An Exploration of the Internet's Effect on Travel

Submission Date: 8/01/2006

Heather Contrino
NHTS Program Manager
Federal Highway Administration
Office of Highway Policy Information, Room 3300
400 7th Street SW
Washington, DC 20590
202-366-5060
Heather.Contrino@fhwa.dot.gov

Nancy McGuckin (corresponding Author)
Travel Behavior Analyst
3932 Garrison St. NW
Washington, DC 20016
202-248-8640
N_McGuckin@rocketmail.com

Abstract

The relationship between the Internet and travel is complex. Early research on the effect of Internet use on travel addressed the complexity surrounding travel choices. However, the literature has often framed the Internet effect on travel using elements of the traditional information and communications technology (ICT) theory, searching for Internet –travel relationships in the context of the subtraction and addition of trips.

We offer up a new paradigm for describing the effect of the Internet on travel. Rather than attempting to identify substitution, modification, and/or complementary effects, we note that there are several tools to accomplish daily activities, including travel and the Internet. We contend that the effect on travel is dependant on the availability and utility of the Internet applications to accomplish various daily activities.

The exploratory analyses presented looks at the impact of e-commerce on home delivery of goods, and the Internet as a possible explanation for shifts in time use. Our research shows that we may be seeing trends in the amount of time spent at home and the miles of travel by purpose for the cohort of early adopters of Internet use.

This paper depends on data from the National Household Travel Survey (NHTS). The NHTS is the only national data source where both technology use and access are included with travel day data. In addition, data from the USPS Household Diary Study (HDS), Current Population Survey (CPS), and American Time Use Survey (ATUS) are used for comparisons, context, and benchmarks.

Words: 245

Keywords: Internet and Travel, Activities, Internet Shopping, Package Delivery, E-commerce and Travel, Mouse Potatoes, Home Delivery, On-Line Shopping, Travel Behavior and Time-Use

The Internet and Travel: Overview

The Internet continues on its path of becoming a universally adopted life tool with a myriad of communication, consumer, and research applications. The impact of this technology mirrors the large-scale change brought on by previous inventions such as the automobile and telephone, which truly transformed the communication and travel behavior of American households. In hindsight, the evolution of the changes in American interactions and lifestyles during the adoption of these new technologies can be easily identified. Imagine though, researching and predicting the effect of the television on American behavior and activities in 1948 when only 1 million households owned a television set[1].

In the early era of television, the hardware was bulky with restricted functions and the geographically limited broadcasts mimicked radio shows in content and length. Now, television broadcasts across the globe and viewing accounts for half of all leisure time, according to the American Time Use Survey (ATUS). In addition, the applications, connectivity, and content of television continue to broaden.

The Internet is still a new technology. While adoption has reached about 60 percent of U.S. households, the technology surrounding the Internet, including integration with other mediums, speed of access, and the activities, goods, and services available via the Internet, are evolving. While we can imagine some of the Internet applications to come, future Internet capabilities and its impact on U.S. household activities and behavior, including travel, are largely unknown.

Solomon created the existing paradigm of travel in the context of telecommunications in the late 1980's, which was subsequently applied to Internet use. Solomon established four types of potential travel impacts (5): substitution, modification, complementarity, and neutrality (8). As the labels would infer, substitution is the replacement of trips due to Internet technology, complementarity the addition of trips, neutrality refers to no change or influence, and modification explains the shifting of trip routing, grouping, or timing (8).   In the two decades following Solomon's pivotal work, a wealth of research exploring the potential Internet-travel relationships has been put forth.

Much of this early research focused on the effect of telecom on human behavior, including travel. In his early research, John Niles aligned the use of telecom as a substitute for transportation as "telesubstitution" (6). His research, not limited to the Internet, focused on all advances in telecom including telephone, Internet, and Intelligent Transportation Systems (ITS). Hiltz, in her examination of on-line communities for work and education, focused on the increases and decreases in travel and found virtually no effect for the majority of participants (2).

