RSG
the science of insight

Scenario Planning in an Uncertain Future

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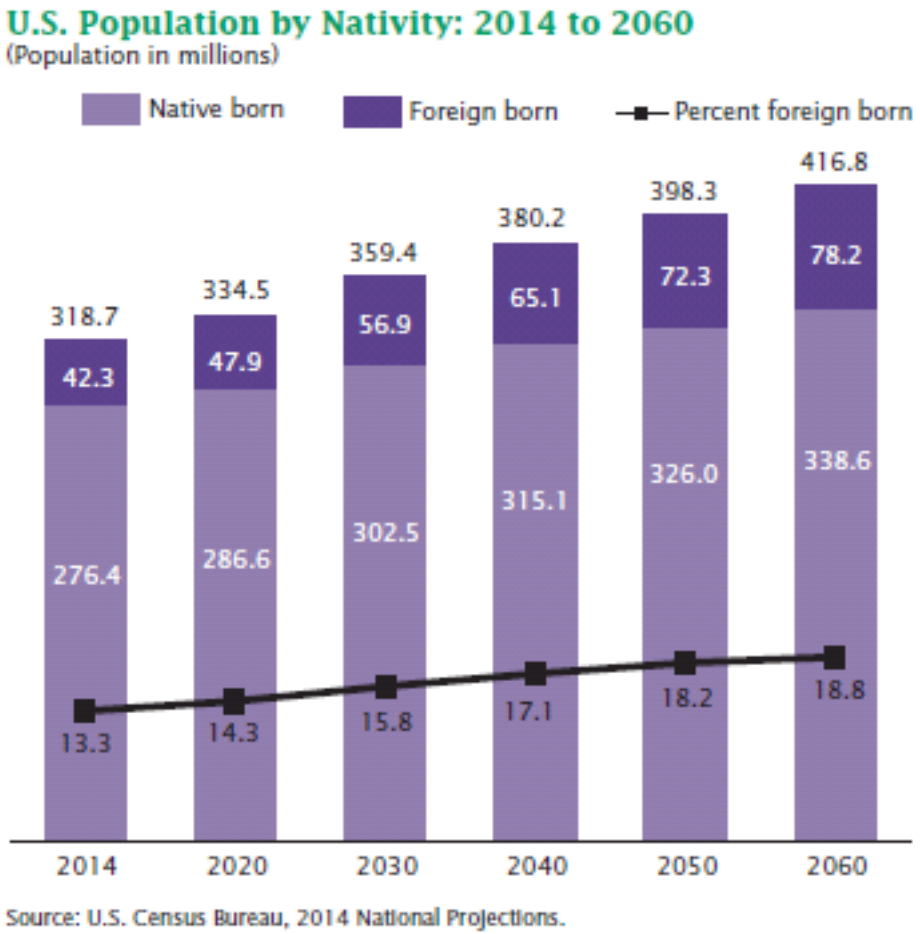
June 21, 2017

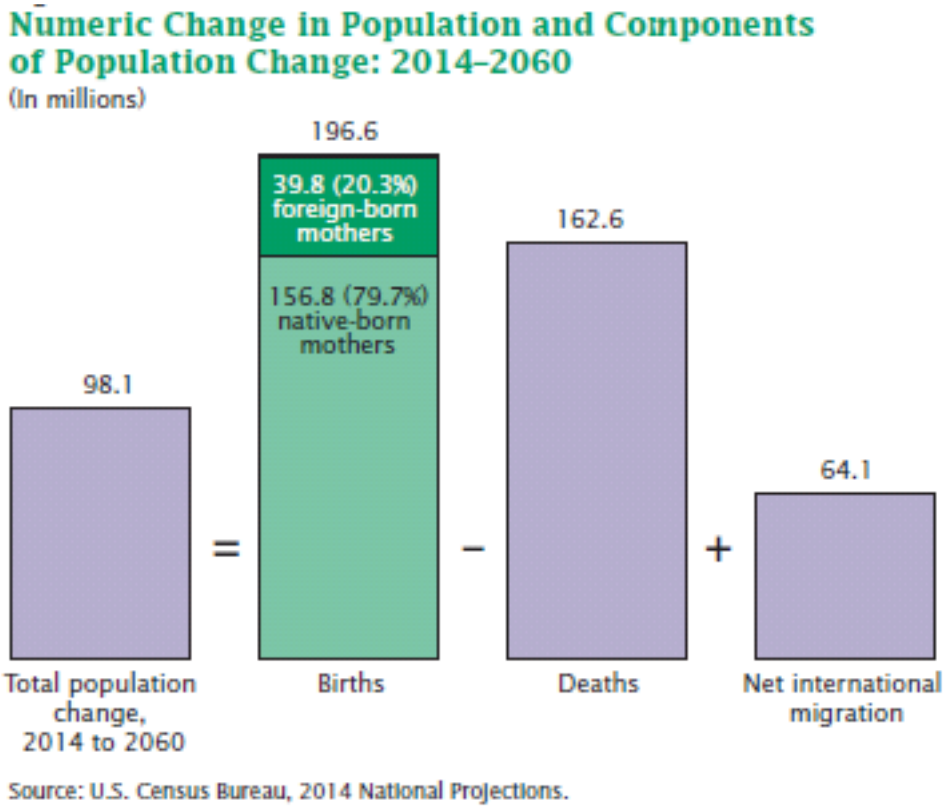
The Next 100 Million People in the U.S.

- US population growing at higher rate than rest of world's developed nations
- For transportation planning, national totals are not that interesting…
- Which sectors will be growing? (age, employment, income, etc.)
- Who will be living where?



