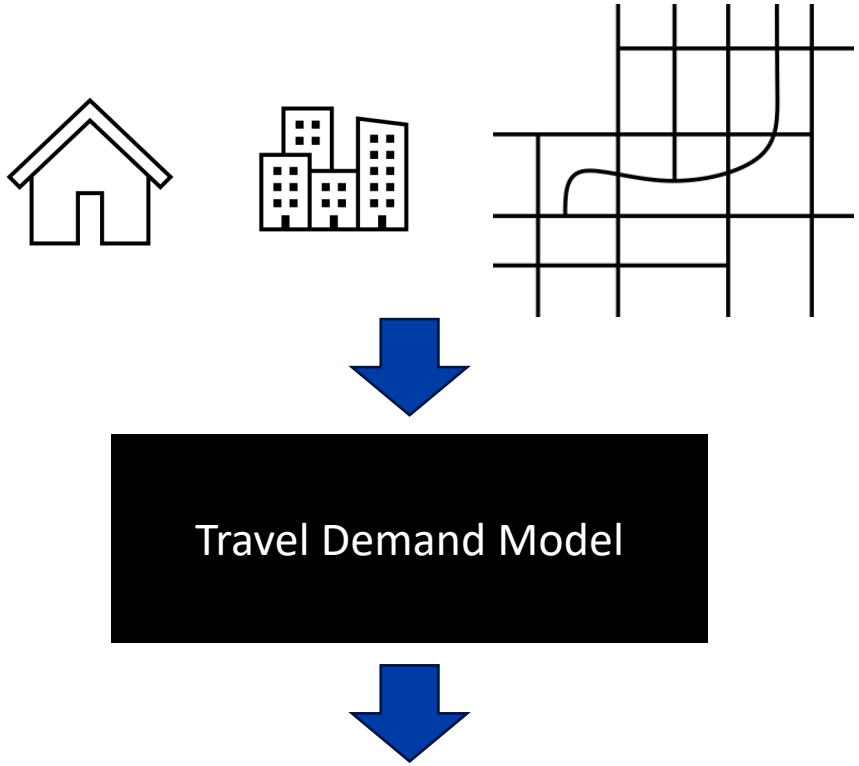
A Comparative Illustration of Trip- and Activity-Based Modelling Techniques

Hayden Atchley

Committee: Greg Macfarlane (chair)
Grant Schultz
Gustavious Williams

BYU Civil & Construction Engineering
IRA A. FULTON COLLEGE OF ENGINEERING

Travel Demand Models



2 main types:

- Trip-based
  - Aggregate
  - Trips happen
- Activity-based
  - Synthetic population
  - People decide to make trips

Advantages of Activity-Based Models

Activity-based models thought to be superior:

- Information on individuals
- Trip chaining (tours)
- Conceptually closer to reality
- More detailed analysis
  - Equity analyses

Difficulties with Activity-Based Models

- Computational complexity
- Complicated design
- Lack of interoperability
- Staff training

- Things may be changing
  - Open-source models (ActivitySim)
  - General maturity/familiarity

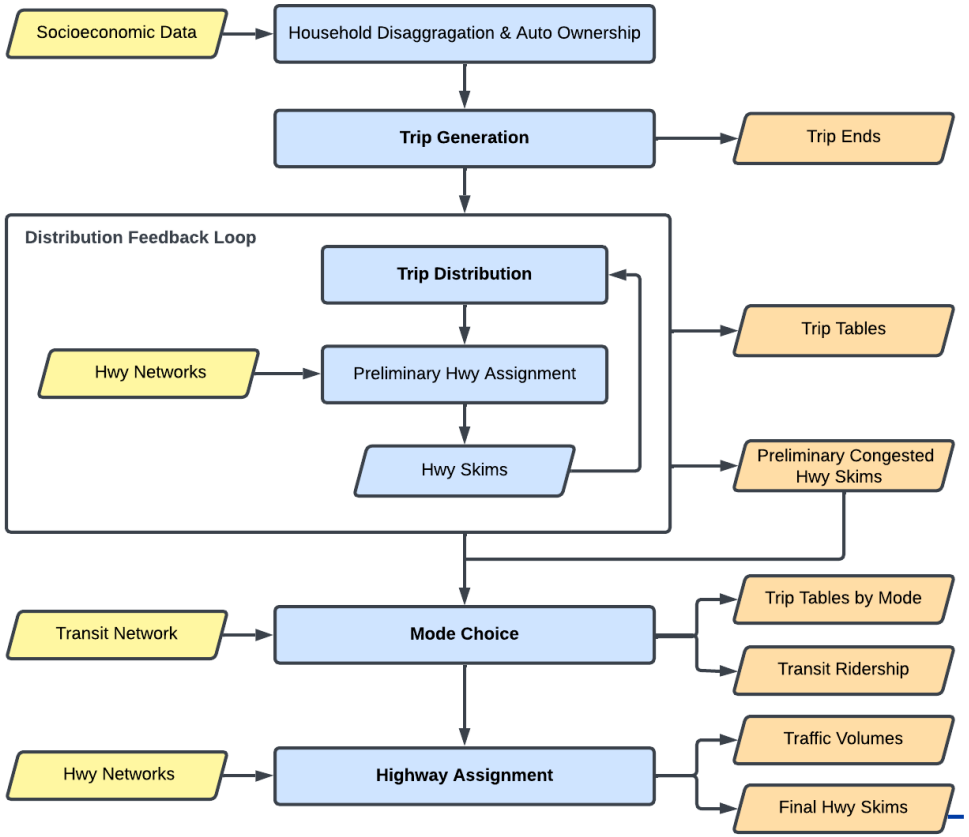
Research Gap

- Comparisons focus on theoretical benefits
- Cited difficulties may be outdated
- Practicality of activity-based models
  - Ease of use
  - Types of analyses
  - Ease of interpretation

