

1 **ACTIVITY-TRAVEL CHARACTERISTICS OF A LARGE UNIVERSITY POPULATON**

2  
3 **Sarah E. Volosin** (*corresponding author*)

4 Arizona State University, School of Sustainable Engineering and the Built Environment  
5 Room ECG252, Tempe, AZ 85287-5306. Tel: (480) 965-3589; Fax: (480) 965-0557  
6 Email: [sarah.volosin@asu.edu](mailto:sarah.volosin@asu.edu)

7  
8 **Sanjay Paul**

9 Arizona State University, School of Sustainable Engineering and the Built Environment  
10 Room ECG252, Tempe, AZ 85287-5306. Tel: (480) 965-3589; Fax: (480) 965-0557  
11 Email: [sanjay.paul@asu.edu](mailto:sanjay.paul@asu.edu)

12  
13 **Ram M. Pendyala**

14 Arizona State University, School of Sustainable Engineering and the Built Environment  
15 Room ECG252, Tempe, AZ 85287-5306. Tel: (480) 727-9164; Fax: (480) 965-0557  
16 Email: [ram.pendyala@asu.edu](mailto:ram.pendyala@asu.edu)

17  
18 **Vladimir Livshits**

19 Maricopa Association of Governments  
20 302 N First Avenue, Suite 300, Phoenix, AZ 85003. Tel: (602) 452-5079; Fax: (602) 254-6490  
21 Email: [vlivshits@azmag.gov](mailto:vlivshits@azmag.gov)

22  
23 **Petya Maneva**

24 Maricopa Association of Governments  
25 302 N First Avenue, Suite 300, Phoenix, AZ 85003. Tel: (602) 254-6300; Fax: (602) 254-6490  
26 Email: [pmaneva@azmag.gov](mailto:pmaneva@azmag.gov)

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1 **ABSTRACT**

2 Metropolitan planning organizations often desire to recognize the presence of large special  
3 generators of travel demand in their regions in transportation modeling and planning processes.  
4 Universities, especially large universities, can generate a significant amount of travel demand  
5 due to a heterogeneous population of travelers with unique behavioral characteristics. The travel  
6 behavior characteristics of university populations are not well understood or documented in the  
7 literature. This paper attempts to fill this gap by describing daily activity-travel patterns of  
8 university students, faculty, and staff for a typical weekday in the middle of a semester. Data for  
9 this paper was obtained from a comprehensive web-based travel survey that was administered to  
10 students, faculty, and staff of Arizona State University, one of the largest universities in the  
11 United States, in April 2012. Travel characteristics, activity participation profiles, and trip  
12 chaining behavior are examined for faculty, staff, and student market segments. The results  
13 suggest that there is considerable heterogeneity in activity-travel behavior across the university  
14 population groups. The data presented in this paper is a first step towards understanding the  
15 activity-travel demand of large university special generators, and developing specialized travel  
16 models for such entities in a region.

17  
18 **Keywords:** college student travel, travel survey data analysis, university population travel,  
19 under-studied population, travel characteristics measurement, activity participation

## 1 INTRODUCTION

2 Many major metropolitan areas around the world are home to one or more large universities  
3 which serve as special generators of travel demand. As the transportation planning field migrates  
4 towards fine-grained activity-based regional travel models, it is important to have a deep  
5 understanding of the activity and travel engagement patterns of all segments of the population.  
6 Recent literature has stressed the importance of understanding activity-travel behavior as a  
7 means to achieving improved simulations of travel demand (Axhausen and Garling, 2013;  
8 Bowman and Ben-Akiva, 2001; Bhat, et al, 2004). However, despite the substantial impact of  
9 large urban universities on regional travel patterns, little research has been done and documented  
10 on the daily activity-travel patterns of university communities.

11 According to the US Department of Education, 21.7 million United States residents were  
12 enrolled in an institution of higher education in 2012 (US Department of Education, 2012).  
13 College students (and sometimes faculty as well) are likely to have more flexible schedules and  
14 very different living and working arrangements than the typical working adult. College student's  
15 schedules are often dictated by set class times and odd work hours, not to mention club and  
16 social activities. In addition, college campuses generally reflect a very accessible, mixed-use,  
17 and densely populated setting, with classrooms, offices, restaurants, and residential buildings all  
18 within close proximity (walkable distance) one another. These unique features of university  
19 environments could lead to daily activity-travel patterns for college communities that differ  
20 substantially from those of the general population, motivating the need to study these segments  
21 and characterize their activity-travel patterns in a detailed way.

22 This study attempts to fill the gap in understanding daily activity-travel behavior of college  
23 students, faculty, and staff. The data used for the characterization of university population  
24 activity-travel demand in this study was obtained through an online travel survey conducted at  
25 Arizona State University (ASU) in the Spring 2012 semester. The following sections of the  
26 paper include a literature review of university and student travel, the methodology by which  
27 travel data was collected, and an investigation and documentation of travel characteristics,  
28 activity participation, and trip chaining patterns for college students, faculty, and staff.

## 29 LITERATURE REVIEW

30 University communities can be considered under-represented populations in travel surveys for a  
31 variety of reasons. Behrens et al. (2008) identify adolescents and those who are "disengaged  
32 from broader society" as typical non-respondents to travel surveys. One could easily argue that  
33 university students, who often live, work, shop, and eat entirely on a college campus, are in  
34 many ways isolated from the broader population. In addition, people who reside in group  
35 quarters (like college dormitories) or who change addresses frequently are often omitted from  
36 survey sampling frames, due to the difficulty in receiving up-to-date contact information from  
37 these groups (Behrens et al, 2008).

38 Several studies have addressed mode choice to and from college campuses by collecting  
39 survey data from the university communities. In 1997, researchers conducted a survey of  
40 commuting behavior at the University of North Carolina, Chapel Hill. The goal of the survey  
41 was to understand the effect of built environment characteristics on commuting mode choice  
42 (Rodriguez and Joo, 2004). The study focused only on the journey-to-campus trips for students,  
43 faculty, and staff. Findings showed that characteristics of the built environment had a significant  
44 effect on the mode choice to campus. A travel survey completed at Ohio State University (OSU)  
45 in 2011 was used to predict modes chosen for travel to campus by OSU students, faculty, and  
46

1 staff (Akar et al, 2012). The survey, administered online, collected information on typical  
2 commute modes to campus and solicited respondent input on various strategies for increasing the  
3 usage of alternative modes. The resulting model showed that students were generally more likely  
4 than faculty or staff to use alternative modes such as biking and transit to travel to campus. A  
5 study concerning sustainable transport development on university campuses showed mode shares  
6 for commuting to campus at eight universities in the event that policy actions aimed at increasing  
7 the prevalence of non-motorized travel were implemented (Balsas, 2003). This study showed  
8 that policy changes on university campuses can significantly increase the mode share of  
9 alternative modes of travel for the commute to school.