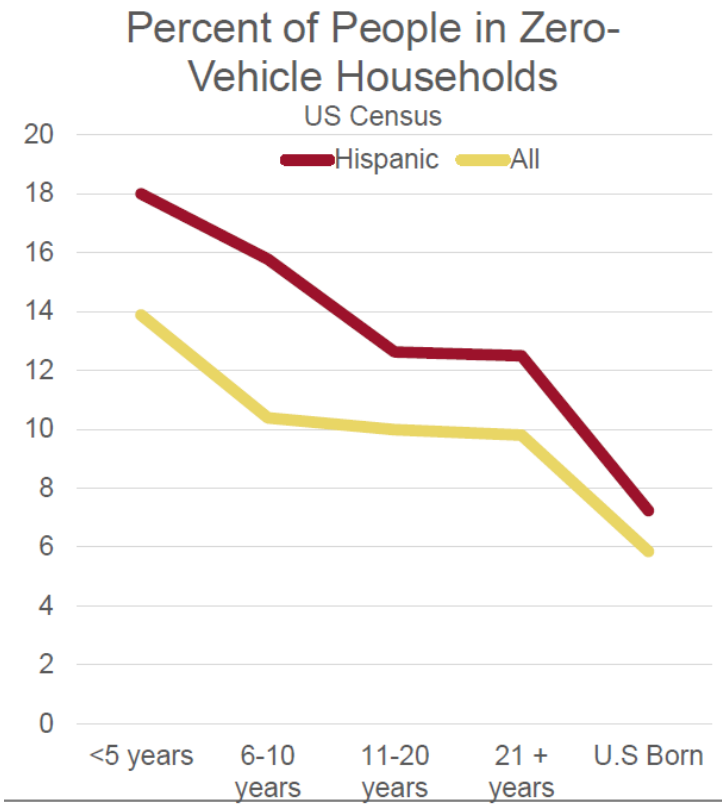
Sources of Population Growth

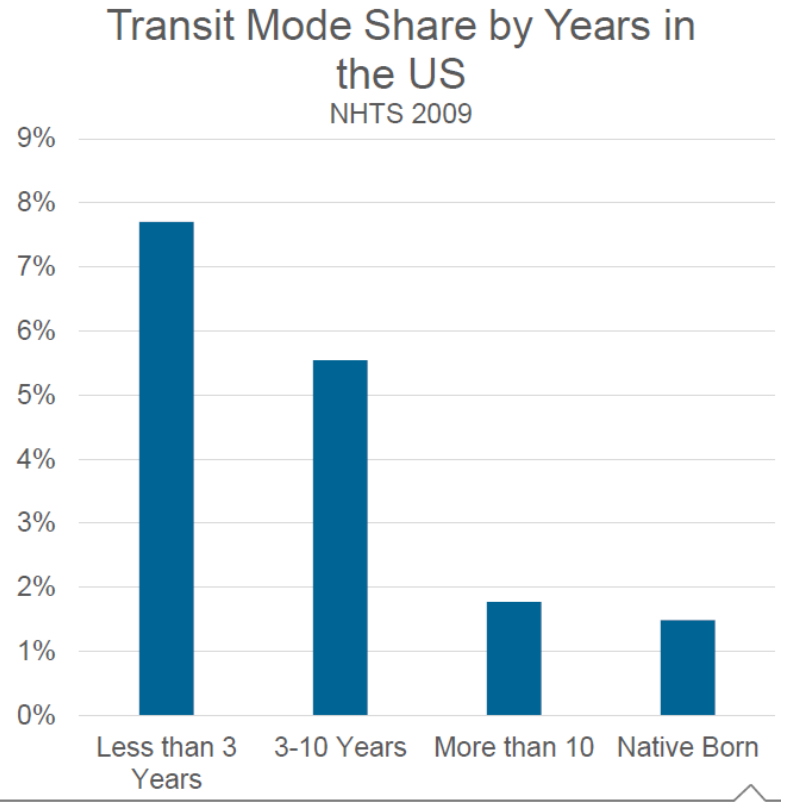
- Projected growth….
  - One third “natural”
  - Two thirds from net international migration
- But, immigration rates depend on a lot of things….
  - National economies
  - Climate change
  - Geopolitics



Acculturation Leads to More Auto Trips

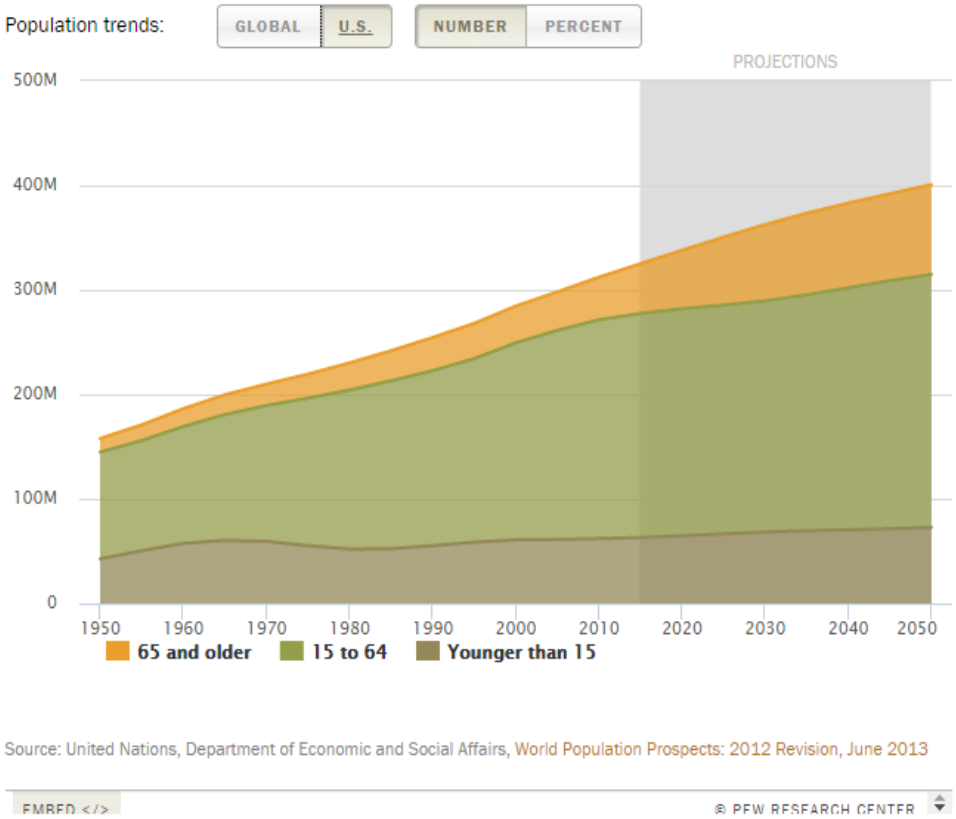
New immigrants are less likely to own a vehicle and more likely to use transit. "Acculturation" occurs within a decade or two.





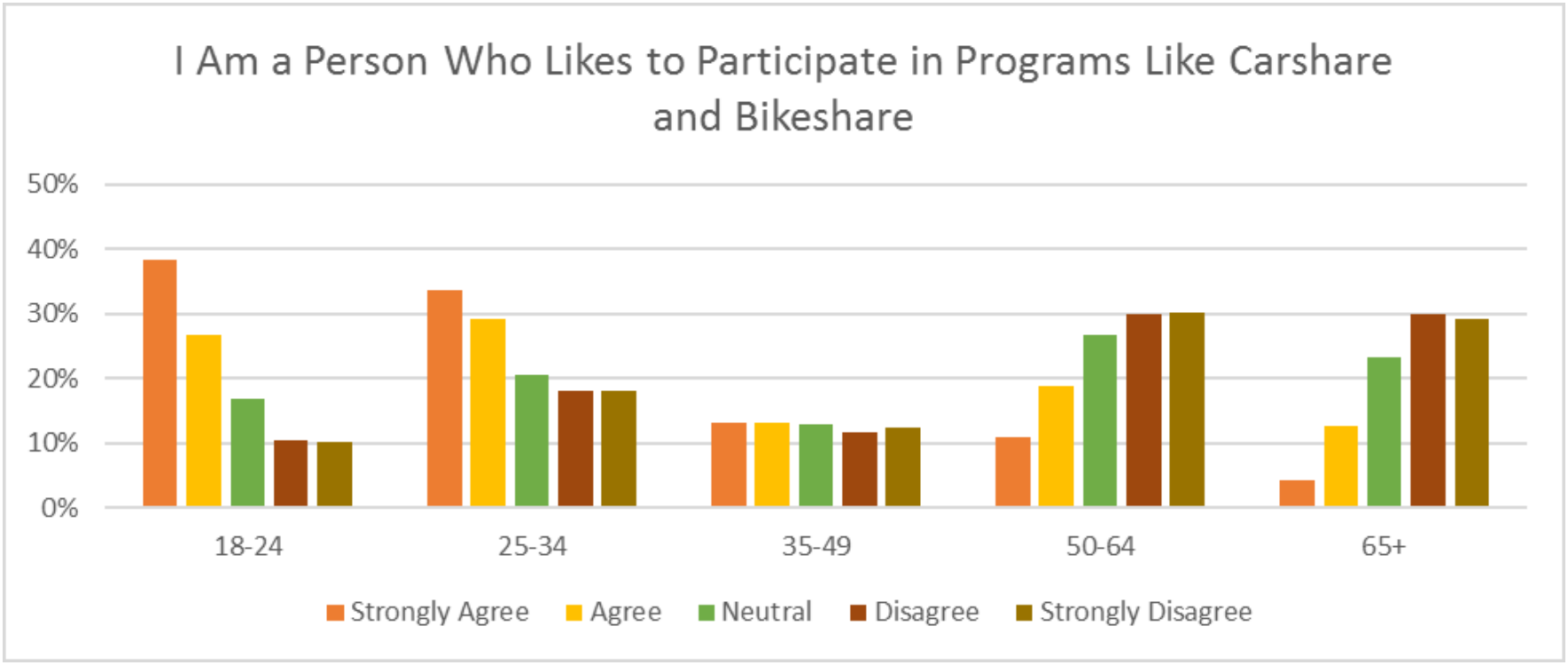
America is Graying

- Significant increase in population age 65+ due to Baby Boomers
- Levels off, until Millennials hit 65?