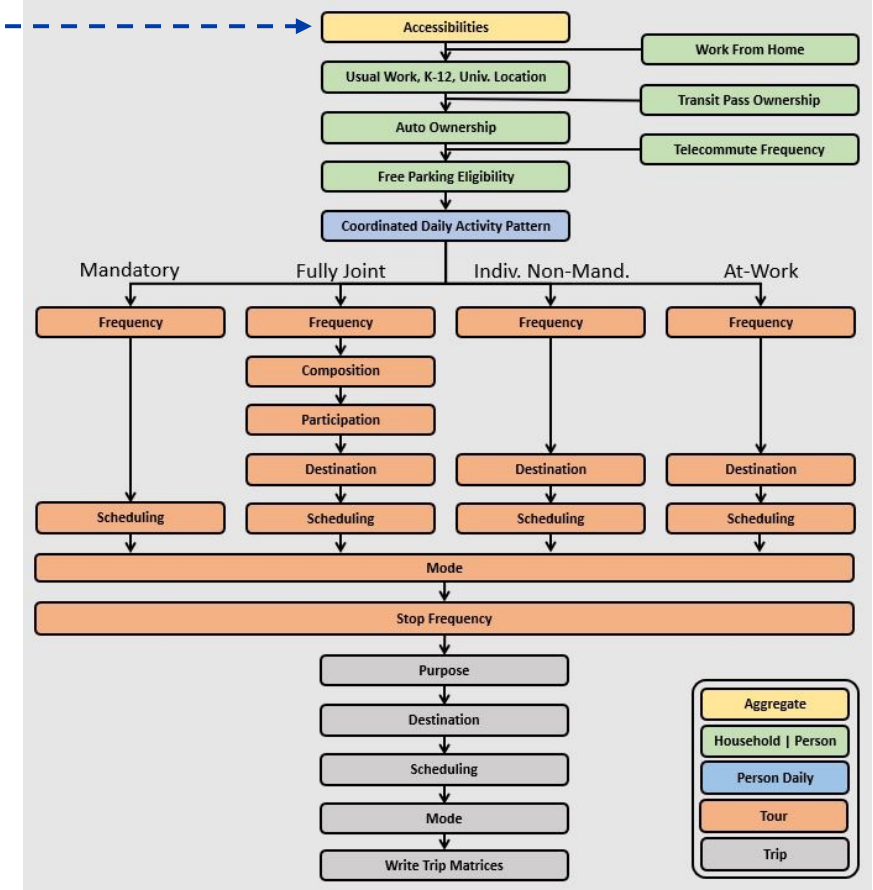
Two Models

BYU Civil & Construction Engineering

WFRC Model (trip-based)

