

**TEMPORAL AND SPATIAL VARIATIONS IN TRIP GENERATION AND PARKING
CHARACTERISTICS AT A SMALL URBAN COLLEGE**

***Texas Wesleyan School of Law
Fort Worth, Texas***

Autumn 2002

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MOVITE, June 2007**

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Study performed for the Law School in October and November, 2002.

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Introducing, the Law School

- Commuter school in downtown Ft Worth
- 670 students; 70 staff (2002-2003)
- Day and evening classes
- Classes run from 8 AM to 10 PM Mon-Thu, no evenings on Fri
- Total floor space = 11, 148 sq m (120,000 sq ft)
- Total classroom space = 1,486 sq m (16,000 sq ft)
- 100% commuters
- Three lots – one staff/faculty, two student
- All parking spaces within 5 min walk of doors
- No carpooling; vehicle occupancy = 1

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- Using walking rate of 60 m/min (197 ft/min), all spaces are within 5 minutes of a door.
- Day and evening classes do not overlap.
- Of the 670 students, approximately 2/3 day, 1/3 night.

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Genesis of Study

- Originally, pedestrian safety study concerning peds crossing Calhoun Street from parking lots to school
- Traffic counters would be placed in each lot, and vehicle counts would be surrogate for pedestrians
- Because of homogeneity of both students and facilities with respect to age and overall physical condition, data collected lent itself to an expansion to both a trip generation and parking characteristics study
 - External variables minimized
 - Parking lots in same condition and close
 - Both lots fenced and gated, use restricted to Law School only
 - Students in practically same physical condition; no mobility restrictions

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• Since there is practically zero carpooling, the average vehicle occupancy for vehicles on the lots is effectively 1. That is why vehicles could be used as a surrogate for pedestrians.

• Students between the ages of 22 and 40, in good physical shape, able to walk up and down stairs, very few handicaps.

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Parking Lot/Space Characteristics

- Closest lot– Faculty/staff
 - All spaces within 125 m (410 ft)
- Closer student lot (35 m)
 - Closest space = 35 m (115 ft)
 - Farthest space = 160 m (525 ft)
- Farther student lot (120 m)
 - Closest space = 120 m (395 ft)
 - Farthest space = 270 m (885 ft)
- 150 on-street metered spaces within 270 m
- Parking lots – free; meters = \$1 per day

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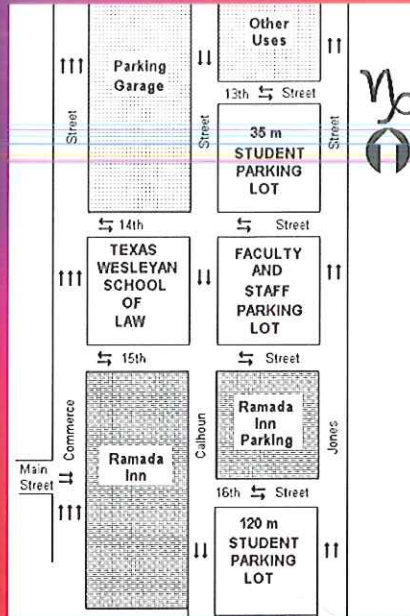
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- Metered spaces heavily and almost exclusively used by students who elect not to park in one of student lots provided.
- Few students park beyond 270 m or in non-Law School parking lots

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Spatial layout of building and parking facilities

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- Doors of school on four corners
- On a typical weekday, 2799 trip ends in parking lots.
- No carpooling.
- First preference for parking – lots. Street parkers will first enter and exit lots looking for space before parking on street. **THUS, TRIPS COUNTED AT PARKING LOTS INCLUDE ON-STREET PARKERS.**
- Number of trips entering/exiting parking lots is the same as actual number entering/leaving campus.
- Number of trip ends at parking lots is a viable and practical surrogate for the actual number of trip ends.
- Each lot has two entrances and is fenced. For Faculty lot, both entrances are on 15th St. For 35 m lot, both entrances are on 14th St. For 120 m lot, both entrances are on 16th St.
- Driveways are gated from 11 PM to 6 AM. Therefore, data collected between 6 AM and 11 PM reflects 24 hr data.