Traveler Attitudes Vary by Age

- Sharing modes preferred by younger people

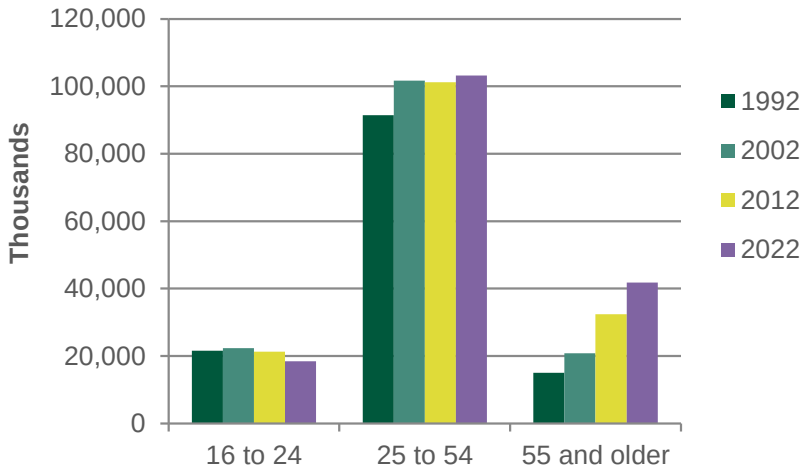


Source: RSG survey data

Changing American Workforce

- Labor-force participation rate declining, but average retirement age increasing
- Workforce is growing older and more diverse
- Future trends will depend on the supply of jobs and who will have the needed skills
- Could vary a great deal by region

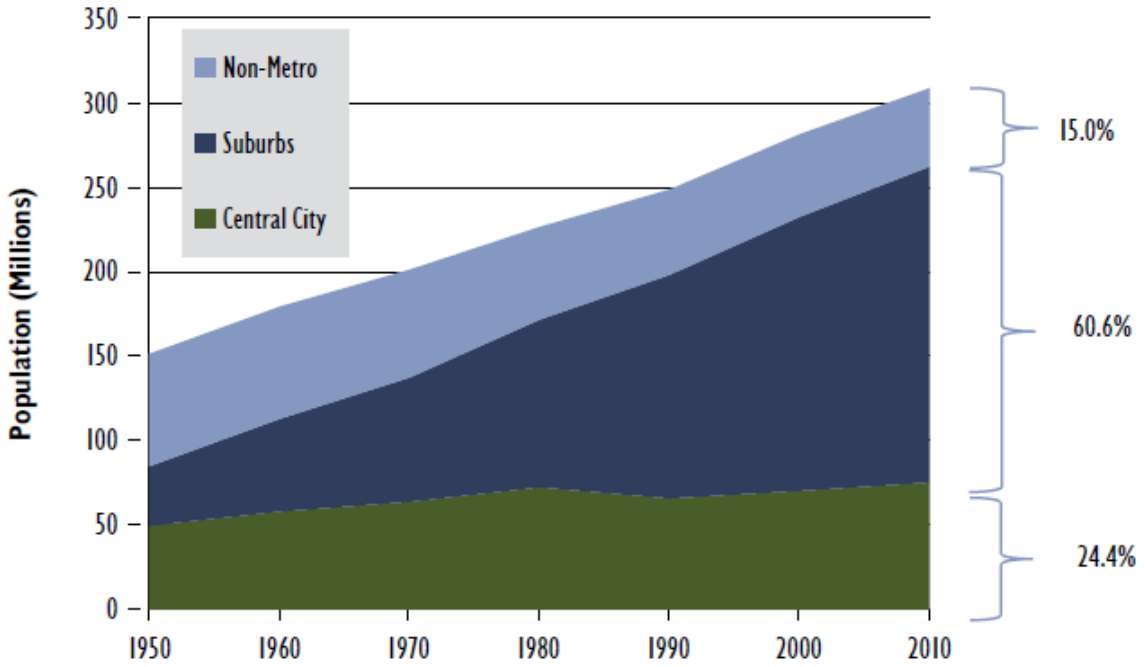
Civilian Labor Force by Age *(Millions)*



Source: BLS, Monthly Labor Review, December 2013;
Toossi, M. December 2013. "Labor Force Projections to 2022:
The Labor Force Participation Rate Continues to Fall." Monthly Labor Review. U.S. Department of Labor, Bureau of Labor Statistics. http://www.bls.gov/opub/mlr/2013/article/pdf/labor-force-projections-to-2022-the-labor-force-participation-rate-continues-to-fall.pdf

(Sub)urbanization of America

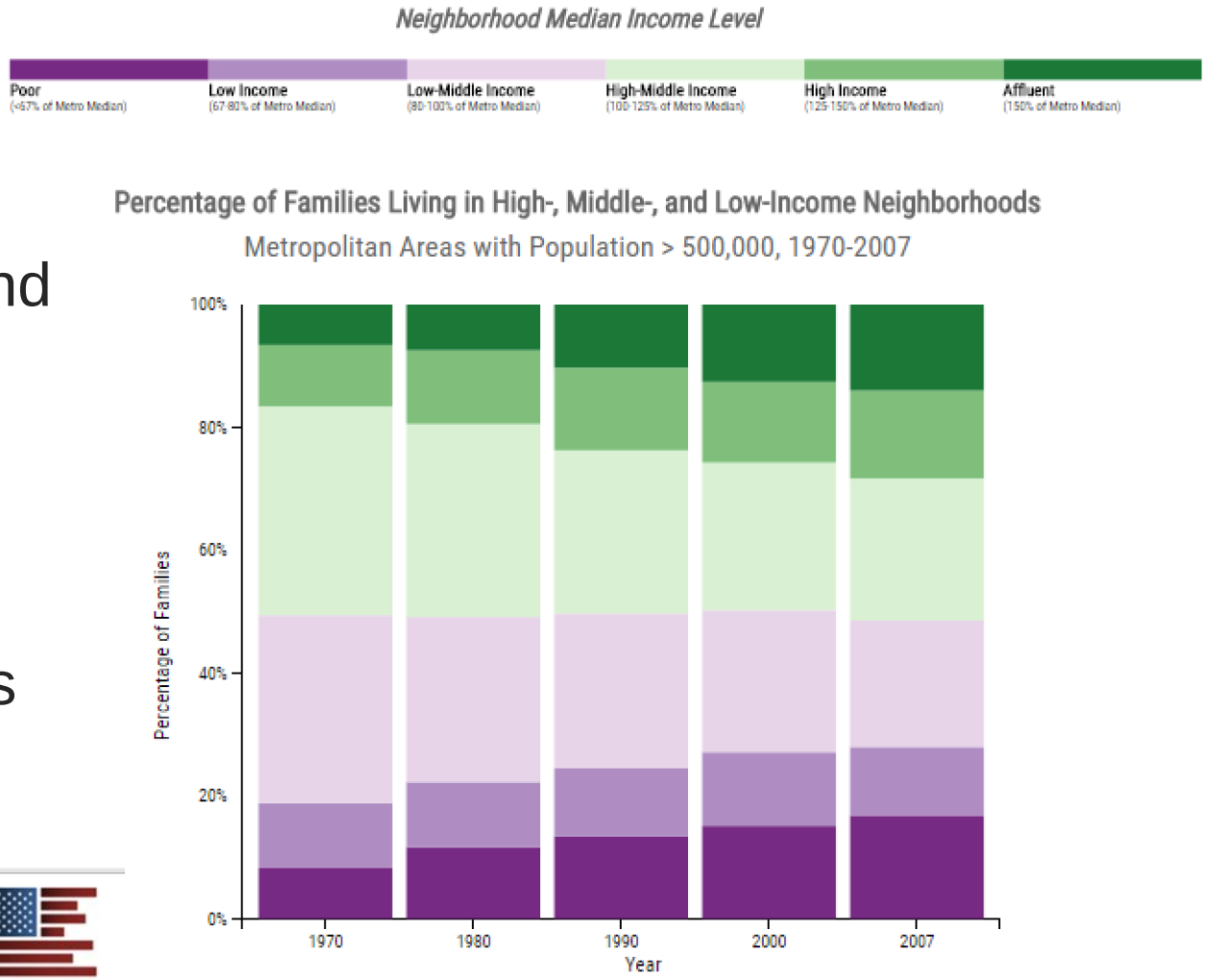
- Metro areas contain 85% of all population (~ 50% in 1950)
- Suburban areas contain about 71% of all Metro population (~25% in 1950)