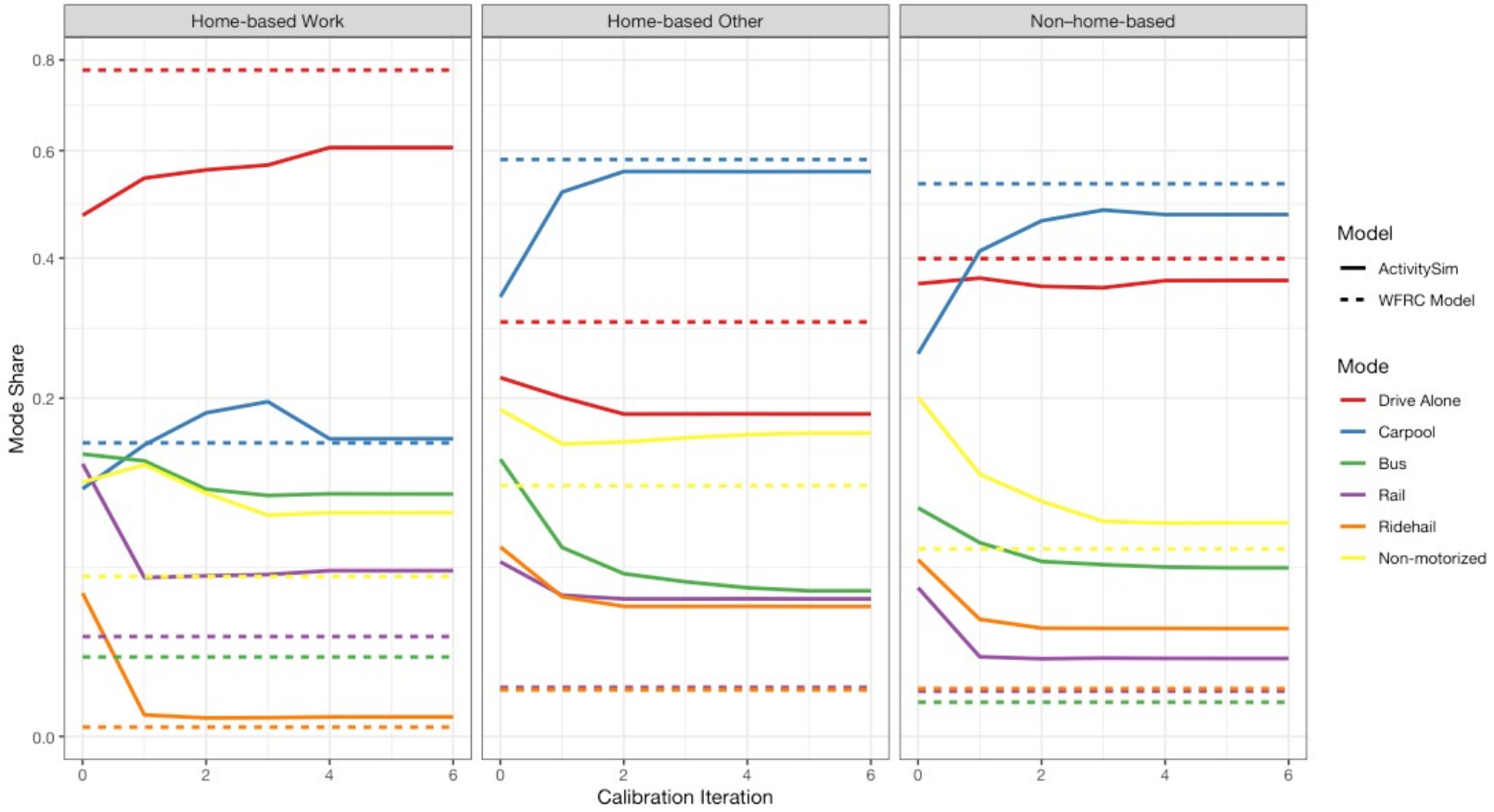


ActivitySim (activity-based)



Model Calibration

- Population
  - Household size
  - Income
- Trips
  - Mode choice
  - Remote work
  - Trip length distribution



Scenarios Overview

Land Use Scenario	Transit Scenario	Remote Work Scenario
• New development at old Draper prison site • Projected 2050 data for The Point development	• Increase frequency and speeds of FrontRunner • New Frontrunner stations • Based on WFRC 2050 plan	• Higher work-from-home and telecommute • Calibrated to WFRC 2050 projections

Land Use Scenario

New development (The Point)

WFRC Model:

- Change land use data for The Point area
  - Match 2050 data
    - 7,430 new households
    - 22,200 new jobs

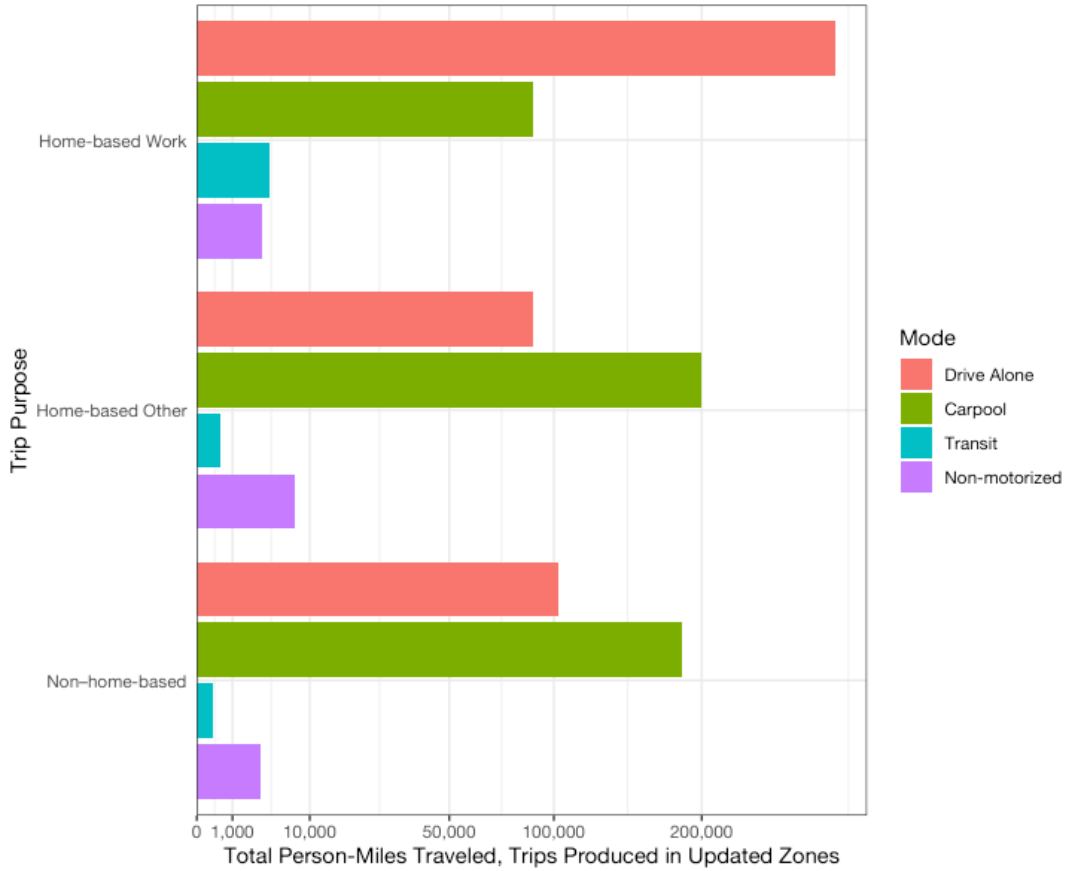
ActivitySim:

- New synthetic population for The Point area
  - Population modeled on Gateway area (SLC)
  - Joined with baseline scenario population