In more recent research (2001), Niles contends that the steady growth of both telecom and travel demand over the past two decades shows that there is little reason to assume that the overall effect of telecom is a net reduction in trip making (3). Niles typology excludes the "no change" outcome from Solomon's work, concentrating on travel substitution, travel stimulation, and travel modification and how telecommunications affect the movement of goods and people. "Overall, the net effect of the changes that expanding telecom brings to travel patterns is very complex and not predictably a cause of reduced overall travel demand." (3).

---

[1] http://inventors.about.com/library/inventors/bl_television_timeline.htm

While various researchers have addressed the complexity of the interrelationships between telecom and travel over the last two decades (Solomon, Niles, Mokhtarian, Black, Gould), much of the work surrounding Internet applications and travel has sought to identify direct relationships. Moving from telecommuting and distance learning to goods purchases, the focus of Internet–travel research has evolved in-line with new applications of the Internet. Research on new applications, such as shopping, typically focuses on the loss or addition of trips comparing Internet users to non-users.

Cubukcu (2001) examined the factors that affect shopping trips to see if the demand for on-line shopping has an observable effect on the number of personal shopping trips (5). Using an estimated model, Cubukcu found a net decrease in shopping trips of 6.15 million annually for a 1 percent increase in Internet access. Using data from a household travel survey in Sacramento, CA, Zmud found a complimentary or stimulation effect on shopping trip rates among Internet shoppers (1). Mokhtarian (2003) found substantial empirical evidence of a net complementarity relationship between the Internet and travel. She argues that studies focusing on a single application of the Internet often find substitution effects while more comprehensive efforts are able to observe the complementarity effects of telecom on travel (12).

The issue, however, may not be whether people travel more or less for different trip purposes depending upon the type and intensity of Internet use. Rather, the challenge lies in the ability to parse out the potential relationships in the complex and inter-connected activities and lifestyles of American households with the Internet as a factor.

The relationship between Internet use and transportation is a complicated and rapidly changing phenomenon (3). In addition, the net effects of the Internet and travel may be difficult to isolate as multiple shifts are happening simultaneously (12). While substitution and addition effects may be a reflection of current patterns of Internet use, the exploration of shifts in travel characteristics and time use provides hints of future effects of the Internet on travel behavior.

In the winter of 2000, several leaders in the transportation and telecom communities met at the Social Change and Sustainable Transport (SCAST) conference. William Black of Indiana University produced the summary of activities and contends that little is known about new technologies and how they will affect individual travel behavior (4). In line with the modification effect of the Internet on travel, Wachs, in his presentation at the SCAST meeting in January of 2000, predicted that travel would be more broadly distributed across space and time (4). This dispersion across space and time will be one of the major factors that will allow us to manage an enormous increase in traffic volumes without enormous increases in congestion (4).

Ferrell (2004) furthered this exploration by not only looking for substitution, modification, or complimentary effects, but also searching for the specific time and activity effects of teleshopping (7). Ferrell uses a series of models to examine the effects of teleshopping on the number and distance of trips for the purpose of shopping. His research indicates a complimentary effect of home teleshopping on the number of shopping trips and chained shopping trips, but found no differences in shopping travel distances. In their research, Gould and Golob (2002) examined the relationships between Internet shopping activities, demand for routine goods, land use and travel. Noting the interrelationships between travel, land use, and activities, Gould and Golob contend that localized e-commerce can alter the characteristics of travel and specifically found a reduction in trip chaining within their study population (13).

This paper offers up a new paradigm for describing the effect of the Internet on travel. Rather than attempting to identify substitution, modification, and or complementarity effects, we note that there are several tools to accomplish daily activities, including travel and the Internet. The effect on travel may be dependant on the availability and utility of the Internet applications to accomplish a spectrum of daily activities, and on the new uses, mechanisms, and products that may shift time use.

We contend that the Internet and travel both serve as a vehicle for completing purposeful activities. Table 1 provides a classification of activities in the travel context, examples of Internet applications that apply to those activities, and some potential travel implications or impacts of carrying out the activity via the Internet. The effect on travel is dependant on the availability and utility of the Internet applications to accomplish these activities, or to induce new activities, travel, or ways of using time.