10 More recently, a few studies have aimed to fill the gap in the understanding of daily  
11 travel patterns of students. A study at four major universities in Virginia – two with urban and  
12 two with rural settings – implemented a travel diary for college students designed to closely  
13 follow the design of the National Household Travel Survey (NHTS) (Khattak et al, 2011). This  
14 study compared daily travel patterns of university students to those of the general population  
15 from the NHTS Virginia add-on sample. Weekday trip rates for students at all universities were  
16 greater than those of the general population. Students in more rural universities had a higher trip  
17 rate by walk and bike than those on urban campuses. The general population of Virginia made  
18 more home-based work, home-based shopping, and home-based social recreation trips than  
19 university students, while students made more non-home-based trips overall. Finally, while the  
20 temporal distribution of trips for the general population was fairly evenly spread throughout the  
21 day, university student trip departure times showed a clear peak in the middle of the day and a  
22 greater proportion of trips after 6:00 PM. In a follow-up study, an online survey instrument that  
23 matched the NHTS questionnaire was implemented and tested at Old Dominion University  
24 (ODU). Student travel demand was analyzed in relation to home location distance from campus  
25 (Wang et al, 2012). The University of California at Davis (UCD) Institute of Transportation  
26 Studies (ITS) conducts an annual travel survey of UCD students, faculty and staff (Miller, 2012).  
27 This survey takes into account only campus-based travel, but includes students, faculty, and  
28 staff, similar to the ASU survey. Because it is conducted every year, the UCD survey offers an  
29 opportunity to view university travel demand from a longitudinal perspective.

30 Activity-based approaches to understanding student travel have also emerged in recent  
31 studies. Kamruzzaman et al. (2011) reported on a study at the University of Ulster at  
32 Jordanstown in Northern Ireland that used a two-day travel diary and GIS representation to  
33 evaluate student activity spaces. The study found that the percent of student trips made by car  
34 was higher than that for the Northern Ireland average adult, most likely because the percent of  
35 students who own a car is greater than that for the general population. Those students who own  
36 a car traveled significantly farther than those without a car, as expected. Low income students  
37 had greater average activity duration than high income students. Another study of the daily  
38 activity patterns of students was published in 2009 based on a 2001 travel survey of students at  
39 North Carolina State University located in Raleigh, North Carolina (Eom et al, 2009). The one-  
40 day travel diary data revealed that on-campus students had a higher trip rate than off-campus  
41 students, consistent with the literature from Virginia schools. Additionally, females made more  
42 trips than males, and undergraduates made more trips than graduate students. Compared to  
43 unemployed students, those employed full time made fewer trips while those employed part time  
44 or with volunteer jobs made more trips.

45 The literature review is evidence of the widespread interest in studying the activity-travel  
46 demand characteristics of university populations. Despite the presence of a few studies, there is

1 considerable paucity of data and empirical insights on the activity-travel patterns of college  
2 students and university populations in general. This study is aimed at filling this gap in  
3 knowledge.

#### 4 5 **ASU TRAVEL SURVEY**

6 The data used in the analysis for this paper comes from the Arizona State University (ASU)  
7 Travel Survey, administered between April 4 and 25, 2012. ASU is one of the largest  
8 universities in the United States, with 4 large urban campuses spread across the Metropolitan  
9 Phoenix Area, serving over 70,000 graduate and undergraduate students. The survey was  
10 administered entirely online and was designed to collect data that could be used to update the  
11 Maricopa Association of Governments (MAG) regional 4-step model and, eventually, aid in the  
12 transition to an activity-based travel demand model for the MAG region. The survey was  
13 administered to the entire university community of faculty, staff, and students through the  
14 cooperation of the university administration.

15 The survey data was gathered in four parts: (1) respondent affiliation with ASU and socio-  
16 demographic information, (2) a one-day travel diary, asking respondents to report trips for the  
17 most recent weekday, (3) typical travel to and from ASU and to and from work, and (4) attitudes  
18 and perceptions, gathering data that addresses feelings concerning safety and convenience of  
19 transit and auto modes. Respondents were asked to complete the travel diary portion of the  
20 survey for their most recent weekday. As the message inviting the university community to  
21 participate in the survey was sent out on a Wednesday, most responses provide detailed travel  
22 diary information for a Tuesday. However, in the case of undergraduate students, only about  
23 29% recorded the travel diary for a Tuesday while another 31% recorded the travel diary for a  
24 Friday suggesting that a large proportion of this population group waited until the weekend to fill  
25 out the survey.

26 Following survey data collection, a rigorous cleaning and filtering process ensued. The  
27 filtered dataset was weighted such that distributions of specific demographic variables matched  
28 the population distributions obtained from ASU institutional data. Weighting was achieved using  
29 the iterative proportional fitting (IPF) and iterative proportional updating (IPU) procedure  
30 employed by the PopGen synthetic population generation software (complete details about this  
31 procedure may be obtained from Ye, et al, 2009). Weighted respondent characteristics for each  
32 segment of the ASU community are presented in Table 1.

33 The data reveals that, while the majority of students are Caucasian, there is a relatively large  
34 population of Latino students and staff at ASU. This is not, however, seen in the faculty group.  
35 As may be expected, more than 12% of both graduate and undergraduate students have zero  
36 vehicle availability, while less than 2% of faculty and staff fall into this category. Graduate  
37 students exhibit the highest proportion of individuals reporting zero trips and the average trips  
38 rate among all segments. In comparison, only 6% of staff members make zero trips on the travel  
39 day. The trip rates shown are calculated by dividing the total number of trips by the total number  
40 of respondents in each segment. Undergraduate students have the highest trip rate of any  
41 segment, making 4.69 trips per weekday. Compared to, for example, the UCD campus (Miller,  
42 2012) many more undergraduate and graduate students at ASU live with family – either with  
43 spouses and children, or with parents and siblings. ASU has a large population of students who  
44 are also area residents. These residents tend to have social contacts, activities, jobs, and  
45 established routines outside of campus life, thus contributing to a relatively high daily trip rate. A  
46 substantially higher proportion of students do not have access to a vehicle when compared to

1 faculty and staff market segments. Students are much more likely to live with roommates than  
 2 faculty and staff. About 19 percent of undergraduate students live on campus.  
 3

4 **Table 1. Description of ASU Travel and Mode Use Survey Respondents (Weighted)**

