Service Planning Hierarchy

Outline

1. Furth's Stop Spacing Model Example
2. Service Planning Hierarchy
3. Introduction to Scheduling

1.258J/11.541J/ESD.226J

Fall 2003 Assignment #2 Summary

Suggested Sample Sizes

Time Period	Early AM	AM	Base	PM	Evening		Annual Checker-Hours
	I/O	I/O	I/O	I/O	I/O		
Team 1	6/26	53/153	28/37	111/86	58/25		262
Team 2	10/61	59/143	81/141	79/65	50/26	14/17	195
Team 3	4/8	26/15	6/15	7/18	14/8		68
Team 4	7/65	54/38	18/30	20/62	56/36		212
Observations/ hour	9	15	8	14	5		
Observations/ period	11	27	68	35	32		
Period length (hours)	1.5	2	7	3	4		

Bus Stop Spacing

U.S. Practice

- **200 m between stops (8 per mile)**
- **shelters are rare**
- **little or no schedule information**

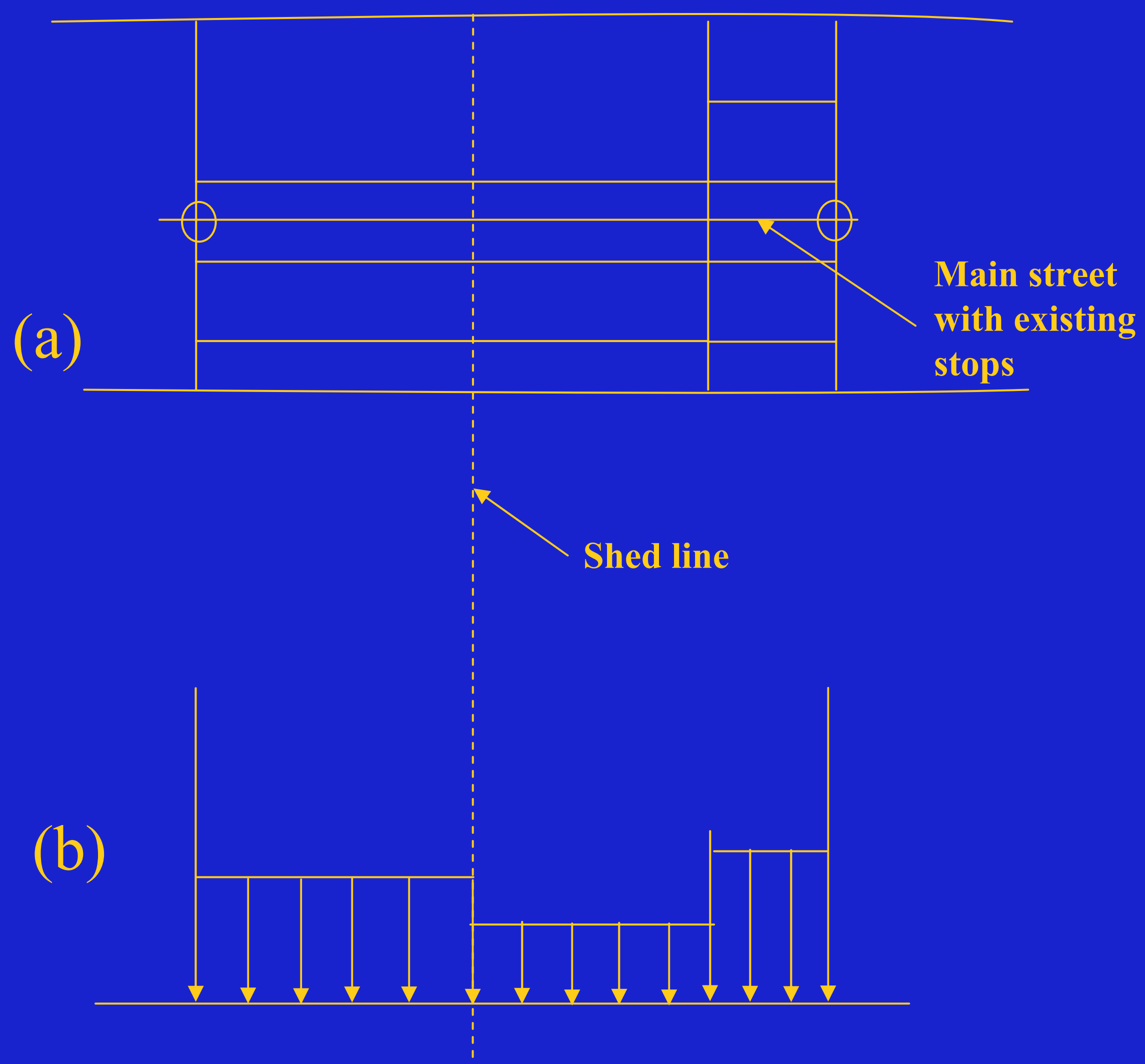
European Practice

- **320 m between stops (5 per mile)**
- **named & sheltered**
- **up to date schedule information**
- **scheduled time for every stop**

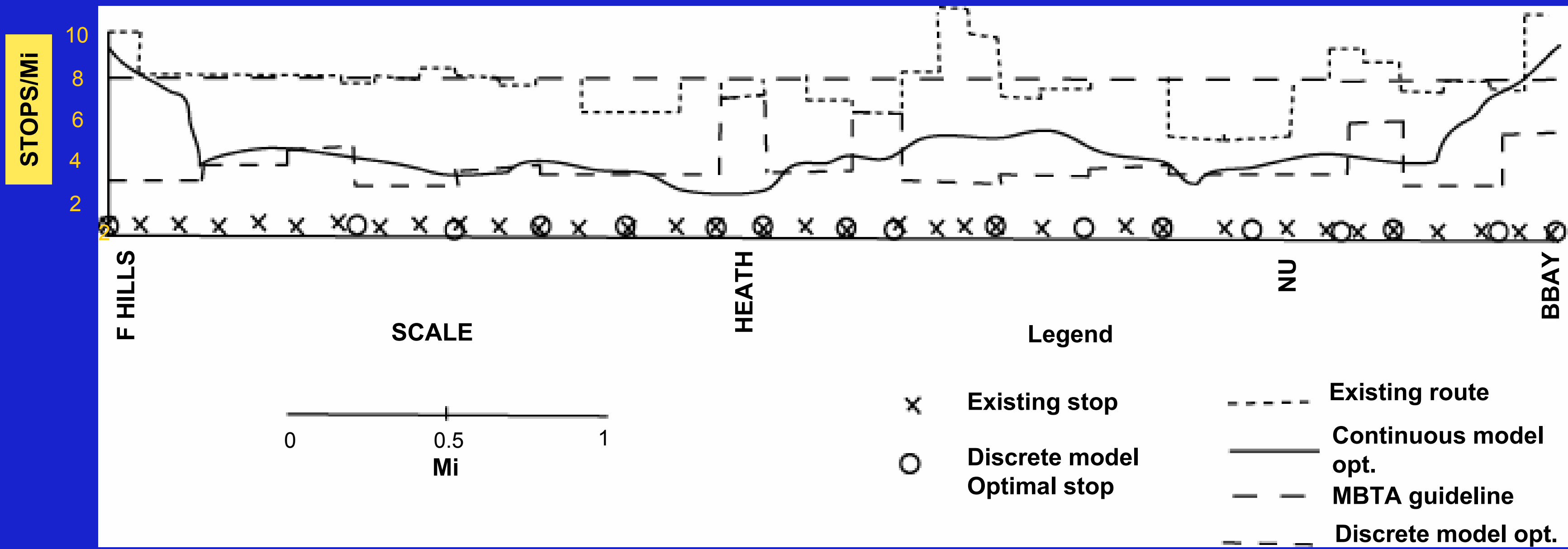
Stop Spacing Tradeoffs

- Walking time
- Riding time
- Operating cost
- Ride quality

Walk Access: Block-Level Modeling



Results: MBTA Route 39*



Adapated from: Furth, P.G. and A. B. Rahbee, "Optimal Bus Stop Spacing Using Dynamic Programming and Geographic Modeling." Transportation Research Record 1731, pp. 15-22, 2000.