The Internet's effect on travel is apparent in two areas: (1) When the Internet supports travel choices including trip frequency, purpose, and time of day, route choice, and distance. This is evident in communication and research and tools such as real time travel information, and mapping and route choice services such as Mapquest. (2) When the Internet is a more attractive vehicle for completing a task. This is evident in activities such as shopping or banking in that the activity is carried out on the Internet instead of going to the location via travel.

These two impact areas do not simplify the relationship between the Internet and travel. Rather, they demonstrate the complexity and dependency on activity type and choices in means for completing the activity. Internet effect on travel is not merely an addition or substitution of trips. There is a complex interrelationship that will potentially impact the way households go about their daily lives, including the characteristics of travel.

Using the National Household Travel Survey (NHTS) series in conjunction with the Current Population Survey (CPS), American Time Use Survey (ATUS), and the USPS Household Diary Study (HDS), this paper examines internet penetration and the overall characteristics of the people in households with Internet access and without, including the number of daily trips and results of looking for purpose shifts to help further the previous research. Secondly, we look at two sectors of evolving Internet use and potential influence on travel—the impact of e-commerce on home delivery of goods, and the potential impacts in time use of Internet use.

Table 1 – Common Daily Activities and Potential Travel Impacts of Internet Use

| Purpose/Activity	Examples	Potential Travel Impacts
Social/Recreational	• Movie Guides/Ticket Purchase (Fandango) • Restaurant/club listings • Sports (fantasy baseball, poker) • Gaming and game information • Web "surfing"	• May increase or decrease recreational travel • Changes in route choice, mode and time of day • May change daily time-use • "Appointment" Internet may increase at-home time
Communications/Social Network	• E-mail • On-line communities (MySpace, MSN Groups, weight watchers, etc.) • Instant messaging (IM) • Blogs/fan clubs/ • Personals/On-line dating •	• Wider social networks encourage wider travel, more visiting friends • Last minute social gatherings may change number and type of visit trips • May decrease visit trips and/or increase trip length
Shopping	• EBay/classifieds • Music/software/game downloads • Movie rentals (Netflix) • Drugs, books and music • Toys/electronics/apparel and flowers/cards/gifts misc. • Grocery and household goods	• May increase or decrease shopping trips • Change from residential-based to commercial delivery trips
Information	• News and articles • Product research • Medical information • Directories/Resources • "Surfing"	• Fewer newspaper deliveries • Fewer library visits • May change destination and/or miles/route • Less time at destinations • More time at home
Personal Business	• Banking/Bill pay/Taxes • Professional services • Government services	• May decrease personal business trips • May change type and location of trips
Work and work-related	• E-mail • Distance learning, Web-enars • Employment search and application • Tele-commuting	• Time of day • Change in number and type of work-related trips • May decrease work trips, may increase other trips
Trip Planning	• Mapquest • Traveler Information sites • Airline/Hotel/Rental Car • Google earth	• Route choice • Mode shifts • May increase of long-distance trips • May change destination choice for long-distance

Getting Wired: Internet Penetration and Use

Computer ownership and Internet access and use are growing rapidly throughout the United States. According to Current Population Survey (CPS), 61.8 percent of households owned a computer in 2003, up from 42.1 percent in 1998 (9). Internet access has grown at similar rates. In 1998, one-third (32.7) of U.S. households had Internet connections, five years later it was well over half (54.6 percent in 2003) (9). More recent data from the 2005 USPS Household Diary Study show household Internet access at 52 percent in 2000 compared to 76 percent 2004. This is consistent with the 70 percent of households with Internet access represented in the 2001 NHTS data.

Although recent history shows a quick adoption if Internet, the National Telecommunications Information Administration (NTIA), using 2003 Current Population Survey data, suggests a slow down in growth trends for U.S. household Internet adoption (9) as shown in Figure 1. NTIA cites only a 4-percentage point increase in the number of households with Internet connections from 2001 to 2003. Between 2000 and 2001 alone, the number of household with Internet access had increased by almost 9 percentage points.

While Internet adoption by U.S. households has begun to slow, the type of Internet connection used by households is changing. Broadband adaptation has seen significant growth. In 2001, only 9 percent of household had a broadband Internet connection. In 2003, that number has grown to over 19 percent (9).