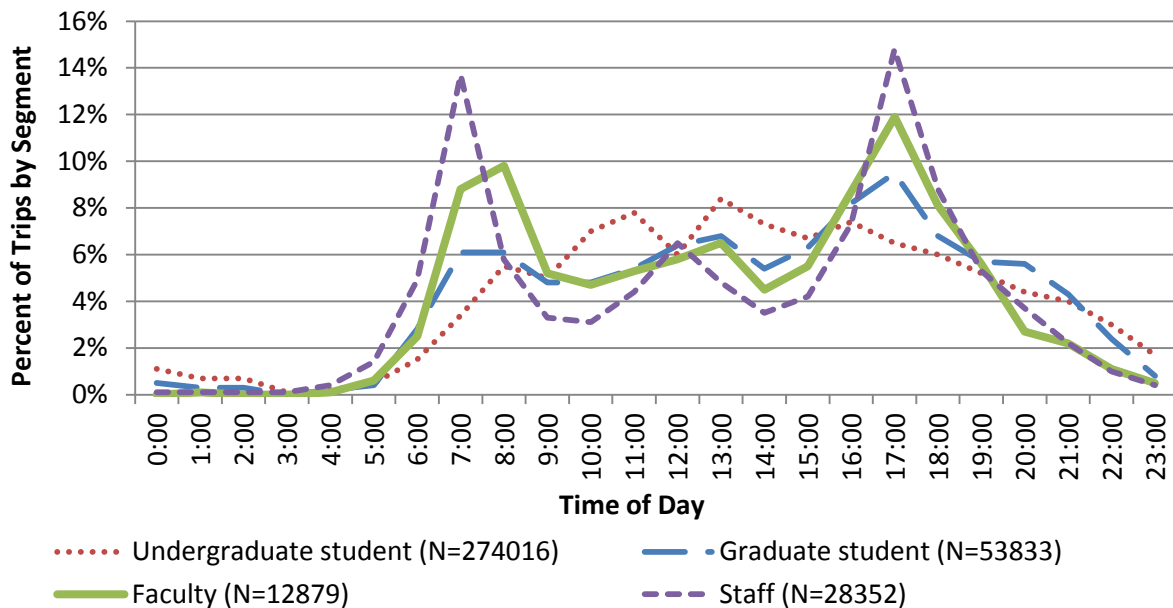
		Undergraduate Student	Graduate Student	Faculty	Staff	Total
N		58,404	13,850	2,991	6,200	81,445
% of Total Sample		71.7%	17.0%	3.7%	7.6%	100.0%
% Female		50.5%	50.8%	42.0%	58.0%	50.8%
Annual Household Income	< 20 K	71.3%	41.8%	0.7%	0.9%	58.3%
	>= 20 K – 40 K	11.5%	25.7%	2.8%	11.5%	13.6%
	>= 40 K – 60 K	2.8%	10.7%	8.7%	19.5%	5.6%
	>= 60 K – 80 K	1.0%	5.9%	11.2%	18.5%	3.5%
	>= 80 K – 100 K	0.4%	2.9%	13.8%	13.9%	2.4%
	>= 100 K	1.0%	5.0%	50.5%	25.1%	5.3%
Ethnicity	African American	5.2%	3.9%	2.4%	4.4%	4.8%
	Native American	1.9%	1.6%	0.9%	1.9%	1.8%
	Asian	8.6%	19.9%	10.6%	6.7%	10.4%
	Latino / Hispanic	18.8%	10.4%	6.9%	14.0%	16.6%
	White / Caucasian	61.4%	60.8%	78.1%	71.5%	62.6%
	Other	2.2%	1.6%	0.3%	0.6%	1.9%
	No Answer	1.9%	1.9%	0.8%	0.9%	1.8%
Vehicle Availability	0 vehicles	16.6%	12.7%	1.0%	1.8%	14.2%
	1 vehicle	26.2%	33.5%	28.8%	24.0%	27.4%
	2 vehicles	26.7%	36.9%	55.0%	51.6%	31.4%
	3 vehicles	18.7%	11.2%	12.9%	15.9%	17.0%
	4 or more vehicles	11.8%	5.7%	2.3%	6.7%	10.0%
Living Arrangement	On Campus	18.8%	0.6%	0.0%	0.0%	13.6%
	With Family	46.7%	52.0%	80.4%	77.5%	51.2%
	With Roommates	24.7%	26.6%	1.4%	4.8%	22.7%
	Both Family and Roommates	2.8%	2.1%	0.7%	1.7%	2.5%
	Alone	7.0%	18.7%	17.4%	15.9%	10.0%
Work Arrangement	Work on-campus	11.0%	38.8%	100.0%	100.0%	33.3%
	Work off-campus	48.4%	32.7%	0.0%	0.0%	36.2%
	Work on- and off-campus	5.3%	9.4%	0.0%	0.0%	4.7%
	Not working	35.3%	19.0%	0.0%	0.0%	25.8%
% Zero-Trip Makers		13.7%	15.4%	11.1%	6.0%	13.3%
Average Daily Trip Rate		4.69	3.89	4.31	4.57	4.53

5  
6

## CHARACTERISTICS OF DAILY TRAVEL BEHAVIOR

The travel characteristics of college students have been addressed in a few prior papers (Rodriguez and Joo, 2004; Khattack et al, 2011; Eom et al, 2009; Miller, 2012), especially in the context of student mode choice to and from campus. The descriptions presented here focus on highlighting a few similarities and differences of travel characteristics across different university segments as well as characteristics unique to the university population. Within the scope of this paper, it is impossible to provide comprehensive tabulations of all travel behavior characteristics.

Figure 1 shows the (weighted) time-of-day distribution of trips for undergraduates, graduate students, faculty, and staff.



**Figure 1. Time of Day Distribution of Travel by Market Segment**

This graph is inclusive of all trips, not just those made for ASU-based travel. The time-of-day distribution for staff travel is quite representative of what one would expect of a typical working adult. There are clear peaks in the AM and PM periods (corresponding to commute travel) and a smaller peak during the midday for lunch. Faculty members also tend to have a three-peak structure similar to that seen for staff. However, faculty members' AM and midday peaks are a bit later in the day and the AM and PM peaks are flatter and less sharply defined. Graduate students behave similar to faculty members in their time-of-day choices, except that they have a lower share of AM trips and tend to schedule a larger proportion of trips in the later part of the evening. The larger share of evening trips could be indicative of the 32% of graduate students who are part-time as well as the full-time graduate students who work late into the night in research labs and the library. Part-time students likely work full time during the day and take graduate courses in the evenings to further their careers. Undergraduate students' time of day distribution has very little in common with the other segments. Undergraduates are seen to participate in travel throughout the day with a few small peaks distributed throughout the midday period, presumably coinciding with class start times. The higher proportions of mid-day and evening trips exhibited by undergraduate students are consistent with findings reported by Khattak et al (2011). The "dip" in undergraduate travel during the noon hour is likely due to the

1 fact that many classes on Tuesdays and Thursdays are scheduled from 12:00 – 1:15 PM, forcing  
2 students to engage in travel just before or after the traditional lunch time (when most staff  
3 members make their midday lunch trips).