Source: US Census Bureau, taken from Commuting in America IV Brief 4

Distribution of Income

- Increasing segregation and gentrification
- Fewer middle-class neighborhoods



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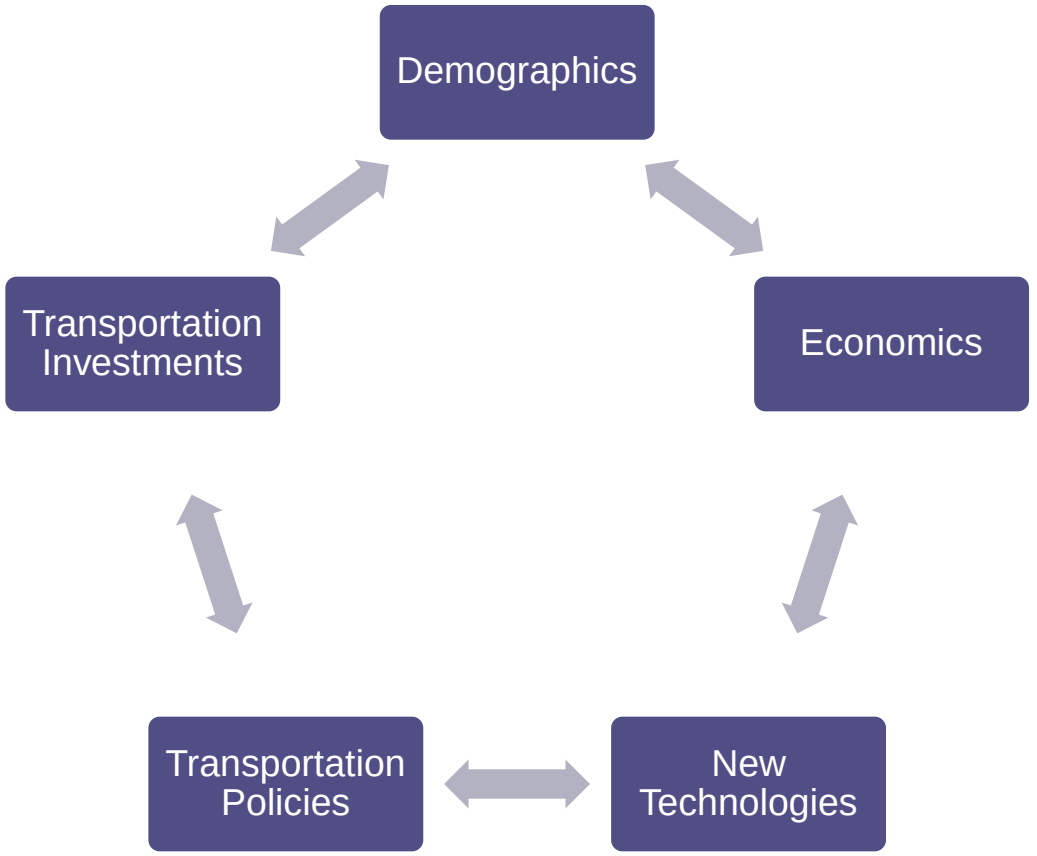
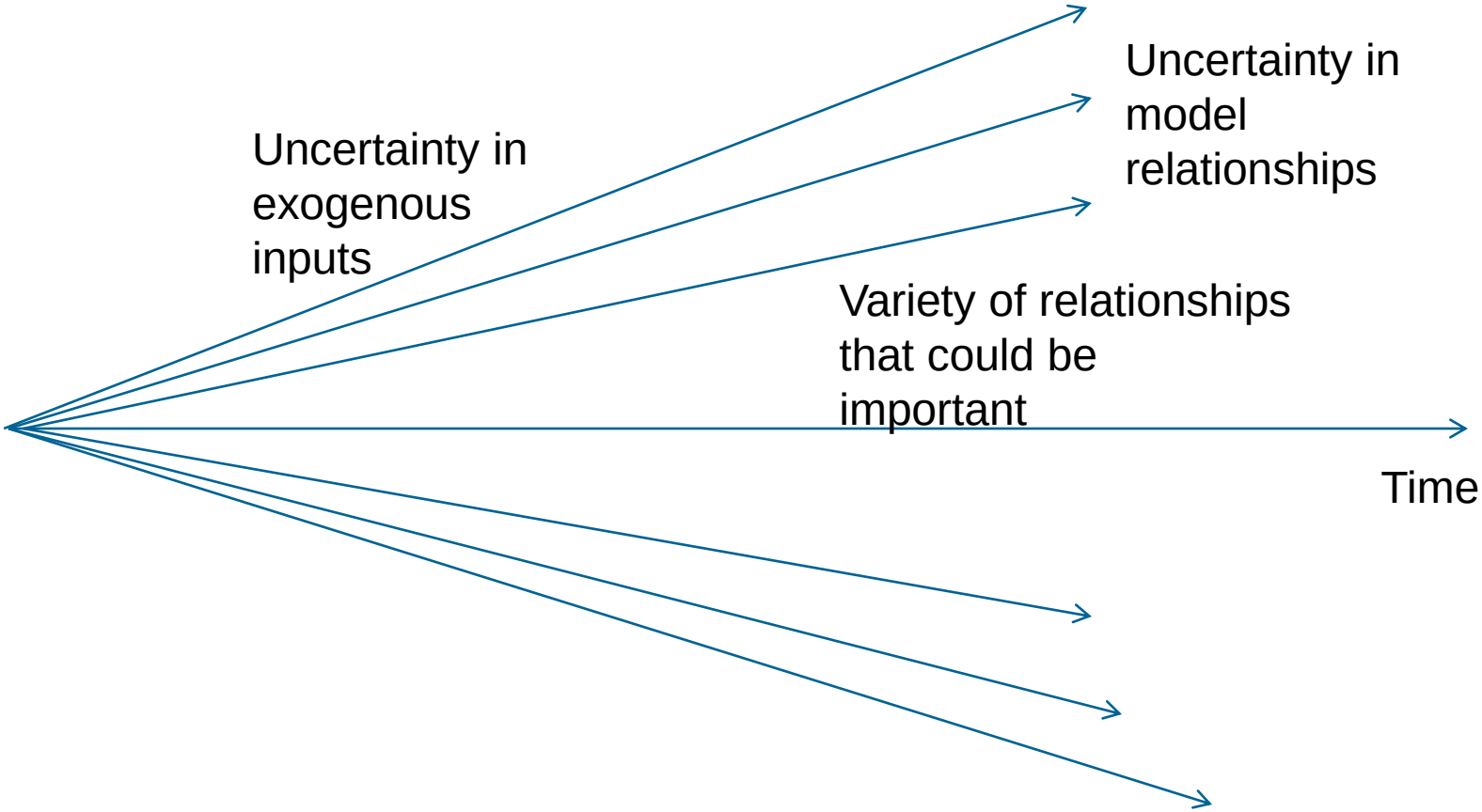
Addressing Uncertainty

Sources of Uncertainty

- Interactions between sources can be significant
- Uncertainty increases as precision in the inputs and forecasts decreases



Scenario Planning Addresses Uncertainty



Strategic Models Support Scenario Planning

- Focus on dynamics of change
- Limit spatial detail
- Represent interactions between forecast assumptions
- Identify range of plausible future assumptions
- Run all plausible combinations of future assumptions as scenarios
- Evaluate range of outcomes

Strategic Models Complement Detailed Regional Forecasting Models

Regional Model

- Spatial detail is very important
- Focus is on quantitative accuracy in input data and model parameters
- Running the model and analyzing results is time-intensive

Strategic Model

- Limit spatial detail, run model over many years
- Focus is on including a wide range of model relationships, and on “qualitative accuracy”
- Running the model is relatively quick and easy

Different from sketch planning tool – a different type of model

Impacts 2050

Dynamic Representation of Socio-Demographic & Travel Scenarios

Impacts 2050 Is . . .

- A strategic scenario analysis tool
- Based on a Systems Dynamics approach that represents the co-evolution of population, land use, employment, transport supply and travel behavior
- Scenarios representing divergent visions of alternative futures