Figure 1 –Percent of US Households with Internet Access, 1997 - 2003
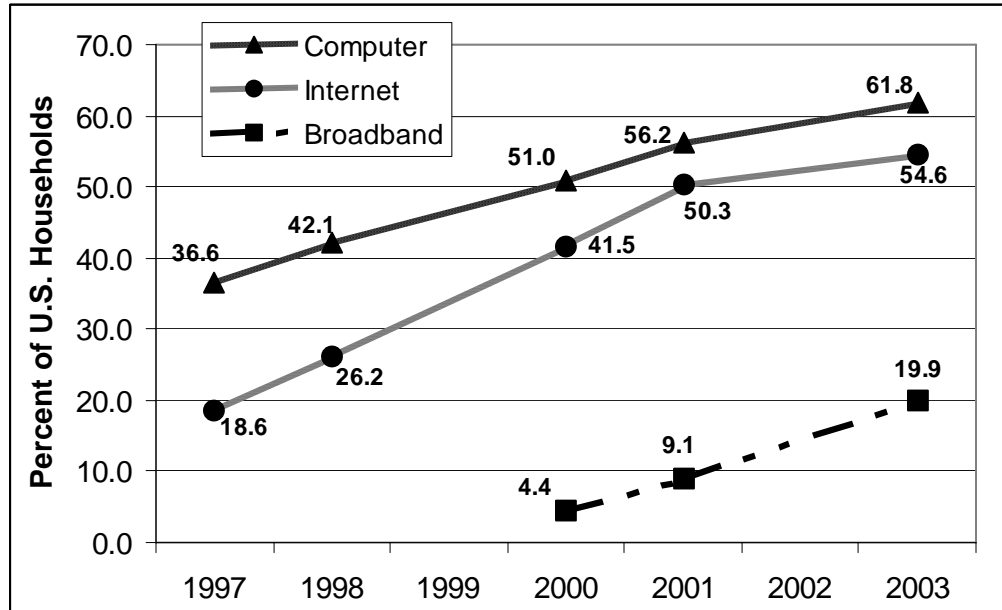
Source: Current Population Survey, October 1997, December 1998, August 2000, September 2001, October 2003 and National Telecommunications and Information Administration report *A Nation Online: Entering the Broadband Age*, 2003.

One of the confounding factors in comparing travel for people with and without Internet access is the socio-economic differences between people who have access and those who do not, as shown in Table 2. Particularly striking is the difference in the characteristics highly associated with

travel: for example, age, worker status, income and occupation. These socio-economic factors are correlated with both travel and Internet access, and may account for the higher trip making for people with Internet access. Households with teens, rural households and people in professional and technical occupations are more likely to have Internet access.