AM Peak Inbound results

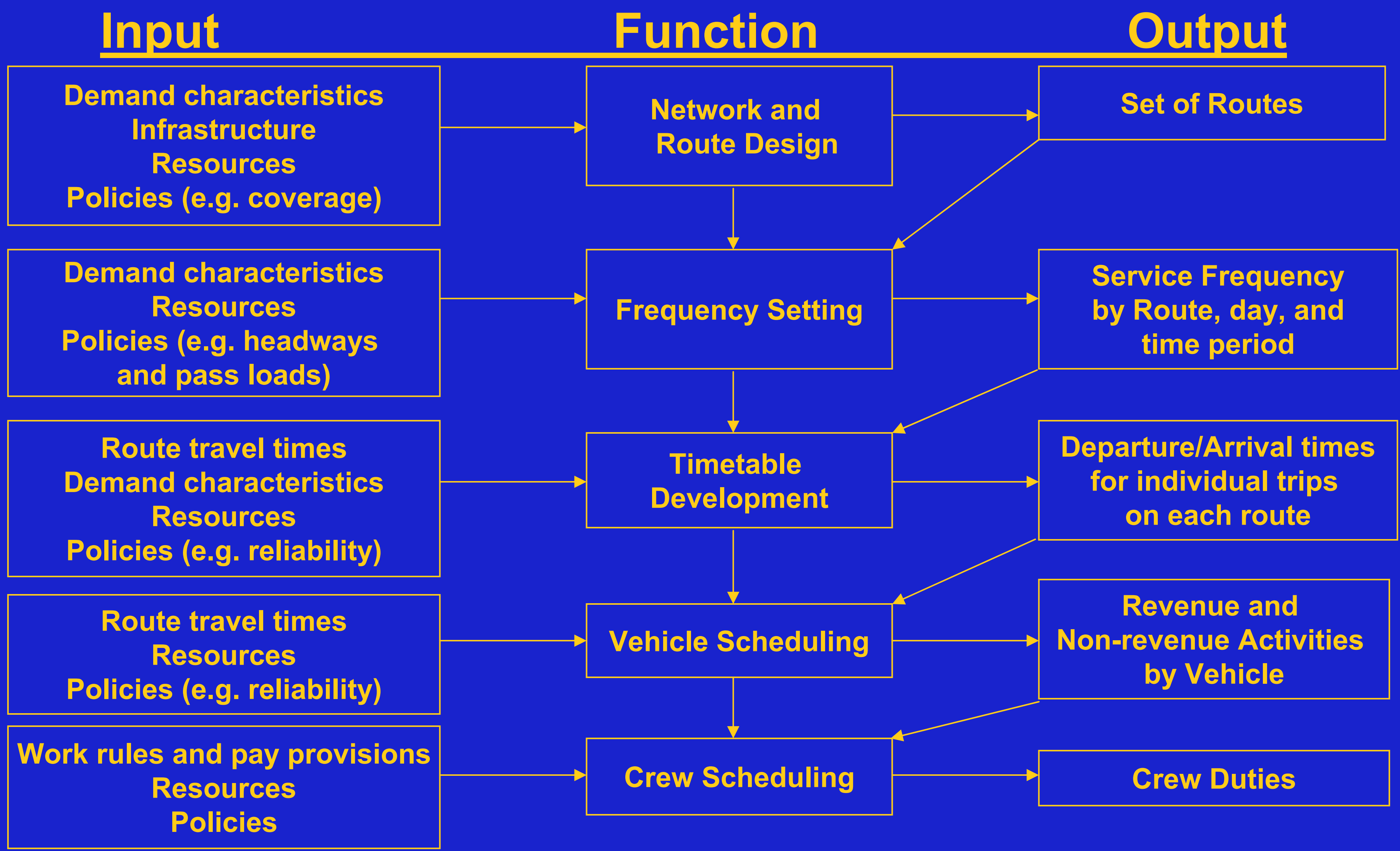
- Avg walking time up 40 s
- Avg riding time down 110 s
- Running time down 4.2 min
- Save 1, maybe 2 buses