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Study Methodology

- Counter placed at each entrance of each lot
- Data collected over three weeks beginning the last week of October
 - No variations in class schedules for these three weeks
 - Consistent ambient lighting- after switch back to Standard Time
- Data for each lot collected separately, then synthesized to typical week
 - Simplified data collection, as only two counters were needed
 - Enhanced quality control, as bad data for one lot could be isolated and expunged without having to recount other lots.
 - Date-specific fluctuations mitigated, as they only impact one third of data instead of entire dataset.

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- For the three weeks selected, there were no holidays. Thus, classes met five days at week at schedules times.
- The week prior to the commencement of the study, while all classes were in session, was in Daylight Savings Time, and thus the natural ambient light characteristics are different. Trip patterns COULD vary due to the difference in the natural ambient light.
- For the three weeks studied, there was little variation in trip patterns from week to week due to the consistency of the class schedule. Thus, the trip ends in a given parking lot on the first Monday would be the same as the trip ends for the same parking lot for the second and third Monday. Because of this consistency, it was possible to count one parking lot the first week, another parking lot the second week, and the last parking lot the third week and add the data together to create a typical week for the whole.
- As a contingency in case of bad data, the period selected contained a fourth week that could be used for recounts.
- Date specific fluctuations – example. Evacuation of Law School. (Actually has happened.) Such an event would only cause skewing of the data for the parking lot being counted on the day of the evacuation; data from other two parking lots would be unharmed. The worse case would be a recount for one day of the one parking lot. A minor event, such as a temporary blocking of a driveway to fill a pothole, would not skew the entire dataset much at all because the other two parking lot datasets would nullify the blip.

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TABLE 1 Average Weekday Trip Generation Rates

DAILY TRIPS GENERATED BY	KNOWN CHARACTERISTIC UNIT (PARAMETER)			
	PER STUDENT	PER STAFF	PER SQUARE METER (sq. ft.) GROSS FLOOR SPACE	PER SQUARE METER (sq. ft.) OF CLASSROOM
<i>Student</i>	2.731	26.143	0.164 (0.015)	1.231 (0.114)
<i>Staff</i>	1.446	13.843	0.087 (0.008)	0.652 (0.061)
<i>All</i>	4.178	39.986	0.251 (0.023)	1.883 (0.175)

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- The per capita trip rate for students= 2.731 (I.e. each student makes 2.731 trips per day); per capita rate for faculty/staff = 13.843 (I.e. each faculty/staff makes 13.843 trips per day).
- Ideal trip generation rate for commuter campus = 2.00 per student (one trip there; one trip away)

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TABLE 2 Percentage of Daily Trips Occurring in Each Hour of the Day for Each Weekday

	MONDAY			TUESDAY			WEDNESDAY			THURSDAY			FRIDAY		
HOUR	Facly and Staff	Stdnt	All	Facly and Staff	Stdnt	All	Facly and Staff	Stdnt	All	Facly and Staff	Stdnt	All	Facly and Staff	Stdnt	All
6 AM	16	02	07	02	03	03	05	05	05	04	06	05	15	19	18
7 AM	25	29	28	28	32	30	86	48	62	20	20	20	41	52	48
8 AM	81	216	167	94	107	103	80	226	171	96	92	93	150	236	249
9 AM	168	75	108	71	130	111	191	72	116	68	152	124	103	109	107
10 AM	60	15	31	44	46	46	54	40	45	47	68	61	62	50	54
11 AM	64	87	79	29	41	37	36	86	67	52	49	50	121	159	147
12 PM	48	71	62	42	40	41	32	66	53	83	69	74	84	56	65
1 PM	56	46	50	43	63	56	52	57	55	50	59	56	125	66	85
2 PM	58	63	61	61	99	86	49	67	60	59	134	109	79	62	68
3 PM	35	51	45	23	60	48	29	49	41	38	32	34	71	27	41
4 PM	42	78	65	76	78	77	48	54	52	67	65	66	34	29	31
5 PM	70	74	73	158	90	112	89	52	65	129	72	92	77	25	41
6 PM	96	46	64	129	50	76	57	46	50	102	54	70	21	10	13
7 PM	77	51	60	57	56	56	99	45	65	57	43	48	07	25	19
8 PM	15	16	15	23	09	13	19	20	19	35	17	23	07	06	07
9 PM	80	67	72	100	64	76	64	60	61	74	58	64	00	03	02
10 PM	08	16	13	21	33	29	10	12	11	18	09	12	04	05	05