4 Previous literature notes that student mode choice tends to vary based on age and level of the  
5 student, the setting of the campus (urban or rural), student living arrangements (on or off  
6 campus), and student worker status (Khattak et al, 2011; Wang et al, 2012). Table 2 shows the  
7 mode choice of students, faculty and staff by trip purpose. In this table, it should be noted that  
8 “school” refers to either attending (in the case of students) or teaching (in the case of faculty)  
9 class.

10 In this urban campus setting, all segments show a preference for using the drive alone mode  
11 to work and work-related trips. As is expected, carpooling (shared ride) is most prevalent for  
12 serve-passenger trips. Faculty and staff show high mode shares for walk, particularly for work  
13 and work-related trips – presumably because these groups walk for job-related reasons within the  
14 campus. As a substantial share of students work off-campus, their walk mode share for work is  
15 consequently less than that for faculty and staff. Students use the walk mode most often for  
16 school and school-related trips, and all segments use the walk mode for a large proportion of eat-  
17 meal trips. This indicates that members of the ASU community tend to eat (lunch) on or near  
18 campus. The large mode share of carpooling for social and shopping trips is unique to the  
19 undergraduate segment. This is consistent with the earlier statistic in Table 1 that 16.6% of the  
20 undergraduate population does not have access to a personal vehicle. For these students, trips  
21 farther than walking distance must be completed by transit, bicycle, or carpool.

22 For all segments and purposes, transit makes up an extremely small portion of trips. This is  
23 not necessarily typical of the university culture (Miller, 2012), but rather of the built environment  
24 and network accessibility in the region. The Greater Phoenix metropolitan area is a sprawling,  
25 auto-oriented region where the mode share for transit is quite low. When trips are no longer  
26 within walkable distance, then auto modes (drive alone and ride share) capture the lion share of  
27 the trips. Light rail and bus appear to have slightly larger shares for “other” trips. These trips  
28 may be special event trips (such as going to a ball game or concert) that are conveniently  
29 accessed using transit.

30 Table 3 presents average trip durations, trip lengths, and trip rates by purpose for each of the  
31 university market segments. Across all segments of the ASU community, the average travel time  
32 for a trip is approximately 20 minutes. Even though undergraduate students average slightly  
33 shorter times while staff members average slightly longer trip durations, the variability in  
34 average travel times is rather modest. Similarly, there is little variability across segments in the  
35 time spent traveling to work and work-related activities. The travel times for intra-campus trips  
36 are reflective of the short distances traveled. The ASU campuses are arranged such that classes  
37 and activity centers are near the geographic center of each campus while student housing is  
38 located along the edges. This geographical arrangement explains the longer time that  
39 undergraduate students spend on intra-campus trips. The average trip distances are generally  
40 consistent with the travel times reported. Even though graduate students spend more time  
41 traveling to personal business trips than other groups, the distances traveled are not necessarily  
42 longer. This suggests that graduate students use slower modes of travel to reach personal  
43 business activity locations. Overall, undergraduate students average the shortest trip distance at  
44 6.2 miles.



1 **Table 2. Mode Share by Trip Purpose for Various University Market Segments**

Segment	Trip Purpose	Drive Alone	Shared Ride	Walk	Bicycle	Light Rail	Bus	Total
<b>Under-graduate Student Trips</b>	<b>Work/ Work-Related</b>	61.9%	10.8%	14.3%	5.9%	2.6%	2.9%	100.0%
	<b>School/ School-Related</b>	23.7%	6.5%	45.5%	11.7%	4.5%	4.7%	100.0%
	<b>Eat Meal</b>	22.9%	26.3%	39.7%	6.6%	1.1%	1.0%	100.0%
	<b>Social/ Recreational</b>	32.1%	32.0%	24.7%	6.1%	1.7%	1.5%	100.0%
	<b>Shopping</b>	42.2%	41.8%	9.7%	2.3%	1.1%	2.4%	100.0%
	<b>Personal Business</b>	46.0%	30.3%	15.4%	4.0%	1.1%	2.0%	100.0%
	<b>Serve Passenger</b>	35.3%	62.1%	1.3%	0.1%	0.3%	0.7%	100.0%
	<b>Go Home</b>	43.9%	22.9%	15.9%	8.4%	3.3%	4.1%	100.0%
	<b>Other</b>	33.7%	20.2%	26.4%	3.8%	7.4%	5.7%	100.0%
	<b>All Purposes (100%)</b>	35.6%	20.1%	27.7%	7.8%	3.3%	3.5%	100.0%
<b>Graduate Student Trips</b>	<b>Work/ Work-Related</b>	62.4%	7.6%	15.8%	7.5%	3.0%	3.4%	100.0%
	<b>School/ School-Related</b>	34.5%	6.0%	36.2%	12.4%	3.9%	6.5%	100.0%
	<b>Eat Meal</b>	36.5%	25.0%	29.9%	6.7%	0.3%	1.3%	100.0%
	<b>Social/ Recreational</b>	37.0%	26.7%	23.7%	7.7%	2.0%	1.3%	100.0%
	<b>Shopping</b>	50.6%	30.6%	8.2%	5.7%	1.2%	3.7%	100.0%
	<b>Personal Business</b>	67.9%	19.2%	8.3%	2.7%	0.6%	1.3%	100.0%
	<b>Serve Passenger</b>	39.5%	58.3%	1.4%	0.7%	0.0%	0.0%	100.0%
	<b>Go Home</b>	55.3%	19.1%	5.7%	11.6%	3.1%	5.0%	100.0%
	<b>Other</b>	40.3%	12.0%	25.0%	3.5%	10.2%	7.0%	100.0%
	<b>All Purposes (100%)</b>	47.4%	16.5%	19.3%	8.9%	3.0%	4.3%	100.0%
<b>Faculty Trips</b>	<b>Work/ Work-Related</b>	41.7%	9.3%	35.0%	8.8%	2.7%	1.7%	100.0%
	<b>School/ School-Related</b>	33.2%	3.7%	58.9%	2.2%	0.7%	1.2%	100.0%
	<b>Eat Meal</b>	35.1%	25.7%	33.5%	4.4%	0.6%	0.8%	100.0%
	<b>Social/ Recreational</b>	39.1%	30.1%	16.4%	10.6%	0.0%	0.9%	100.0%
	<b>Shopping</b>	68.0%	25.0%	4.2%	1.1%	0.0%	1.8%	100.0%
	<b>Personal Business</b>	78.7%	14.9%	4.6%	1.9%	0.0%	0.0%	100.0%
	<b>Serve Passenger</b>	38.9%	57.7%	2.4%	1.0%	0.0%	0.0%	100.0%
	<b>Go Home</b>	56.6%	24.5%	4.7%	9.3%	2.0%	3.0%	100.0%
	<b>Other</b>	44.6%	14.4%	23.6%	4.9%	9.0%	3.5%	100.0%
	<b>All Purposes (100%)</b>	47.2%	19.0%	22.9%	6.8%	1.9%	1.8%	100.0%
<b>Staff Trips</b>	<b>Work/ Work-Related</b>	48.8%	10.3%	28.8%	5.0%	2.0%	3.8%	100.0%
	<b>School/ School-Related</b>	30.9%	17.2%	43.4%	5.1%	2.0%	1.5%	100.0%
	<b>Eat Meal</b>	25.7%	26.4%	44.4%	1.9%	0.5%	0.9%	100.0%
	<b>Social/ Recreational</b>	37.5%	28.2%	24.2%	6.2%	1.5%	1.0%	100.0%
	<b>Shopping</b>	67.0%	25.3%	5.1%	1.4%	0.2%	0.8%	100.0%
	<b>Personal Business</b>	68.9%	20.0%	8.2%	2.0%	0.4%	0.4%	100.0%
	<b>Serve Passenger</b>	35.3%	63.9%	0.7%	0.0%	0.0%	0.1%	100.0%
	<b>Go Home</b>	62.8%	25.3%	2.9%	4.3%	1.6%	3.1%	100.0%
	<b>Other</b>	40.6%	16.1%	24.9%	1.3%	7.9%	8.5%	100.0%
	<b>All Purposes (100%)</b>	50.4%	21.1%	19.3%	3.6%	1.9%	3.0%	100.0%