Bus Stop Locations and Policies

- Far-side (vs. Near-side)
  - less queue interference
  - easier pull-in
  - fewer ped conflicts
  - snowbank problem demands priority in maintenance

- Curb extensions benefit transit, peds, and traffic (0.9 min/mi speed increase)
- Pull-out priority (it's the law in some states)
- Reducing dwell time (vehicle design, fare collection, fare policy)

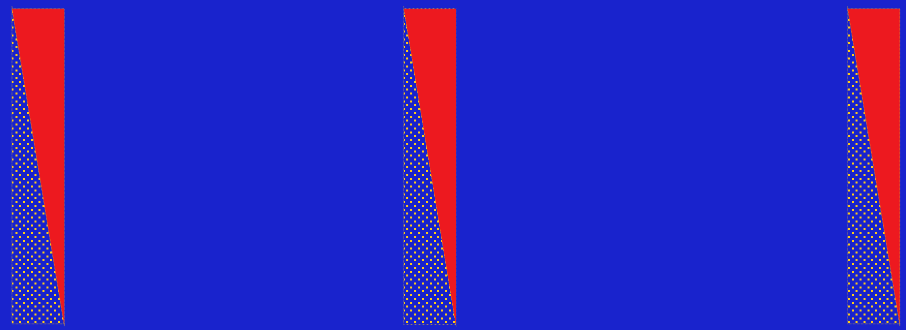
Service Planning Hierarchy



Service Planning Hierarchy

	Infrequent Decisions	Service Considerations Dominate	Judgement & Manual Analysis Dominate

Network Design
Frequency Setting
Timetable Development
Vehicle Scheduling
Crew Scheduling



	Frequent Decisions	Cost Considerations Dominate	Computer-Based Analysis Dominates

Introduction to Scheduling

Sequence of steps:

1. Determine Running Times and Layovers based on:
   - running time data
   - desired reliability levels
2. Determine Frequencies by route and time period
3. Determine # of vehicles by time period, focusing on:
   - policies affecting integer constraints
   - revise step 1 and 2 decisions as needed
   - focus on transition periods

Introduction to Scheduling

Sequence of steps:

4. Determine timetable, typically:
   - start at peak load point
   - generate start and end times

5. Chain vehicle trips together to form vehicle “blocks”

6. Cut and combine vehicle blocks to form crew duties or runs.

Common Issues

A. Integrality constraints:

- if book times are 26 mins each way, recovery time is 5 mins at each terminus, and desired frequency is 10 per hour:

$$Min\ \#\ of\ vehicles = \left\lceil \frac{31 * 2}{6} \right\rceil^{+} = \left\lceil 10.3 \right\rceil^{+} = 11$$

  Trade-off between shortening cycle time by 2 mins to save 1 vehicle, or not?

- in a similar case, but if desired frequency is 1 per hour, choice is to:
  - shorten cycle time by 2 mins, or
  - interline with another route having cycle time of 58 mins or less

Common Issues

B. Marginal cost of additional trips:

- a single trip for a vehicle/crew in peak period is typically uneconomic, so choice is between:
  - eliminating the single trip and saving the vehicle/crew costs
  - adding additional trips to make a minimum sized "piece of work"
- where you add extra trips will affect the costs -- outer shoulders of peak tend to be most expensive.

C. Hard constraints:

- contract terms include hard constraints which determine feasibility or infeasibility