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- Orange reflects the top hour, purple the second hour, green the third hour.
- Values are percentage of daily trip in that hour.
- Distribution varies by day of the week.
- For students, peak hour on Monday, Wednesday, and Friday occurs at 8 AM and represents over 20% of all daily trips; on Tuesday on Thursday, peak hour occurs at 9 AM and represents over 10% of daily trips.
- On Monday and Thursday, student trips are more concentrated than on Tuesday and Thursday. For example, on Monday 42% of all trips occur between 6 AM and Noon; on Tuesday, only 36% of trips occur during this period. On Friday, the student trips are even more concentrated, as 69% of trips occur during this time period.
- Staff and faculty daily trip distribution patterns exhibit some of the same characteristics as the student ones – they are more concentrated and have a higher magnitude peak on Mondays and Wednesdays, and are more evenly distributed with lesser peak hours on Tuesday and Thursday.
- Staff/faculty peaks do not occur simultaneous with student peaks.
- Staff/faculty trips more evenly distributed throughout the day than student trips.
- Overall trip distribution is a synthesis of the student daily distribution and the faculty and staff distribution, but tends to follow the student distribution closer.

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TABLE 3 Hourly Distribution of Typical Weekday Daily Trips for All Stratifications

PERCENT OF AVERAGE (TYPICAL) WEEKDAY DAILY TRIPS					
HOUR	120 m Student Lot	35 m Student Lot	All Students	Faculty & Staff	ALL
6 AM	0.5	0.7	0.6	0.8	0.7
7 AM	0.7	4.7	3.4	4.1	3.7
8 AM	19.0	16.6	17.4	9.5	14.6
9 AM	24.9	4.3	11.0	12.3	11.4
10 AM	5.6	3.9	4.5	5.2	4.7
11 AM	11.3	5.8	7.6	5.3	6.8
12 PM	7.5	5.4	6.0	5.5	5.9
1 PM	5.9	5.7	5.8	5.8	5.8
2 PM	10.2	6.3	8.9	5.9	7.9
3 PM	3.5	5.0	4.5	3.5	4.2
4 PM	3.2	7.8	6.3	5.6	6.1
5 PM	2.9	8.4	6.6	10.8	8.1
6 PM	1.6	5.8	4.4	8.6	5.9
7 PM	0.9	6.2	4.5	6.6	5.2
8 PM	0.3	1.9	1.4	2.1	1.7
9 PM	0.8	7.7	5.5	7.0	6.0
10 PM	1.3	1.7	1.6	1.3	1.5

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- Orange is the top hour, purple the second hour, green the third, blue the fourth, gray the fifth.
- 35 m lot, trips distributed fairly evenly throughout the day. The five top hours spread throughout the day – earliest at 8 AM, latest at 9 PM, and represent 49% of daily trips. 60% of trips in this lot occur before 4 PM; 40% after.
- 120 m lot, distribution concentrated. The five top hours bunched between 8 AM and 2 PM, and represent 72% of daily trips. 89% of trips in this lot occur before 4 PM; 11% after.
- Because of these stark differences, it is important to take into account parking facility location in order to get the most accurate trip generation simulation.