Table 2—Profile Of People Ages 16-65 With Access to the Internet and Without

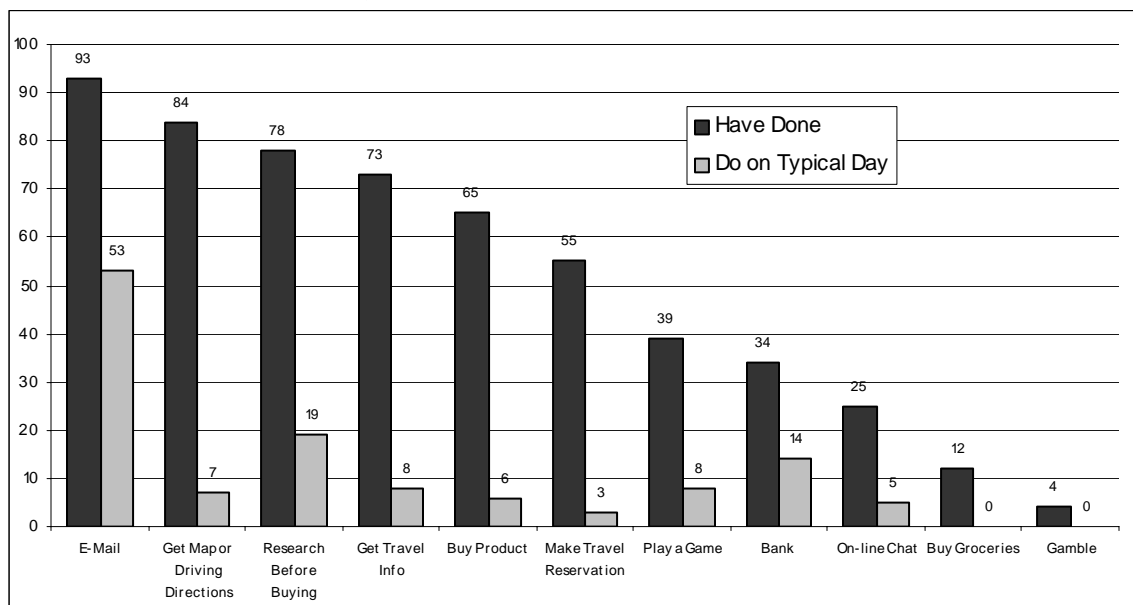|	Internet Access	
	Has Access to Internet	**Does Not Have Access to Internet**
Percent of NHTS Households	67.8	32.2
Percent of Household that are Urban	78.5	79.9
Percent of Households that are Rural	21.4	20.1
Percent of People who are Workers	77.9	48.7
Percent of Men	83.9	59.4
Percent of Women	72.0	38.0
Percent of Households by Income		
<$50K	41.0	74.7
$50-100K	27.4	7.3
$100K+	15.9	2.1
No Answer	15.7	16.0
Total	100.0	100.1
Household Lifecycle		
HH w/ no Child	35.9	36.0
HH w/ Child <15	33.2	33.6
HH w/ Teen(s)	6.1	5.3
Retired HH	24.8	25.1
Total	100.0	100.0
Mean Age	39.4	52.1
Occupation		
Sales/Service	19.7	15.1
Cleric/Admin	9.5	3.4
Manufacturing/Const	11.2	17.8
Prof/Tech/Managerial	32.7	7.2
Other	26.9	56.5
Total	100.0	100.0
Daily Trips (Workers)	4.8	3.9
Men	4.6	3.8
Women	4.8	3.9
Daily Trips (Non-Workers)	4.4	3.4
Men	4.0	3.3
Women	4.3	3.0

People with Internet access make about one trip more per day than those with no access, overall. This is true for workers and non-workers, as shown in Table 2. We also examined the number of

trips by purpose, and found overall higher amounts of work, shopping, personal business, and recreational travel for people with Internet access.

Home Delivery: E-Commerce and Changes in Commercial Traffic

Much of our daily household business, correspondence, and entertainment activities can be accomplished through the Internet. Tasks like buying and sending greeting cards, renting home movies, banking, and purchasing goods and services, which have traditionally generated trips, can be done from the comfort of home. Growing Internet activities also include gaming (e.g. Fantasy Football), address location (Mapquest), events/activities research, and weekly grocery shopping. The most common types of Internet use are shown in Figure 2.

Figure 2—Typical Uses of the Internet

Source: 2004 –2006 Pew Research Internet and American Life Project.

According to the latest data from the Pew Internet Project (2006), about 97 million people use the Internet in an average day. As shown in Figure 2, email is the most common use of the Internet; 93 percent of Internet users have emailed and 53 percent email on a typical day. Other widespread uses include obtaining maps or driving directions (84 percent), researching products and services before buying (78 percent), getting travel information (73 percent) and purchasing products (65 percent). In terms of purchases, areas of forecasted steep growth (above 30 percent) are in the home and personal categories such as home improvement, grocery, and over the counter drugs. ("Market Forecast: U.S. Retail 2004 – 2008," Jupiter Research, January 2004.)

The Internet has evolved to become a marketplace of goods, and on-line shopping has emerged as a separate area of research for transportation-related changes in behavior. The Internet enables consumers to enjoy access to a wide range of goods and services, in some cases at lower cost, with the convenience of having the selected books, block-buster movie, or drugs shipped to your residence or business.