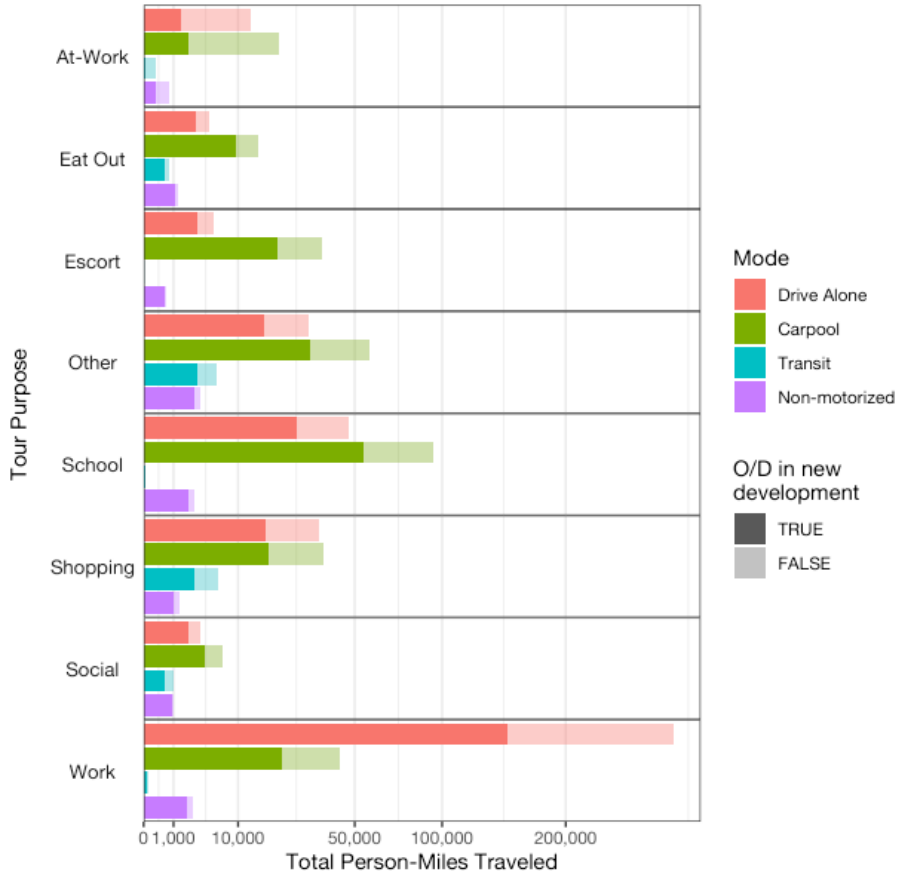
New Trips

BYU Civil & Construction Engineering

WFRC Model

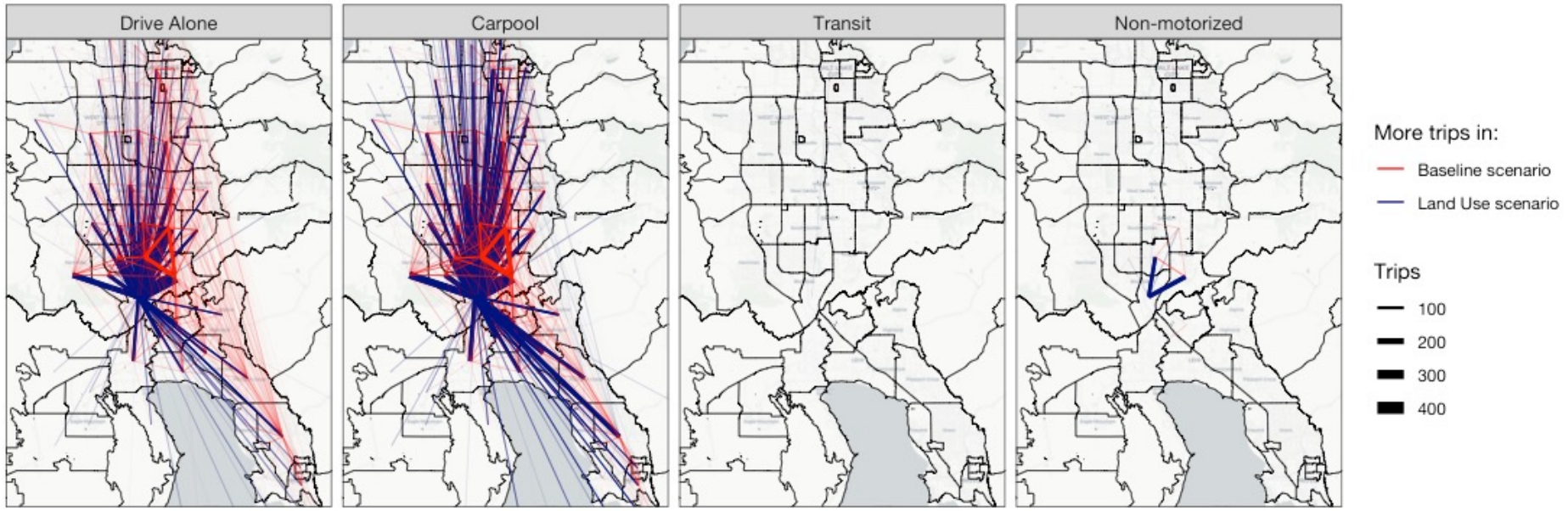


ActivitySim

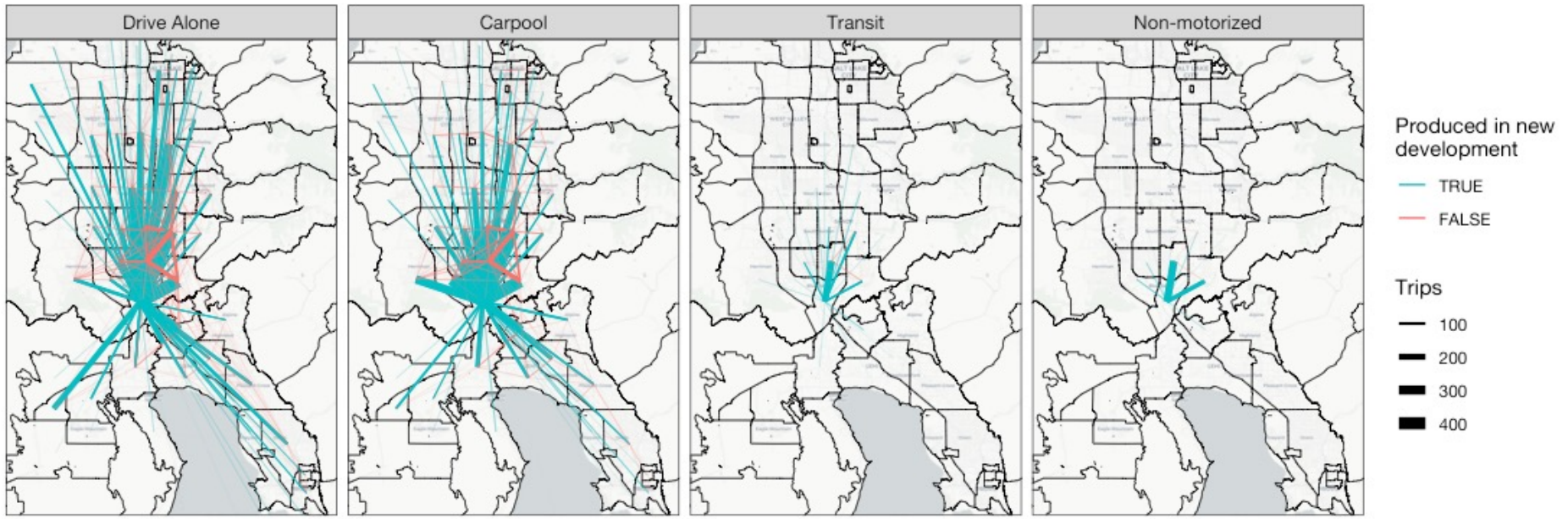


WFRC: Non–Home-Based Trips

BYU Civil & Construction Engineering



ActivitySim: New Resident Trips



Transit Scenario

Improved FrontRunner

WFRC Model:

- Doubled train frequency
  - Peak: 2 → 4 trains per hour
  - Off-peak: 1 → 2 trains per hour
- Used future speed and track extensions
  - Additional stations in Vineyard, Springville, Spanish Fork, and Payson