Systems Dynamics Models

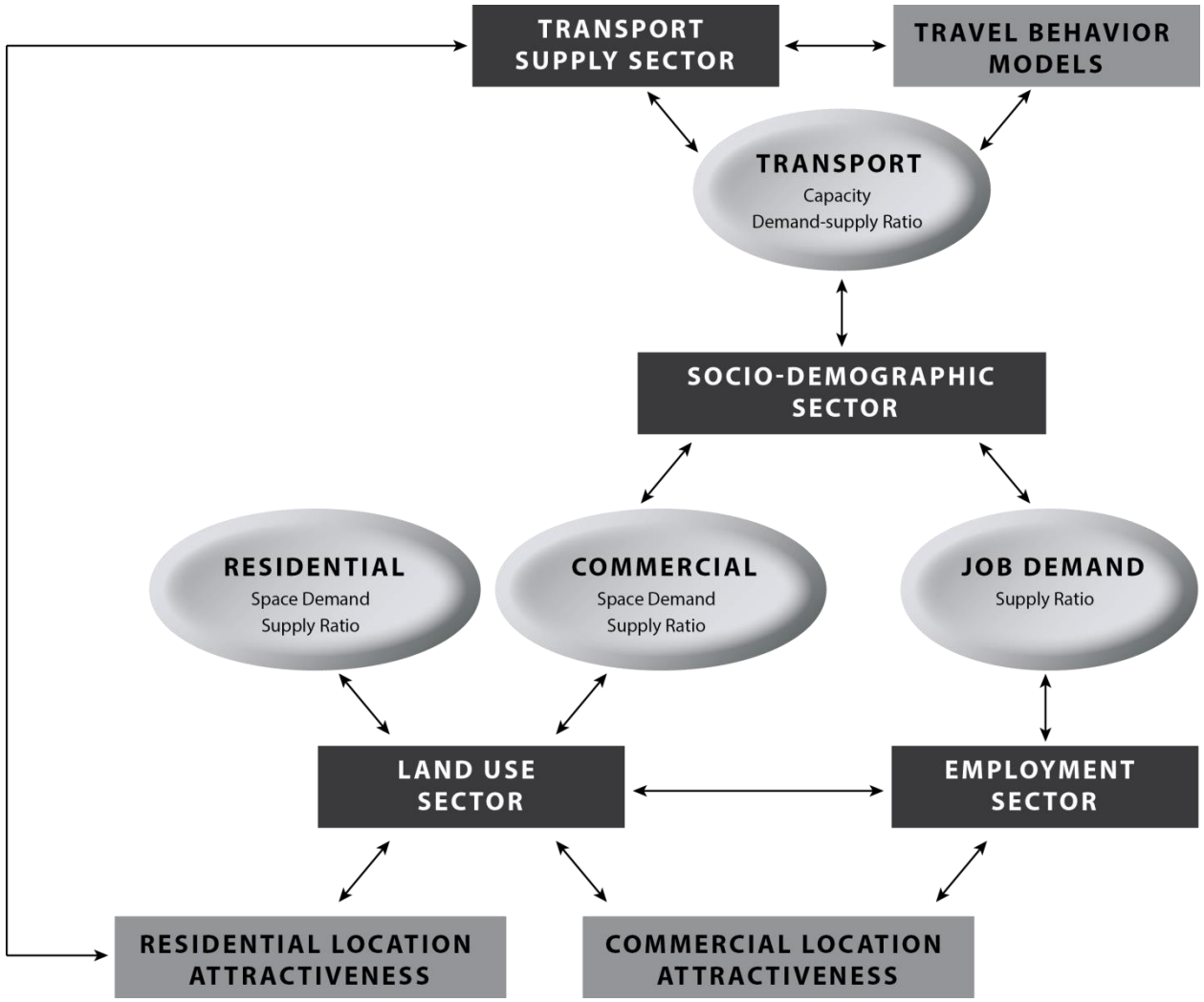
The focus is on relationships between variables **over time** *(rates of change).*

Behavior results from **feedback** between system components *(can be limiting effects or reinforcing cycles)*

Developed at MIT in 1960's for industrial systems (Forrester).

- "Limits to Growth" Club of Rome study (Meadows, *et al.* 1970's)
- Urban Dynamics (Forrester, 1970's)
- Many applications since in many different fields.

System Dynamics Model



Socio-Demographic Transition

- Basic rates derived from analysis of the Panel Survey on Income Dynamics (PSID) 2003-2009
- Rates for:
  - Birth
  - Death
  - “Marriage”
  - “Divorce”
  - Leave nest/empty nest
  - Enter/leave workforce
  - Enter/leave income group
- The user can apply scenario-specific multipliers on these rates

Rates vary by combination of:
- Age group
- Household type
- Race/acculturation

Socio-Demographic Migration

- Three types of migration:
  - Foreign (from / to other countries)
  - Domestic (from / to other regions of the US)
  - Regional (from / to other area types in the region)
- Base rates are derived from Census data, and modified by:
  - Residential attractiveness – function of demand vs. supply of jobs, housing, road capacity
  - User-defined scenario effects

Other feedbacks…

The Employment Sector

- A very simple model of job creation, loss & migration

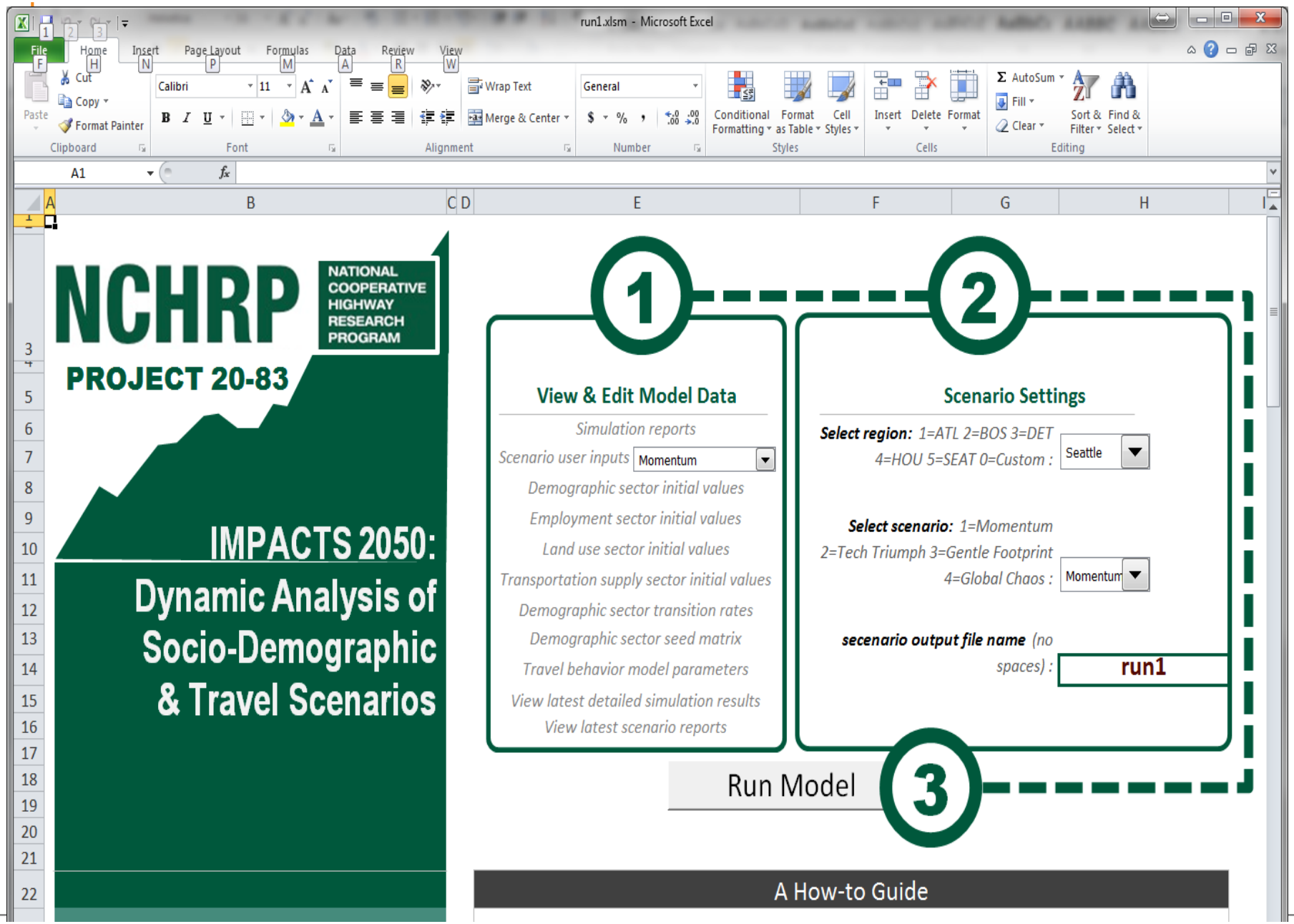
The Land Use Sector

- A very simple model of transition of land between residential, non-residential, undeveloped & protected