1  
2

**Table 3. Average Trip Travel Times, Distances, and Trip Rates to Various Activity Types**

		Undergraduate	Graduate Student	Faculty	Staff
Trip Duration (minutes)	Work/ Work Related	22.45	23.37	21.82	22.94
	School/ School Related	18.99	19.58	16.48	16.66
	Eat Meal	13.74	14.32	13.16	12.14
	Social/ Recreational	21.18	19.89	18.05	19.64
	Shopping	16.21	14.54	15.30	17.09
	Personal Business	18.00	20.34	15.79	18.69
	Serve Passenger	20.61	19.06	16.97	18.84
	Go Home	22.01	22.08	23.85	24.54
	Other	22.18	22.04	21.56	19.35
	Intra-Campus	8.92	7.49	6.21	7.59
	Inter-Campus	53.10	50.35	38.50	51.52
	To/From Campus	26.54	22.82	27.67	27.43
	Non-Campus Based	20.96	21.41	19.84	19.42
	All Trips	19.73	20.18	20.23	21.00
Trip Distance (miles)	Work/ Work Related	7.8	9.0	9.9	8.3
	School/ School Related	4.7	5.7	4.9	4.4
	Eat Meal	3.5	3.8	3.2	3.1
	Social/ Recreational	7.8	6.4	5.8	5.2
	Shopping	4.5	4.1	5.4	5.7
	Personal Business	8.2	7.8	5.3	6.6
	Serve Passenger	8.1	7.8	7.2	7.2
	Go Home	7.3	9.2	8.3	9.0
	Other	9.0	6.6	7.5	9.0
	Intra-Campus	0.6	0.5	0.4	0.5
	Inter-Campus	18.3	20.8	18.5	20.1
	To/From Campus	7.6	5.9	8.8	10.0
	Non-Campus Based	8.4	9.0	9.7	7.6
	All Trips	6.2	7.1	7.8	7.6
Trip Rate	Work/ Work Related	0.41	0.60	1.58	1.62
	School/ School Related	1.36	0.93	0.33	0.07
	Eat Meal	0.52	0.38	0.27	0.39
	Social/ Recreational	0.31	0.24	0.19	0.20
	Shopping	0.22	0.23	0.19	0.29
	Personal Business	0.20	0.18	0.23	0.29
	Serve Passenger	0.12	0.10	0.30	0.25
	Go Home	1.20	0.99	1.02	1.09
	Other	0.34	0.24	0.20	0.38
	Intra-Campus	1.21	0.52	0.75	0.64
	Inter-Campus	0.04	0.03	0.01	0.04
	To/From Campus	1.35	1.12	1.48	1.71
	Non-Campus Based	2.09	2.22	2.06	2.19
	All Trips	4.69	3.89	4.31	4.57

3  
4  
5

Trip rates (the third block of the table) are calculated by dividing the total number of trips by the total number of respondents in the respective segment. This means that trip rates account for

1 zero-trip makers. The trip rates for intra-campus trips appear to be rather low for all segments.  
2 However, these rates should be viewed in the context of about 13% of respondents reporting zero  
3 trips on the travel survey day, and another 31% of respondents who report trips but do not visit  
4 an ASU campus at all on the travel survey day. It is also possible that there is some under-  
5 reporting of intra-campus trips, as it is quite burdensome to report each and every movement  
6 within a campus environment.  
7

## 8 **CHARACTERISTICS OF DAILY ACTIVITY PARTICIPATION**

9 This section explores the activity participation behavior of the university community. Activity  
10 participation information was derived from the trip data collected in the survey. Only those  
11 respondents who reported making at least one trip were included in the activity participation  
12 analysis (all others are assumed to stay home all day). Trips were included in the activity  
13 analysis as “travel” activities (episodes). It was assumed that each respondent began his or her  
14 day at home, and each subsequent activity was assigned a purpose corresponding to the  
15 destination of the trip leading up to the activity. For example, if trip number one was recorded as  
16 a school trip, then activity number one is home stay (assumed), activity number 2 is travel, and  
17 activity number 3 is school. Table 4 presents statistics concerning activity participation for each  
18 segment of the ASU community.

19 The average daily time expenditure is shown in the table for various activity purposes. In  
20 addition, the table shows the percent of day spent each activity purpose, and the percent of all  
21 respondents who participated in each activity. A summary of maintenance, discretionary, and  
22 mandatory activities is shown at the bottom of the table. In this paper, mandatory activities are  
23 the aggregation of all work, school, work-related, and school-related activities, maintenance is  
24 combined shopping and personal business, and discretionary is combined social or recreational  
25 and eating a meal (outside the home). Mandatory, maintenance, and discretionary activities  
26 performed inside the home are not included in these summaries.