ActivitySim

- New transit skims from WFRC model

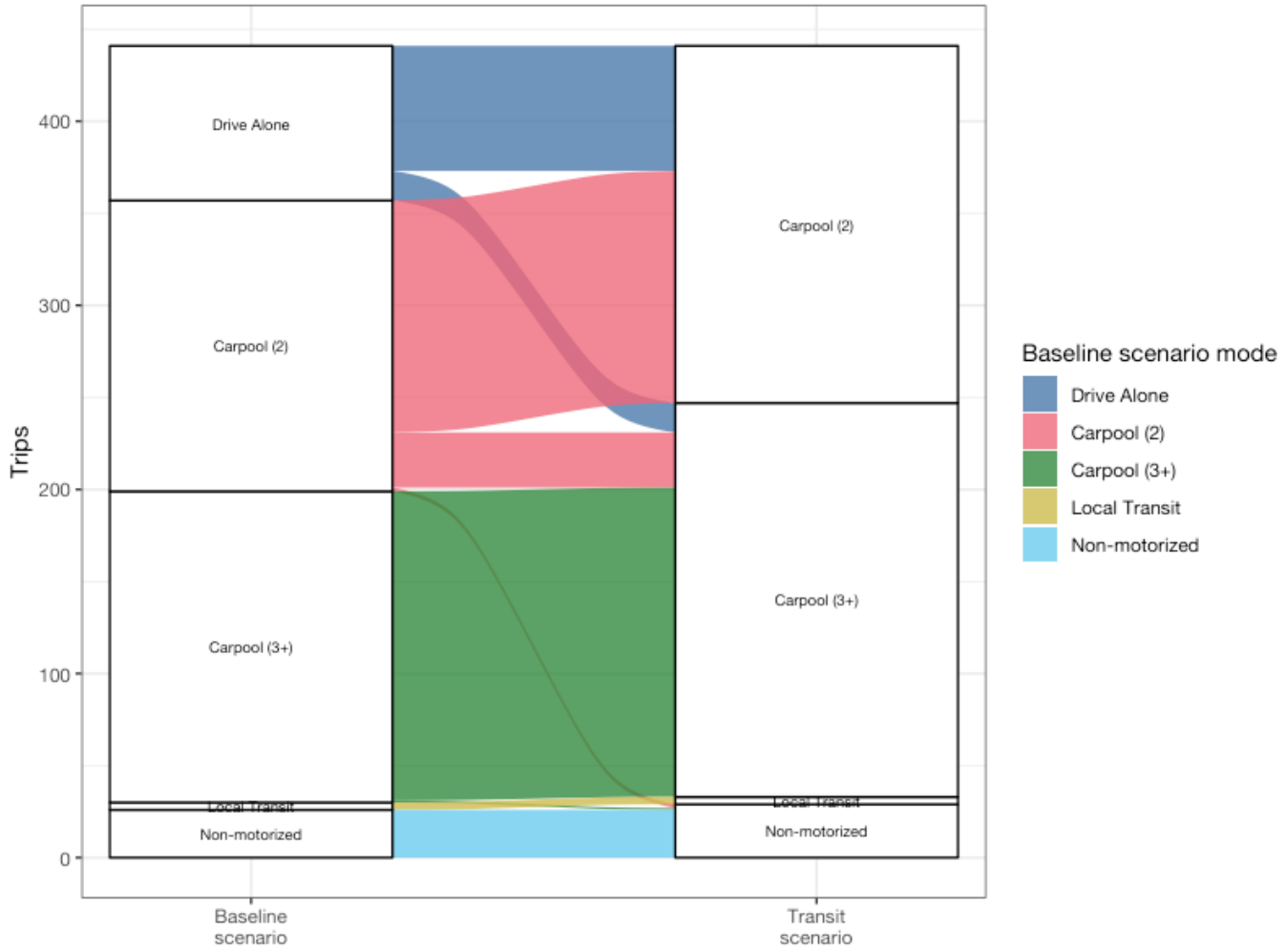
Change in Mode Split

BYU Civil & Construction Engineering

		WFRC Model			ActivitySim		
Purpose	Mode	Baseline Trips	Transit[1] Trips	Change	Baseline Trips	Transit[1] Trips	Change
Home-based Work	Drive Alone	1328609	1326191	-0.2%	1012180	1010565	-0.2%
	Carpool	257783	256654	-0.4%	258459	256550	-0.7%
	Local Transit	37935	36494	-3.8%	232222	233426	0.5%
	Commuter Rail	10821	15891	46.9%	19846	22265	12.2%
	Ridehail	—	—	—	1108	1099	-0.8%
	Non-motorized	76506	76396	-0.1%	145957	145845	-0.1%
Home-based Other	Drive Alone	1394415	1394095	0.0%	700133	698809	-0.2%