9

Overall, compared to the immense retail market in the U.S. on-line retail expenditures are still small--2003 estimates put the total retail share for Internet sales in dollars at less than 2.0 percent of all sales. However, in some retail markets the penetration of on-line sales is impressive, notably computer hardware and software (32 percent of sales were on-line), books (12 percent), toys and video games (7 percent), and consumer electronics (6 percent). (Morgan-Stanley, The State of Retailing On-Line 6.0, 2003).

The availability of broadband, the diversification of the marketplace, and diminishing concerns about security, are expected to encourage even more users to shop on-line. Recent forecasts show the $65 billion of on-line retail sales in 2004 to grow by a compound annual growth rate of 17 percent through 2008 (Jupiter Research, January 2004. "Market Forecast: U.S. Retail 2004-2008"). Average spending per buyer is also expected to increase from $540 per buyer in 2003 to close to $780 per buyer by 2008. This would bring the 2008 on-line retail sales over $117 billion (14).

Many researchers note that Internet use is cyclical depending on the type of use and time of year. For instance travel and weather-related content sites show increased use during summer months as people plan their vacations. Students being home from school during summer results in overall increased activity on communication sites (blogs and chat rooms) and in IM activity (On-Line Publishers Association Internet Activity Index, June 2005).

Internet commerce, just like retail sales in general, is highest during the year-end holiday season, and drops in January. For just the 2005 holiday season, Nielsen Medial Research found that Internet purchases totaled $30.1 billion, and increase of 30% over the same period in 2004.

Shopping activities are aided by on-line gathering of information about what to purchase from traditional outlets, and it is possible that time spent gathering such information on the Internet may influence the number, timing and destination choice of traditional shopping trips. According to Deiringer Research Group (http://www.thedrg.com/) internet-influenced offline spending is 50 percent greater than online spending — meaning that for every $1 spent online, the Internet influences $1.50 in brick-and-mortar sales.

According to the HDS data, on-line purchases have become more common in the years between 2000 and 2004. Figure 3 shows the average number of on-line purchases in the previous month for surveyed households for the years 2000 through 2004. According to the US Postal Service, in 2005, US households received 2,712 million packages (2,138 via USPS), and about 863 million of those were from Internet orders (31.8 percent).

Figure 3 - Average Number of On-Line Purchases per Month
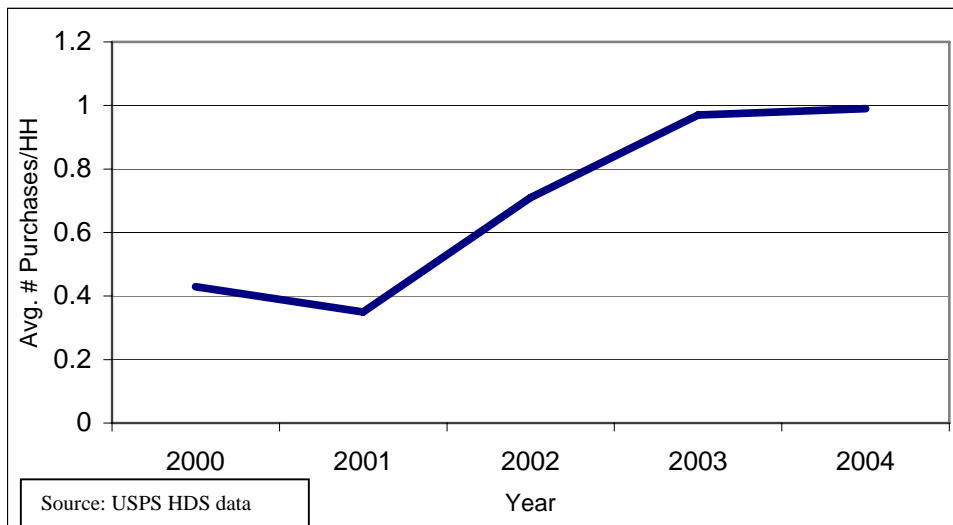
One unintended consequence of on-line shopping is the impact of delivery vehicles. "More online and telephone ordering by households and businesses creates more diverse sources of product supply and more package delivery." (3) A shift from residential-based travel to commercial package or service delivery is a change on the system that is difficult to measure at the household level. For example, commercial delivery may occur during weekdays while diverting residential-based travel form the weekends.