27 Since the activity participation dataset was limited to those respondents who made at least  
28 one trip, 100% of every segment participated in travel. Also, because the first activity was  
29 assumed to be at home for every respondent, 100% of every segment participated in in-home  
30 stay activities. Across various segments, the time spent in maintenance activities differed very  
31 little. However, the percent of staff members who participated in maintenance activities is  
32 greater than for any other segment. This could indicate that staff members are likely to have  
33 more responsibilities to the household or family than other segments.

34 As expected, faculty and staff spend a larger portion of their day in mandatory activities than  
35 students. In addition, a slightly larger proportion of faculty and staff participate in mandatory  
36 activities when compared to students. Staff spends a larger portion of the day in work activities,  
37 relative to any other segment. However, one should keep in mind that teaching classes was  
38 considered a school activity. Therefore, school and school-related activities are, in fact, work  
39 activities for faculty respondents. Based on this interpretation, faculty members spend 32  
40 percent of their day on work (and teaching class), while staff spend 33 percent of their day on  
41 work.  
42

**Table 4. Activity Participation by Segment**

Activity	Average Daily Time Spent (min)				Average Portion of the Day Spent				Percent of Segment that Participated			
	UGs*	Grads**	Faculty	Staff	UGs*	Grads**	Faculty	Staff	UGs*	Grads**	Faculty	Staff
All In-Home	826.6	806.0	773.6	721.0	57%	56%	54%	50%	100%	100%	100%	100%
Travel	133.8	107.1	105.5	116.8	9%	7%	7%	8%	100%	100%	100%	100%
Work/Work-Related	130.1	193.7	396.8	471.6	9%	13%	28%	33%	37%	47%	85%	93%
School/School-Related	195.9	211.8	54.7	9.6	14%	15%	4%	1%	74%	63%	21%	5%
Eat Meal (Out of Home)	36.3	30.3	18.5	24.8	3%	2%	1%	2%	43%	37%	25%	32%
Social Recreation/Sport	45.6	36.9	30.7	27.0	3%	3%	2%	2%	24%	22%	18%	17%
Shopping	14.6	16.1	10.9	15.1	1%	1%	1%	1%	19%	21%	19%	24%
Personal Business	18.7	13.2	19.4	21.1	1%	1%	1%	1%	15%	15%	19%	19%
Serve Passengers	6.5	3.2	14.7	8.5	0%	0%	1%	1%	8%	6%	16%	13%
Other Activities	31.9	21.7	15.2	24.4	2%	2%	1%	2%	21%	14%	14%	17%
Total Discretionary	81.9	67.3	49.1	51.8	6%	5%	3%	4%	55%	49%	36%	42%
Total Maintenance	33.3	29.2	30.3	36.3	2%	2%	2%	3%	31%	32%	33%	39%
Total Mandatory	326.0	405.5	451.5	481.1	23%	28%	31%	33%	89%	90%	93%	94%

\* Undergraduate students; \*\* Graduate Students

Perhaps somewhat surprising is the proportion of the day that students spend in the home. Compared to staff members, for example, undergraduate students have a home time allocation proportion that is six percentage points higher (corresponding to 90 additional minutes in home per day). This is rather counter to the notion that students spend their time being social and having fun. This is not to say, however, that students do not spend time being social. Table 4 indicates that 55% of undergraduate students (compared to 36% of faculty) spend some time in discretionary activities each day. This 55% spends on average about 6% of their day on discretionary activities – more than any other segment.

Faculty and graduate students spend just over 7% of their day (about 100 minutes) in travel. In comparison, staff members spend 8% and undergraduate students spend 9% of their day on travel. This could largely be due to the distance between home locations and campus. As noted in Table 3, staff members spend on average more time on a typical home-bound trip than any other segment. The additional travel time for undergraduate students could be indicative of longer distances traveled or, more likely, of simply having a larger trip rate than any other segment. This segment may also be using slower modes (due to a higher level of zero vehicle ownership). Also, undergraduates who live on campus have the flexibility to return home (to the dormitory) in between classes and other responsibilities, which is likely the reason for the larger trip rate seen in Table 3.

An analysis of what each person is doing along the continuous time axis of a day is a useful way to visually understand and compare temporal activity patterns through the course of a day. Figure 2 shows the time-of-day activity engagement profiles different university groups. At each time point, the profiles indicate the percent of each segment engaged in each type of activity. The time axis covers a 24 hour period beginning at 3:00 AM and ending at 2:59 AM on the following day. One can clearly see the times of day when a large proportion of individuals are at home. In general, a vast majority of individuals are at home during the overnight hours although it appears that a small percent of individuals work the night shift or engage in social recreational activities late into the night and the very early morning hours. A small percent of students engage in school related activities in the overnight hours, which is not unexpected.

When compared to faculty and staff, a vast majority of whom are working during the middle of the day, students are found to stay at home in larger proportions, presumably because they neither have school nor work at that time. The non-home, non-mandatory activities (personal business, eating meal, shopping, social/recreation, etc.) are clearly bunched at the end of mandatory activities and before going home in the faculty and staff profiles. This does not hold true, however, for students who seem to distribute their non-home, non-mandatory activities more evenly from about mid-day until very late at night.

The percent of individuals pursuing work and work-related activities at any given time is shown in blue while school and school-related activities are shown just above in red. Students tend to work in the afternoon and distribute school activities evenly throughout the day. Graduate students, however, tend to work a bit earlier in the day and participate in school more in the afternoon and evening (consistent with the large percent of part time graduate students). Faculty members are found to engage in work activities in greater proportions than staff members in the latter part of the day; larger proportions of staff members engage in work activities earlier in the day, showing a clear work “peak” in the AM.