	Carpool	2702277	2701039	0.0%	2148429	2145135	-0.2%
	Local Transit	33168	32583	-1.8%	195062	194649	-0.2%
	Commuter Rail	4180	6332	51.5%	81094	87337	7.7%
	Ridehail	—	—	—	113624	113538	-0.1%
	Non-motorized	510143	510103	0.0%	613134	611996	-0.2%
Non–home-based	Drive Alone	951561	951407	0.0%	716143	714854	-0.2%
	Carpool	1273279	1272977	0.0%	938056	936408	-0.2%
	Local Transit	12213	12068	-1.2%	107526	108395	0.8%
	Commuter Rail	1243	1806	45.3%	12317	13344	8.3%
	Ridehail	—	—	—	40092	40061	-0.1%
	Non-motorized	146404	146409	0.0%	156819	156587	-0.1%

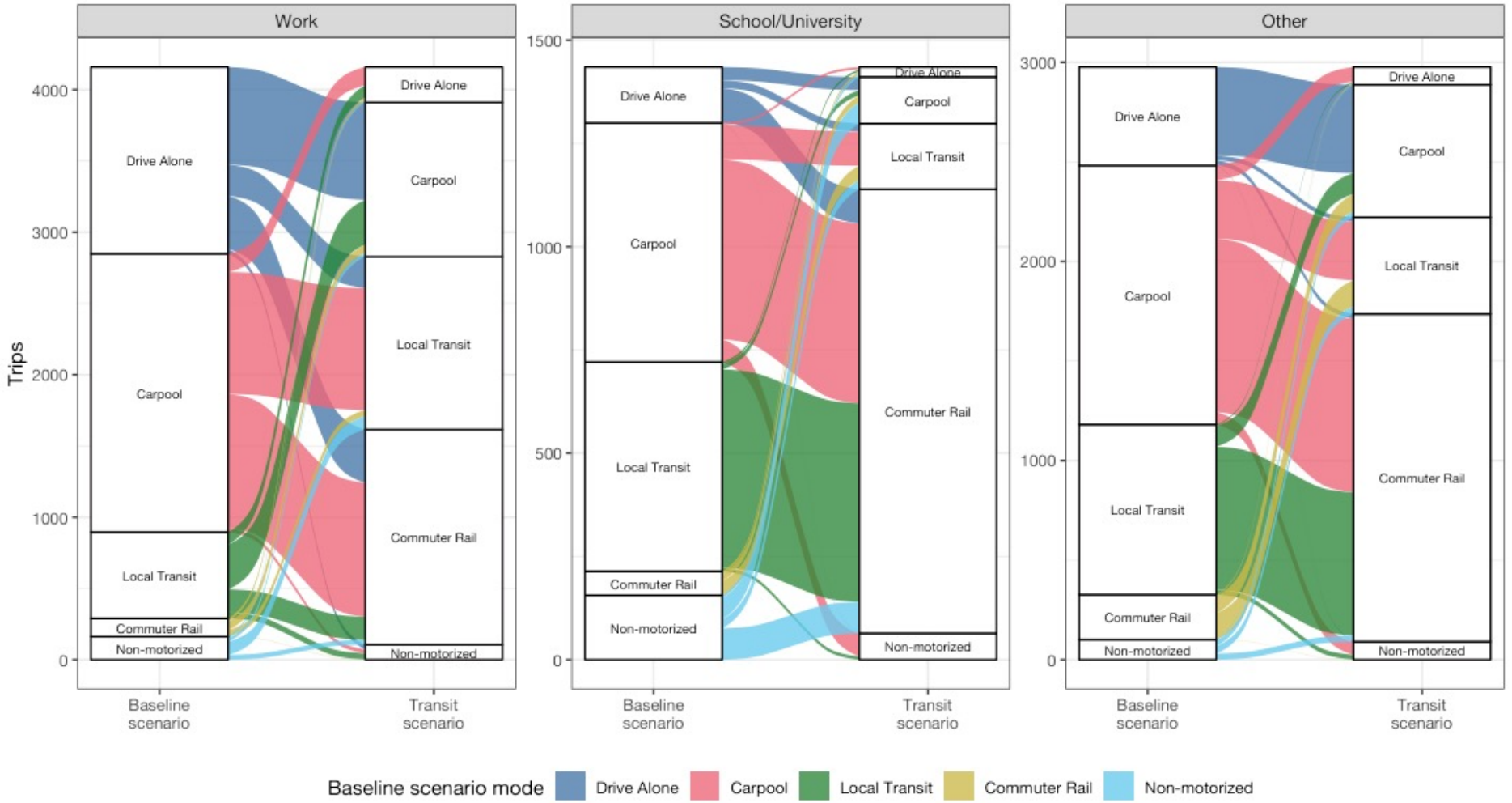
[1] "Transit" here refers to the Transit scenario, not the mode of travel