The Transportation Supply Sector

- A very simple model of capacity addition and retirement for roads and transit

These feedbacks can be turned “on” or “off to investigate the difference between unconstrained and constrained demand, and between responsive and unresponsive supply


run1.xlsm - Microsoft Excel
NCHRP
NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM
PROJECT 20-83
IMPACTS 2050:
Dynamic Analysis of Socio-Demographic & Travel Scenarios
1
View & Edit Model Data
Simulation reports
Scenario user inputs
Momentum
Demographic sector initial values
Employment sector initial values
Land use sector initial values
Transportation supply sector initial values
Demographic sector transition rates
Demographic sector seed matrix
Travel behavior model parameters
View latest detailed simulation results
View latest scenario reports
2
Scenario Settings
Select region: 1=ATL 2=BOS 3=DET 4=HOU 5=SEAT 0=Custom :
Seattle
Select scenario: 1=Momentum 2=Tech Triumph 3=Gentle Footprint 4=Global Chaos :
Momentum
secenario output file name (no spaces) :
run1
Run Model
3
A How-to Guide

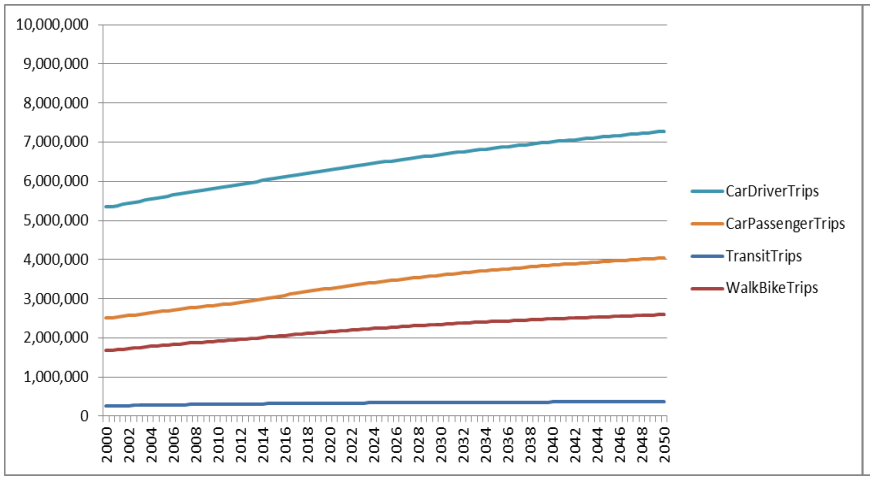
Pre-Programmed Scenarios

Based on Delphi panel deliberation

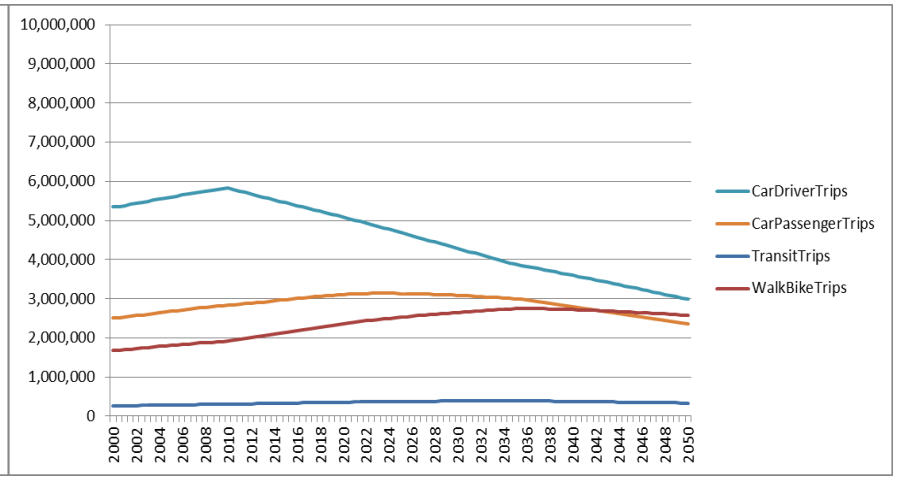
- **Momentum**
  - Change is based on population dynamics
- **Technology Triumphs**
  - Innovations mitigate difficult challenges
- **Gentle Footprint**
  - Public consciousness and political shifting toward taking serious action to curb climate change
- **Global Chaos**
  - Distressing new normal – financial instability, climate change impacts, isolationism

Trips by Mode

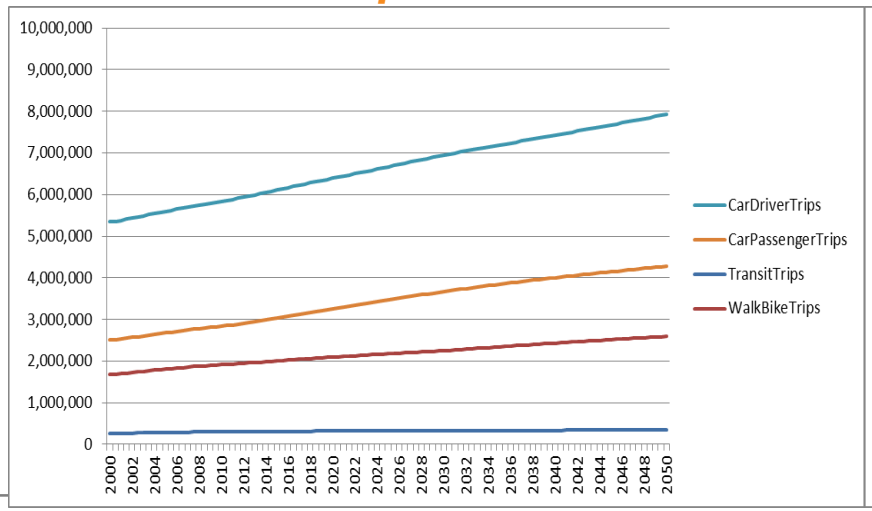
Momentum



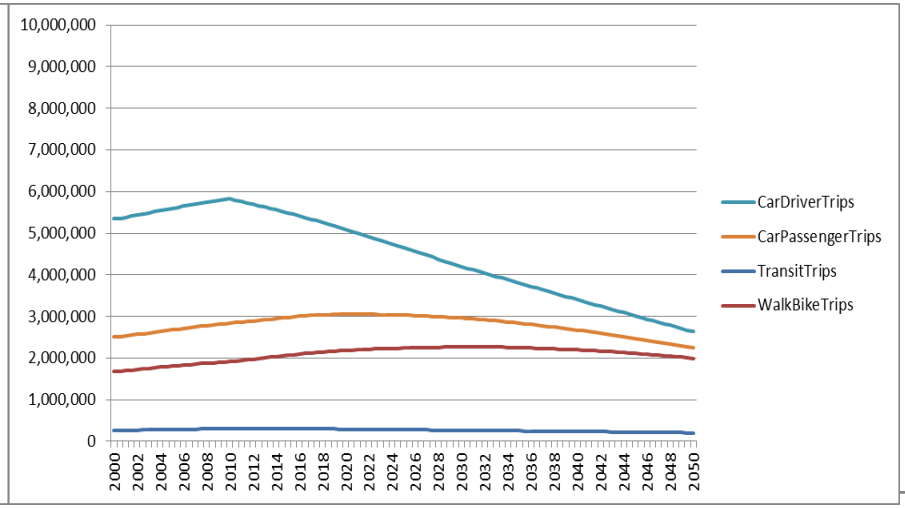
Gentle Footprint



Tech Triumphs



Global Chaos



For more information……

- The project report, scenario tool and user's guide is available for download from TRB…

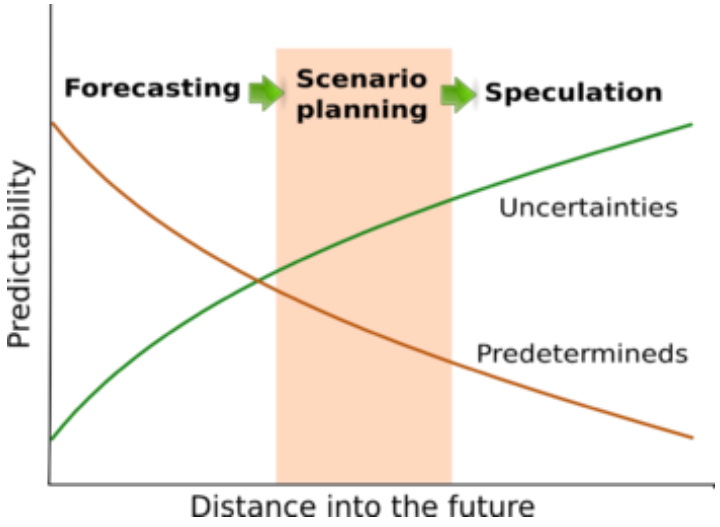
  http://www.trb.org/Main/Blurbs/171200.aspx

- Follow-up project to work with an MPO and DOT to implement the tool with local staff.