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TABLE 4 Student Parking Preference by Time of Day for Typical Weekday

HOUR	PERCENT OF STUDENTS PREFERRING LOT	
	120 m Student Lot	35 m Student Lot
6 AM	26.8	73.2
7 AM	7.0	93.0
8 AM	35.2	64.8
9 AM	73.3	26.7
10 AM	40.2	59.8
11 AM	48.1	51.9
12 AM	39.8	60.2
1 PM	32.8	67.2
2 PM	37.0	63.0
3 PM	25.0	75.0
4 PM	16.4	83.6
5 PM	14.2	85.8
6 PM	11.6	88.4
7 PM	6.7	93.3
8 PM	7.8	92.2
9 PM	4.6	95.4
10 PM	26.2	73.8
DAY	32.3	67.7

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- Because of the homogeneity of the student population (healthy and under 40) and the physical characteristics of the student parking facilities (exclusive, free, proximate, and accessible), the data collected can provide some useful insight into parking preferences and parking demand assumptions.
- It has characteristically been assumed that all spaces with an approximately equal proximity, cost, and accessibility will be equally attractive to a motorist, and will have the same daily trip generation and time distribution characteristics. This data reveals that this assumption may not be correct.
- Although all the student spaces on campus are free, easily accessible, and within a five-minute walk of the building, students prefer the closer one.
- Trip generation used as a surrogate for demand.
- Demand to park in 35m lot twice that for the 120 m lot. (67% vs. 33%)
- With the exception of 9 AM, (highlighted) 35 m lot is always preferred. At 9 AM, closer lot is at capacity and students bypass it.

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Why Do Students Prefer Closer Lot?

- Perceived time savings
- Perceived safety/security

When students perceived that the 35 m lot may not be full or when students did not have time constraints, they preferred to park in the closer (35 m) lot.

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•Students interviewed indicated that they went to the 35 m lot first, searched on-street spaces second, and then if unsuccessful, parked in the 120 m lot. However, the time they spent searching for the closer spaces was actually more than the time they would spend if they went directly to the 120 m lot! Thus, the time savings are “perceived”

•Depending on how long a student had to wait to cross Calhoun Street, which dropped traffic as the street number increased (it was busier across from the closer lot at 14th than it was across from the further lot at 16th), the amount a time a person is “exposed” walking to the closer lot could be greater than the amount of time walking to the further lot. Thus, safety/security was “perceived”

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Conclusions

- Trip Generation
Trip Generation distribution patterns fluctuate greatly from day to day, and these fluctuations should be considered when analyzing the impact of changes on the adjacent transportation network for a particular time period during the day
- Parking Preference
 - A spatial difference of less than 100 m yielded a noticeable and significant difference in parking demand/utilization
 - Relationship between desirability and distance:

Desirability of farther lot [%] = $1/(\text{Dist. to farther lot}/\text{Dist. to closer lot})$

Perceived safety and perceived convenience are a larger factor in parking preference than cost.

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• In other words, for any particular hour (e.g. 8 AM), the trip generation distribution is different for each day of the week, and so the day of week should be considered when analyzing the impact of network changes. (I.e. the impact at 8 AM on Monday is not the same as the impact at 8 AM on Tuesday.)

• A study by St. Jacques, Schrader, and Shahi of parking characteristics on the campus of Baylor revealed that for large spatial distances between parking facilities (over 500 m), parking utilization varies, with closer facilities being utilized the most. Because of the geographic size of that study, variations of utilization for small differences in spatial distances (100 m) could not be ascertained. This study shows that the patterns found for large differences hold true for small differences as well.

• For example, if the distance to the farther lot is 150 m, and the distance to the closer one is 50 m, then the desirability of the farther lot is 33%. ($1/(150/50)$) or (1/3)

• Students would rather feed the meters and pay a buck or more a day (which requires walking to the meter several times a day) than walk a block to a free lot that they only have to walk to and from once.