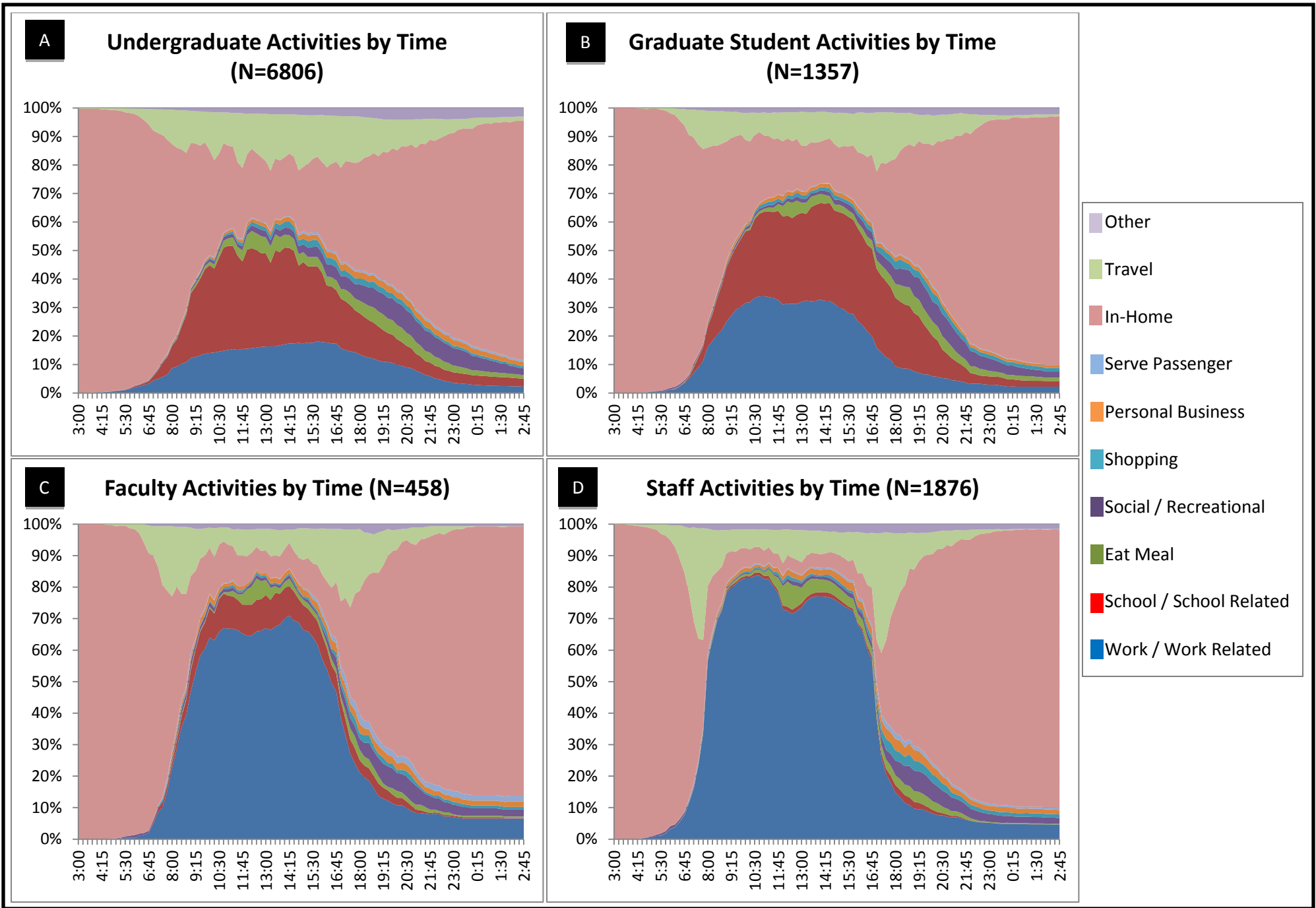


Figure 3. Time-Of-Day Profiles for (A) Undergraduates, (B) Graduate Students, (C) Faculty, and (D) Staff

1 It is worth noting that the cyclical peaks and valleys in the student profile (very clearly  
2 discerned in the travel engagement profile at the top of the chart in light green) during the middle  
3 of the day may be attributed to ASU class schedules. A typical class at ASU lasts for 75 minutes,  
4 with a 15-minute break between the end of one class and the start of the next. The profile for  
5 undergraduates shows that students travel during these 15-minute breaks, and then settle back  
6 into class or another activity. If one were to visit the ASU campus during a typical semester  
7 weekday, one would note the massive surge of students that crowd the campus walkways during  
8 these 15-minute breaks between classes. The jagged edge of the travel and activity engagement  
9 profiles is remarkably aligned with class start and end times in a typical weekday schedule.

## 10 11 **CHARACTERISTICS OF TRIP CHAINING**

12 Of particular interest to developers of activity-based models is trip chaining behavior. Models of  
13 activity scheduling may be enhanced by understanding the types of trips that occur in a multi-  
14 stop chain, the ordering of trip purposes, the length of the tour, and the time allocated to a tour.  
15 For the analysis of trip chaining in this paper, home-based trip chains are defined as a series of  
16 activities in a closed loop beginning and ending at home. For example, a home-based ASU tour  
17 may be one that involves a departure from home, a stop at a coffee shop, proceeding to an ASU  
18 campus, and then going back home. This example tour would have two activity locations outside  
19 home: coffee shop and ASU. The specific purpose of the trip to ASU is not considered in this  
20 analysis. The exception to this is the case of on-campus residential students. For these students,  
21 trips to the ASU campus were separated into home (dorm) and all other purposes, so that a trip  
22 from the dorm to somewhere else on campus and back to the dorm would be counted as a home-  
23 based trip chain.

24 Table 5 presents a summary of home-based trip chaining behavior derived from the ASU  
25 travel survey. The data presented is unweighted so that the raw profile may be gleaned from the  
26 table. While undergraduate students have the greatest number of tours per trip maker, staff  
27 members spend the longest time (duration) on home-based tours. Staff members are likely to  
28 spend full work days on campus; couple this with the longer commute times and the longer tour  
29 durations can be easily explained. A large proportion of undergraduates, on the other hand, live  
30 on campus or in neighborhoods very close to campus; they can make return home trips in the  
31 middle of the day, thus resulting in shorter duration home-based trip chains (but a higher  
32 frequency).

33 Though faculty and staff seem to have slightly more locations per tour, every segment has  
34 between 2.5 and 3.0 out of home stops per tour (on average). About 60% of all home-based tours  
35 have a stop at ASU for all groups. Students make more home-based trip chains in a day, but  
36 spend on average less time per trip chain. Students generally do not have to stay on campus as  
37 long as faculty and staff members do, and the close proximity of the home location to campus  
38 allows temporary midday home sojourns.

39 Table 5 provides a breakdown of the “1<sup>st</sup> stop.” This refers to the location visited  
40 immediately after departing home. One can see that a majority travel from home directly to  
41 either ASU or work. Faculty, and to a lesser extent staff, are likely to travel for serve-passenger,  
42 reflecting drop-off events that tend to occur on the way to and from work. A small portion of “1<sup>st</sup>  
43 stop” types are home, indicating a home-to-home trip. Many of these trips are “walk the dog”  
44 type trips, where a person leaves the home, participates in some activity like walking the dog and  
45 jogging, and then returns home. For undergraduate students this is also partly comprised of trips  
46 from one “home” to another. Undergraduates often stay on campus or in an apartment near

1 campus, but also still consider their parents’ homes as their own. Therefore, undergraduates who  
 2 made trips from their dorms to their parents’ homes coded them as “Go Home” trips.