Rapid Policy Assessment Tool (RPAT)

Rapid Policy Assessment Tool (RPAT)

- **RPAT** is a tool for scenario planning.
- Scenario planning is a data-driven process that seeks to explore many potential futures.
- RPAT is fast and easy to apply.



Strategic Planning

Strategic models

- Supports strategic (not project) planning efforts
- Provides data that bridge the gap between regional visioning and strategic plans

Why is it strategic?

- Considers many possible scenarios
- Combines high-level analysis of transportation supply with transportation policies and demand characteristics.

Quickly compare changes in travel demand, transportation policies and transportation supply.

Travel Demand

- Changes in population demographics
- Changes in personal income
- Changes in firm size or industry
- Auto and light truck proportions by year
- Induced demand – short term impacts

Transportation Policy

- Vehicle miles traveled charges
- Parking pricing programs
- Intelligent transportation system strategies for freeways and arterials
- Demand management policies (carpool, transit pass programs)

Transportation Supply

- Amount of regional transit service
- Amount of freeway and arterial capacity

Built Environment and Land Use

Classify growth by area type and development type

	Area Type			
Development Type	Urban Core	Close in Community	Suburban	Rural
Residential	✓	✓	✓	
Employment	✓	✓	✓	
Mixed-Use	✓	✓	✓	
Transit Oriented Development	✓	✓	✓	
Rural/ Greenfield				✓

Performance Metrics

- Evaluate scenarios across a range of performance metrics
  - Community Impacts
  - Travel Impacts
  - Environmental and Energy Impacts
  - Financial and Economic Impacts
  - Location Impacts
- Compare multiple scenarios at a time graphically to quickly assess results

Household and Firm Synthesis

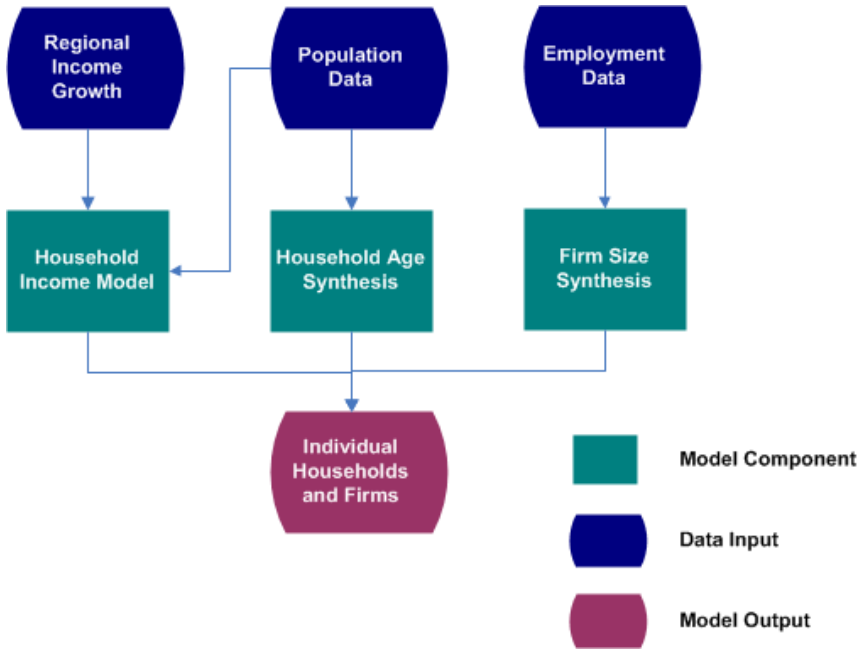
- Households
  - Persons by Age

  from Census data
  - HH Income

  from Bureau of Economic Analysis data
- Firms
  - Employees
  - Industry

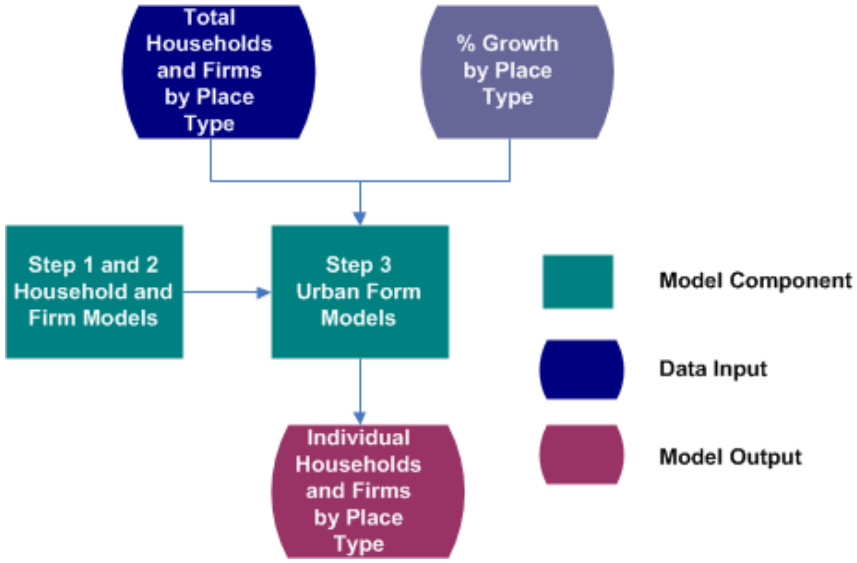
  from County Business Pattern data

- Data can be updated from local sources



Urban Form Models

- Predicts Place Types
  - Area Types (4)
  - Development Patterns (4)
- Based on Households with
  - Working age persons
  - Children
  - Seniors
- Adjusted to fit regional totals



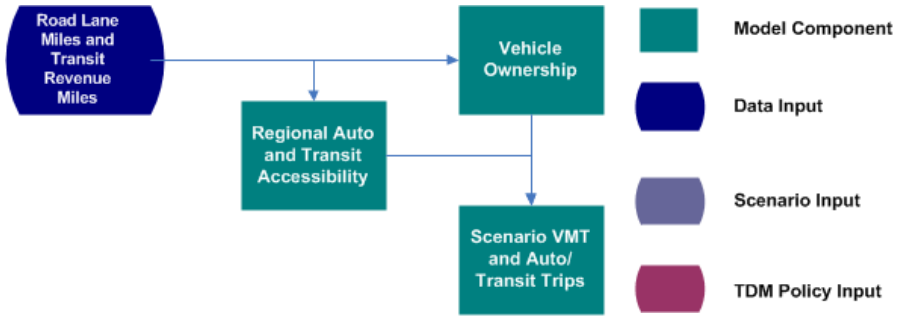
Accessibility

INPUTS

- Freeway Lane Miles
- Transit Revenue Miles (annual bus and rail revenue miles per capita)