At-Work Mode Switching



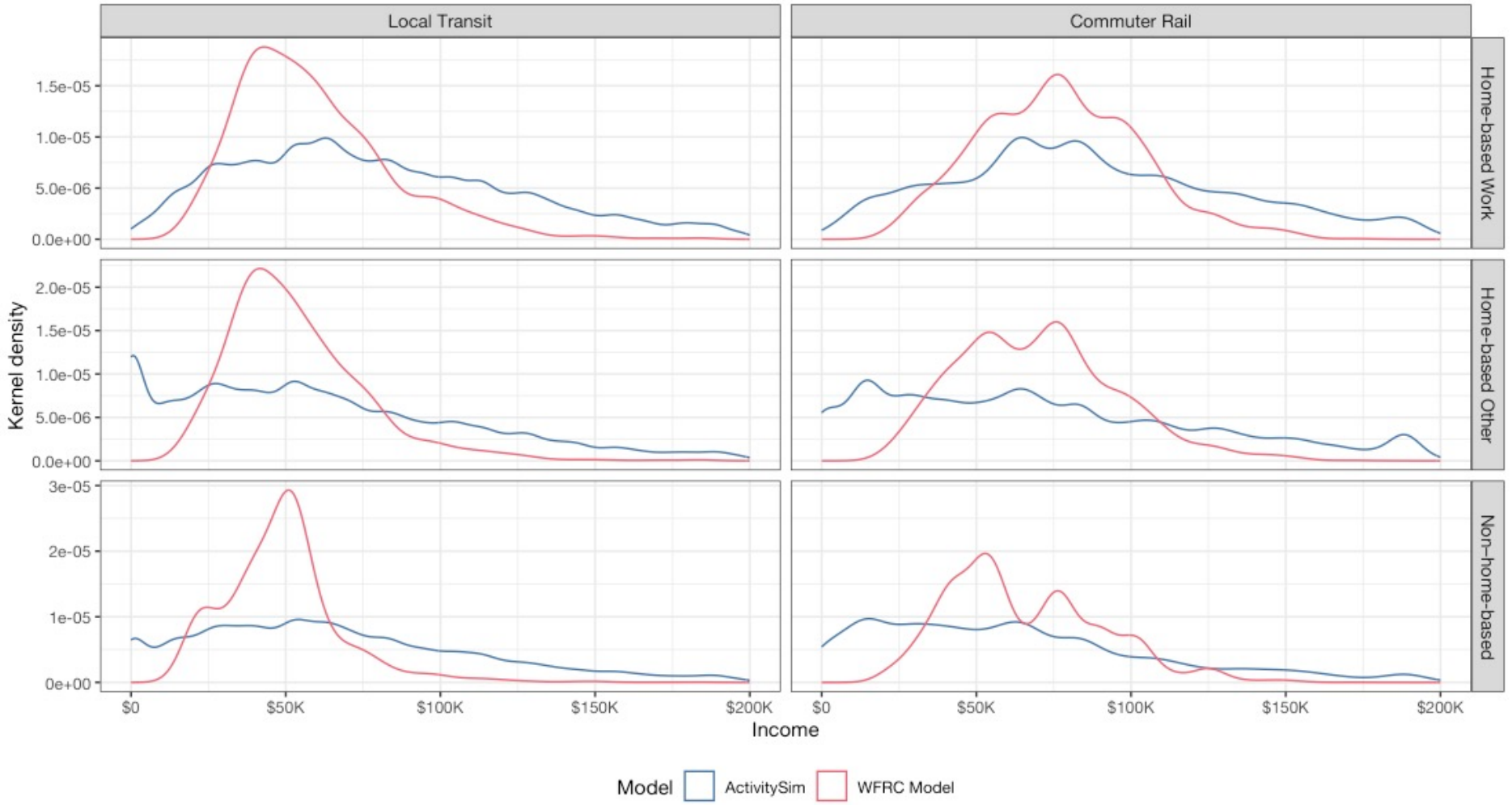
Daily Mode Switching

BYU Civil & Construction Engineering



Transit Riders Income Distribution

BYU Civil & Construction Engineering



Remote Work Scenario

Increased remote work rates

WFRC Model:

