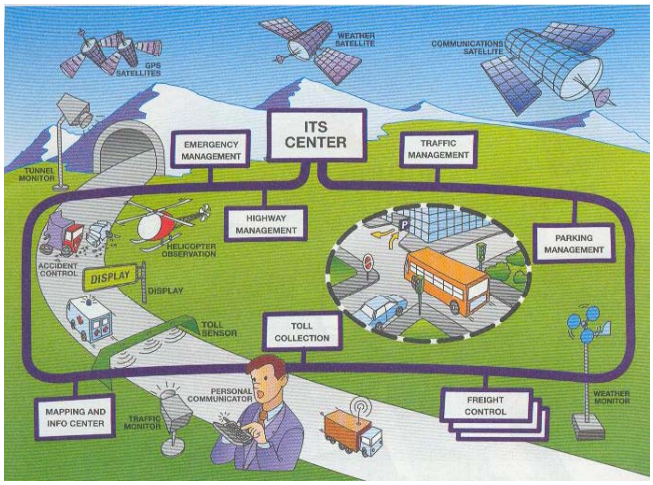
- Modelling Traffic Flow for ITS
  - Implications of Technology
  - Information Availability
  - Driver Behaviour/Compliance
  - Heterogeneity
- Network Issues
  - Alternate Routes
  - Area-wide Vs. Corridor
  - Adaptive Actions
  - Capacity Restrictions
  - Absence of Urban Expressways
  - Optimisation

ITS Application Issues and Challenges (Contd.)

- Field Implementation
  - Technology Issues
  - Connectivity for Real-time Needs
  - Security/Vandalism
- Reliability of Systems
  - Credibility Issues
- Agency Roles
  - Identification of Roles and Responsibilities
  - Inter-agency Coordination
- Funding Issues

A Full Fledged ITS Scenario

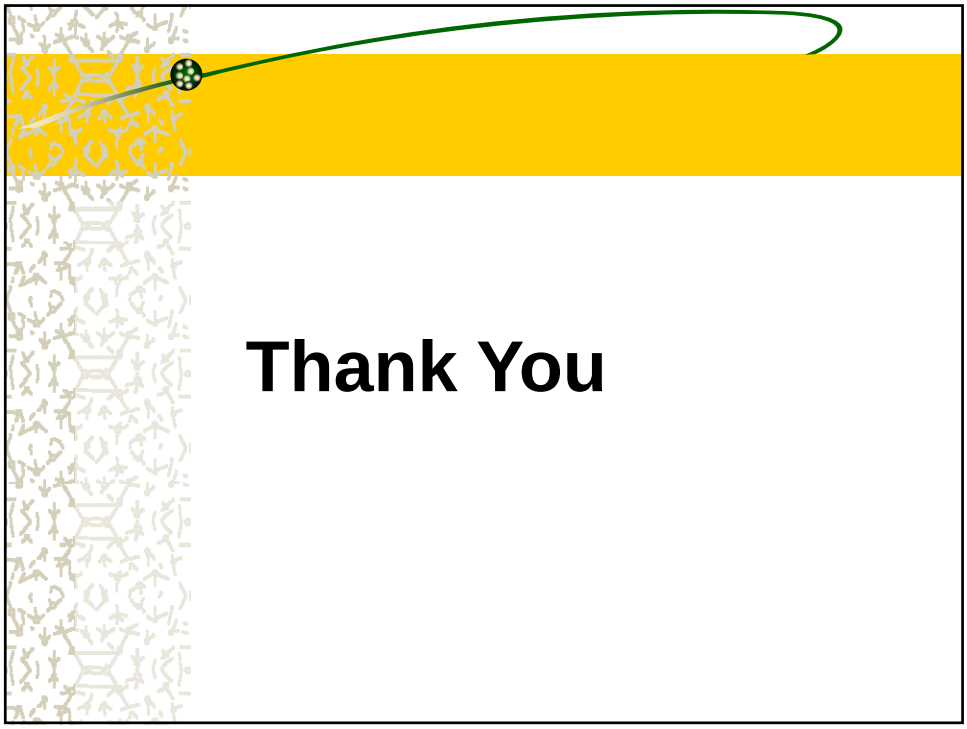
- Complexities in Deployment



Source: *Traffic Technology International '99*

Summary

- Potential for ITS Applications
  - ATMS, ATIS and APTS in Urban Situations
- Understanding User Needs
- Selective Adoption/Adaptation
- Use of Appropriate Technologies
- Deployment in Incremental Fashion
  - Pilot Studies
  - Sub-area/Corridor Applications
- Benefits to be Convincing to User Agencies
- Inter-agency Cooperation and Coordination Essential
- Research Needs in Several Aspects – Role of Academic Institutions


Thank You