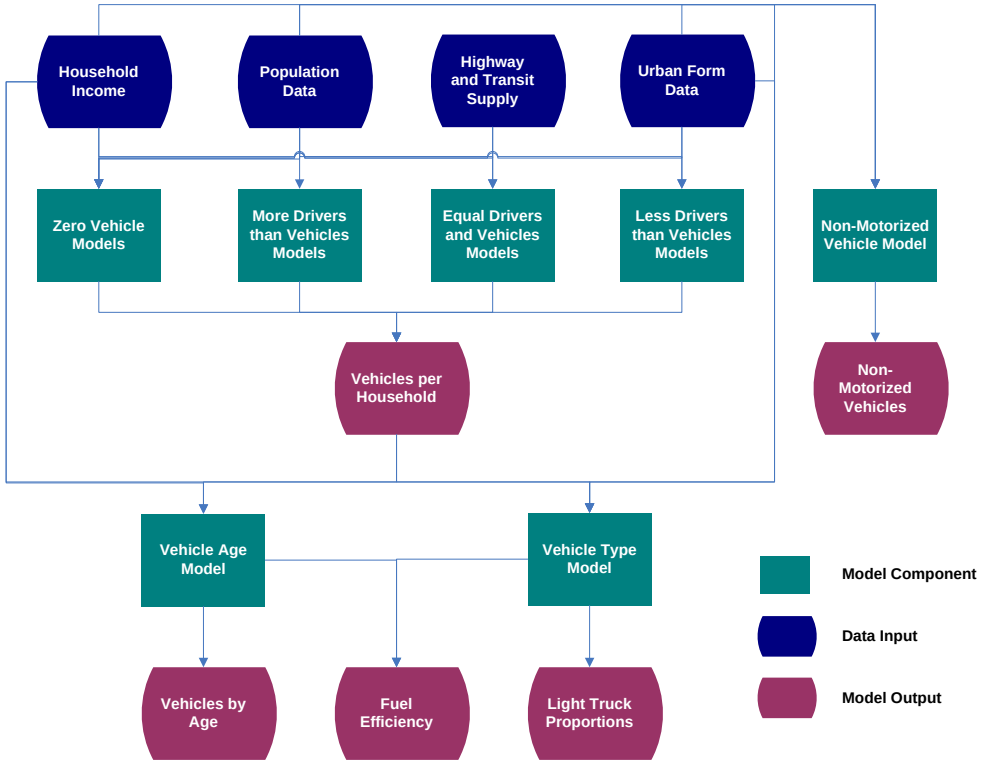
OUTPUTS

- Freeway Lane Miles per Person
- Transit Revenue Miles per Person



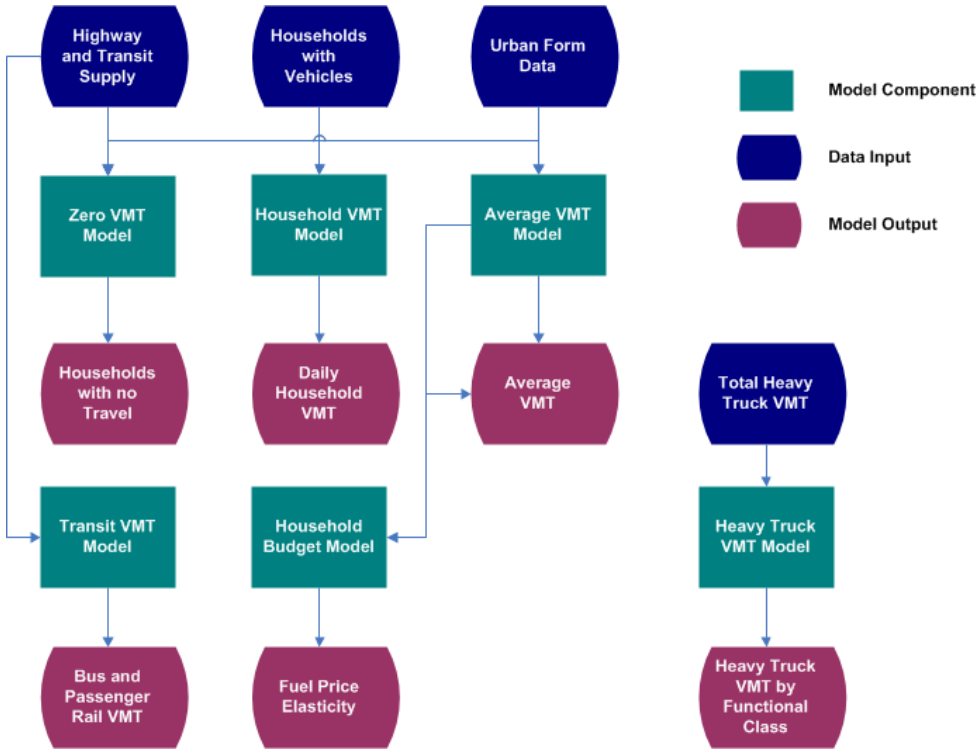
Vehicle Models

- **Predicts number of vehicle for each household**
  - Autos
  - Bikes
  - Light Trucks
- **Predicts vehicles by age/ fuel efficiency**
- **Based on**
  - Number of persons of driving age
  - Elderly persons
  - Household income
  - Population density
  - Freeway and transit supply
  - Urban mixed-use area



Travel Demand Models

- **Predicts Vehicle Miles Traveled for each Household**
  - Autos and Light Trucks
  - Heavy Trucks
  - Buses and Passenger Rail
- **Based on**
  - Household income
  - Population density
  - Number of household vehicles
  - Freeway and transit supply
  - Driving age persons in household
  - Elderly persons in household
  - Mixed use development



Congestion and Induced Demand

Congestion is represented in three ways

1. VMT is allocated to freeways and arterials by congestion level
2. Speeds and fuel economies are calculated for freeways and arterials
3. Congestion in local areas is estimated from increased activity

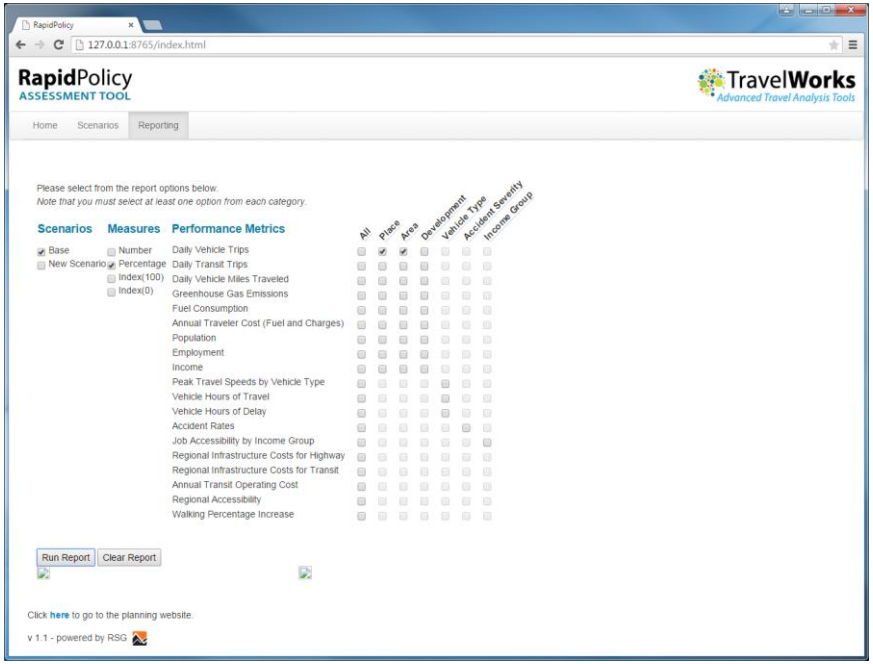
Congestion is part of a feedback loop between changes in each scenario and induced demand.

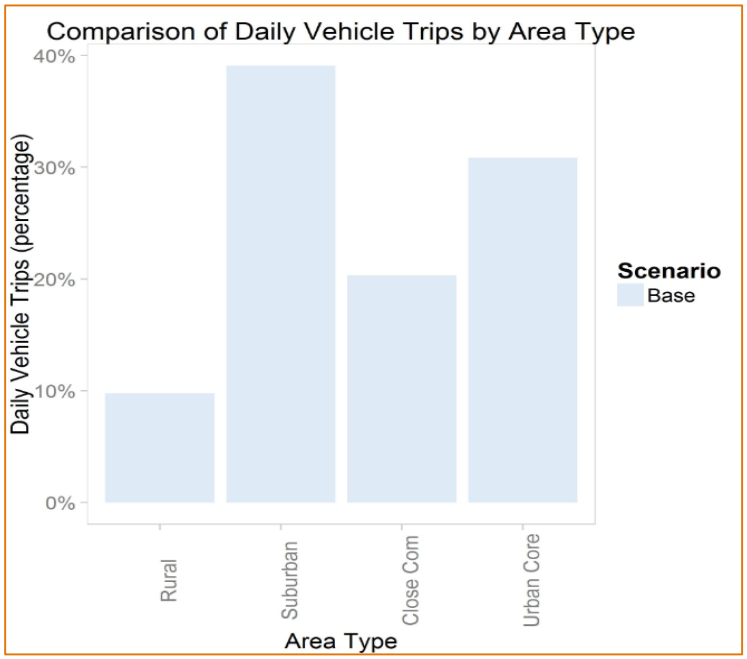
Induced demand is defined as additional demand resulting from adding transportation supply

- Short Term – Induced Demand
  - Changes in road supply, function of speed
  - Potential mode and route shift
- Long Term – Induced Growth
  - Changes in growth patterns resulting from changes in travel patterns

Outputs

Selecting Performance Metrics and Producing Reports





For more information……

- RPAT software, research and user's guide is available at

  https://planningtools.transportation.org/551/rapid-policy-analysis-tool.html

- There are resources and a technical forum on the RPAT website as well.

Contacts

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