- Used 2050 remote work rates
  - Work-from-home average increase from 2.9% to 3.5%
  - Telecommute average increase from 3.7% to 10.2%

ActivitySim:

- Recalibrated remote work to WFRC 2050 rates
  - Work-from-home matches WFRC data
  - Telecommute matches % by job type

Remote Work Considerations

- “Rebound effect”
  - Fewer work trips may cause more non-work trips
- Trip length
  - Longer commute more likely to work remotely
- Household structure
  - Single- vs. dual-parent
  - Age of children

ActivitySim Work-From-Home Model

Description	Coefficient
Constant for Working from home	0.438
Full time worker (1 if true)	-0.812
Female Worker	-0.347
Female worker with a Preschool Child in Household	0.573
Accessibility to workplaces of the home mgra	-0.140
Presence of Non Working Adult in the Household	-0.372
Education Level Bachelors or higher degree	0.285
Household income Less than 30K	-0.393
Age Group - Less than 35 years	-0.574
Age Group - 35 yrs to 45 yrs	0.000
Age Group - 45 yrs to 55 yrs	0.214
Age Group - 55 yrs to 65 yrs	0.452
Age Group - Older than 65yrs	0.584

Change in Number of Trips

BYU Civil & Construction Engineering

		WFRC Model Trips			ActivitySim Trips		
Purpose	Mode	Baseline	Remote Work Scenario	Change	Baseline	Remote Work Scenario	Change
Home-based Work	Drive Alone	1328609	1244451	-6.3%	1012180	950306	-6.1%
	Carpool	257805	238669	-7.4%	258459	242497	-6.2%
	Transit	48752	44977	-7.7%	253176	237881	-6.0%
	Non-motorized	76506	71063	-7.1%	145957	137684	-5.7%
Home-based Other	Drive Alone	1394415	1395196	0.1%	700133	709957	1.4%
	Carpool	2702272	2702625	0.0%	2148429	2171566	1.1%
	Transit	37346	37359	0.0%	389780	396815	1.8%
	Non-motorized	510143	508869	-0.2%	613134	617480	0.7%
Non–home-based	Drive Alone	951561	938653	-1.4%	716143	687935	-3.9%
	Carpool	1273317	1254548	-1.5%	938056	922662	-1.6%
	Transit	13453	13199	-1.9%	159935	158366	-1.0%
	Non-motorized	146404	144126	-1.6%	156819	152688	-2.6%

WFRC: Trip Count vs Length

BYU Civil & Construction Engineering

		Trips			Person-miles		
Purpose	Mode	Baseline Scenario	Remote Work Scenario	Change	Baseline Scenario	Remote Work Scenario	Change
Home-based Work	Drive Alone	1328609	1244451	-6.3%	12736970	12070213	-5.2%
	Carpool	257805	238669	-7.4%	3204552	2945150	-8.1%
	Transit	48752	44977	-7.7%	547804	500953	-8.6%
	Non-motorized	76506	71063	-7.1%	132216	122930	-7.0%
Home-based Other	Drive Alone	1394415	1395196	0.1%	6088804	6122517	0.6%
	Carpool	2702272	2702625	0.0%	13420596	13448784	0.2%
	Transit	37346	37359	0.0%	264203	264432	0.1%
	Non-motorized	510143	508869	-0.2%	591297	590349	-0.2%
Non–home-based	Drive Alone	951561	938653	-1.4%	4777297	4736979	-0.8%
	Carpool	1273317	1254548	-1.5%	7650625	7538596	-1.5%
	Transit	13453	13199	-1.9%	73563	72018	-2.1%
	Non-motorized	146404	144126	-1.6%	136914	134784	-1.6%

ActivitySim: Trip Count vs Length

BYU Civil & Construction Engineering

		Trips			Person-miles		
Purpose	Mode	Baseline Scenario	Remote Work Scenario	Change	Baseline Scenario	Remote Work Scenario	Change
Home-based Work	Drive Alone	1012180	950306	-6.1%	9632251	9021681	-6.3%
	Carpool	258459	242497	-6.2%	2631886	2463552	-6.4%
	Transit	253176	237881	-6.0%	2911616	2728897	-6.3%
	Non-motorized	145957	137684	-5.7%	353246	332978	-5.7%
Home-based Other	Drive Alone	700133	709957	1.4%	4280006	4332319	1.2%
	Carpool	2148429	2171566	1.1%	11498994	11624928	1.1%
	Transit	389780	396815	1.8%	3547052	3583630	1.0%
	Non-motorized	613134	617480	0.7%	1090176	1098043	0.7%
Non–home-based	Drive Alone	716143	687935	-3.9%	3984191	3804674	-4.5%
	Carpool	938056	922662	-1.6%	3962840	3898220	-1.6%
	Transit	159935	158366	-1.0%	867867	852243	-1.8%
	Non-motorized	156819	152688	-2.6%	194493	189483	-2.6%

Conclusions

Cited difficulties with activity-based model:

- Computational complexity
- Complicated design
- Lack of interoperability
- Staff training

Conclusions

- Computational complexity
  - Similar runtime on same hardware
- Complicated design
  - ActivitySim easier to interpret
  - Trip-based aggregate data harder to interpret
- Lack of interoperability
  - ActivitySim remote work sub-models taken from SEMCOG
  - Simple to add/edit parameters
- Staff training
  - Similar time/effort between models

Cited difficulties may not be applicable!