3

4 **Table 5. Analysis of Trip Chaining Behavior**

	Undergraduates	Graduate Students	Faculty	Staff	All	
Number of Home-based (HB) Trip Chains	9486	1606	531	2167	13790	
Avg HB Chains per Person	1.20	1.00	1.02	1.09	1.15	
Avg HB Chains per Trip Makers	1.39	1.18	1.16	1.16	1.31	
Avg HB Chain Duration (min)	353.9	444.8	454.1	521.7	394.7	
Avg Stops/HB Chain	2.59	2.59	2.82	2.90	2.65	
% HB Chains with ASU Stop	62%	58%	58%	62%	61%	
<b>Purpose of the 1<sup>st</sup> Stop</b>	Work / Work Related (not ASU)	12%	18%	18%	16%	14%
	School / School Related / Campus	52%	47%	40%	46%	50%
	Eat Meal	7%	6%	5%	5%	6%
	Social / Recreational	6%	8%	7%	6%	6%
	Shopping	5%	6%	5%	5%	5%
	Personal Business	4%	5%	6%	5%	4%
	Serve Passenger	4%	3%	12%	9%	5%
	In-Home	4%	2%	2%	2%	3%
	Other	7%	6%	6%	7%	6%
<b>Purpose of Stop Following Last ASU Stop</b>	Work / Work Related (not ASU)	5%	3%	7%	6%	5%
	School / School Related / Campus	1%	2%	1%	0%	1%
	Eat Meal	7%	9%	4%	5%	7%
	Social / Recreational	3%	4%	4%	4%	4%
	Shopping	4%	6%	6%	10%	5%
	Personal Business	3%	3%	5%	8%	4%
	Serve Passenger	2%	2%	7%	6%	3%
	In-Home	67%	67%	63%	54%	65%
	Other	6%	4%	4%	7%	6%
% of Tours that are Home-ASU-Home	17%	15%	15%	14%	16%	

5

6 Table 5 also provides detail on the type of location visited directly after the last ASU stop in  
 7 the chain. For all segments, a good majority go straight home from ASU. The proportion of  
 8 students reporting that they proceed to eat-meal after the last ASU stop is larger than that for  
 9 faculty and staff members. As in the 1<sup>st</sup> stop on the tour, staff are likely to serve passengers after  
 10 leaving ASU. Staff members are more likely than any other segment to run errands after leaving  
 11 ASU, indicated by the higher percent of shopping and personal business stops. This supports the  
 12 notion that staff may have more family or household responsibilities than any other segment.

13 Activity schedule modelers may be interested to see that 17% of undergraduate and 15% of  
 14 graduate student and faculty home-based tours are simple home-ASU-home tours. In other  
 15 words, they travel from home directly to ASU and then directly back home again.

16



## 1 **DISCUSSION AND CONCLUSIONS**

2 This paper describes trip making, activity participation, and trip chaining behaviors of  
3 undergraduate students, graduate students, faculty, and staff at Arizona State University, one of  
4 the largest universities in North America. Data was collected from the ASU population by means  
5 of an online travel survey. Although large universities represent significant special generators of  
6 travel demand in many large metropolitan regions, the daily activity-travel behavior of university  
7 populations is not well understood. In this paper, detailed analyses of travel characteristics,  
8 activity participation, and trip chaining behavior for students, faculty, and staff are presented.  
9 Several notable patterns come to light through the analysis presented in this paper.

10 Consistent with the results of other university population surveys, university students travel  
11 profile deviates from the typical time-of-day distributions of travel. While the general population  
12 displays an AM and PM peak hour of travel and a smaller peak at midday, students distribute  
13 their travel much more evenly throughout the day and tend to concentrate trips during the middle  
14 of the day. Student travel profiles show a larger percent of trips being made very late at night in  
15 comparison to other segments. Though the mode choice of all segments of the population is  
16 dominated by driving alone, undergraduate students show a greater share of carpool trips,  
17 particularly for social, recreational, and shopping activities. This is probably due in part to the  
18 greater share of undergraduate students who do not have access to a personal vehicle and must  
19 rely on friends and family to travel to destinations farther than walkable distance.

20 The paper presents detailed tabulations of average trip rates, trip lengths, and trip durations  
21 by purpose. In general, it is found that staff members tend to reside farther away from campus  
22 locations and drive longer distances to and from work. Staff members spend more time traveling  
23 to shopping and personal business locations while faculty members, in general, spend less time  
24 than other segments doing any traveling at all, with the exception of the home and work trip  
25 times.

26 An examination of daily travel and activity time expenditure patterns suggests that  
27 undergraduates spend more time than any other group on discretionary activities. Even though  
28 undergraduate students spend a greater amount of travel time on chauffeuring trips than faculty  
29 or staff, they are less likely than faculty or staff to participate in these activities; only 8% of  
30 undergraduate students participate in serve passenger activities on a typical day. This observation  
31 suggests that undergraduates are serving passengers to/from farther distances. Similarly, graduate  
32 students spend less time than any other segment participating in personal business activities, but  
33 more time traveling to those activities. Graduate students may be willing or need to travel farther  
34 for personal business, even though the activities themselves take less time.

35 The analysis reveals some interesting differences between faculty and staff at ASU. A trip  
36 chaining analysis shows that a combined 18% of staff members stop at shopping or personal  
37 business locations – activities generally thought of as running errands – immediately after their  
38 last ASU stop and before returning home. This, coupled with the greater time that staff spend  
39 both traveling to and participating in these “errand” activities, indicates that staff members likely  
40 take on more household or family maintenance burden than faculty members. Recent literature  
41 on the travel patterns of women might suggest that this behavior is more indicative of that of  
42 females in households with children (McGuckin and Murakami, 1999); additional investigation  
43 is need to fully unravel the complex reasons for the differences between faculty and staff  
44 member household responsibilities and associated travel and activity participation behavior.

45 In conclusion, a rich data set on university population travel behavior has been collected by  
46 conducting a survey of faculty, staff, and students at Arizona State University. This data has

1 made it possible to analyze and document the daily activity-travel patterns of the university  
2 community. The analysis presented in this paper is just a small sample of the possible analyses  
3 that could be undertaken using the dataset obtained from the survey. The analysis shows that  
4 university communities are considerably heterogeneous with respect to their travel and activity  
5 participation, although the different market segments were also observed to show similarities on  
6 selected activity-travel characteristics. Universities, especially those with large enrollments,  
7 constitute special generators of travel demand and the data analysis reported in this paper is but a  
8 first step in the development of comprehensive activity-travel demand models specifically  
9 constructed for university environments.

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