According to Highway Statistics, light-duty truck VMT is growing faster than freight or passenger car VMT. In addition, preliminary work by the NYSDOT has found potential increases in the light-duty truck sector of vehicle travel (Erlbaum) related to changes in package delivery. That research showed that possibly 3.7 billion VMT, or about 4 percent of the total residential household VMT in New York State, had been diverted from the household generating a shopping trip to commercial delivery vehicles delivering goods to the household.

Some supporting evidence comes from recently published work showing that there may be a slowing of growth in residential-based vehicle miles of travel (Polzin, et al. 2006), although current estimates of business and personal service vehicles and package delivery vehicles show a small impact on urban VMT. (Outwater, et al. 2005).

Overall, distributing e-commerce goods to households is a huge new demand on the transportation system, and there is great concern among the private sector about the ability of the current infrastructure to handle the capacity and speed demands of a virtual marketplace. Until recently, the fastest growing sectors of on-line sales and services came from areas that don't require delivery of a product (financial services, music, games, and software) or small packaged goods that are delivered via existing third-party vehicles (books, computers, and drugs). Future growth may come from consumer demand for more everyday needs—groceries, for instance--that require a new method of delivery and possibly are more infrastructure-dependent.

American consumers demand flexibility of delivery options for on-line purchases in terms of timed slots and specified delivery days, as well as overall improvement in reliability and reduction in cost. The ability of the local and national transportation systems to accommodate

demands of retailers and consumers for fast, flexible, on-time delivery of goods to households, and the potential growth in light-duty truck volumes that may accompany greater home delivery, will become an important policy and planning question in the future in all types of geographic areas.

Mouse Potatoes: Behavior Modification and Time Use

As a methodology, activity analysis is suited to study Internet – travel interactions because it begins with the assumption that activities motivate trip making (11). As the Internet offers alternative means for completing certain activities or groups of activities, then changes in activity patterns and by extension, a modification in trip characteristics, may follow. On-line activities such as shopping, communication, and information gathering have grown both as a practical convenience and leisure activity.

From a traditional focus on travel characteristics (trip rates, mode, distance, etc.), the genesis of this paper came from a new way of looking at the NHTS data. For activity analysis, the coding of time spent at home and out-of-home activities, as well as in travel tours categorized into various purposes, is required. The NHTS data for 1995 and 2001 had been coded into tours for previous research on trip chaining, but we had not explicitly examined the time at home and away from home. Our Internet-travel research began by breaking away from the focus on the substitution and addition of trips due to Internet activity. Instead, we began a comprehensive exploration of travel and time-use across Internet access and population groups.

When the data exploration was complete, two significant relationships emerged. First, the amount of time spent at home increased for both men and women in 2001 compared to 1995. Second, there appears to be a trend towards shorter trip distances for shopping and personal business activities among high access cohorts.

The NHTS shows that adults (16-65) spent more time at home –1 hour and 15 minutes a week – than they did in 1995. Simultaneously, we also see an increase in time spent using the computer from the ATUS. Men are spending 2 hours more a week at home (2001 NHTS) and two and a half hours per week using the computer at home for leisure activities (2004 ATUS). An intriguing clue came from gender differences in the effect. Women spent 30 minutes more per week at home in 2001 as compared to 1995 (NHTS data series) and spend only 90 minutes per week using the computer at home for leisure activities (ATUS). The first analysis was to see if the effect came from the growth in the number of people in the oldest cohorts (46-60 years old).

We found that the opposite—the youngest cohort showed the greatest change (as shown in Figure 5). Of people with Internet access at home, young people spent 43 minutes more at home, compared to 23 minutes for people aged 31-45, and just 11 minutes for 46-60 year olds compared to the same age groups in 1995 (we do not know about Internet access in the 1995 NHTS). We would like to compare this group of young people to the same aged people *without* Internet, but were surprised to find that even in 2001-2002 (the years the last NHTS were collected), 97 percent of the people 16-30 years old said that they had access to the Internet, 65 percent had access at home or at home and some other place, and more than half said that they used it every day.

Figure 5- Time Spent at Home by Age Group in 1995 and 2001 for People with Internet Access at Home
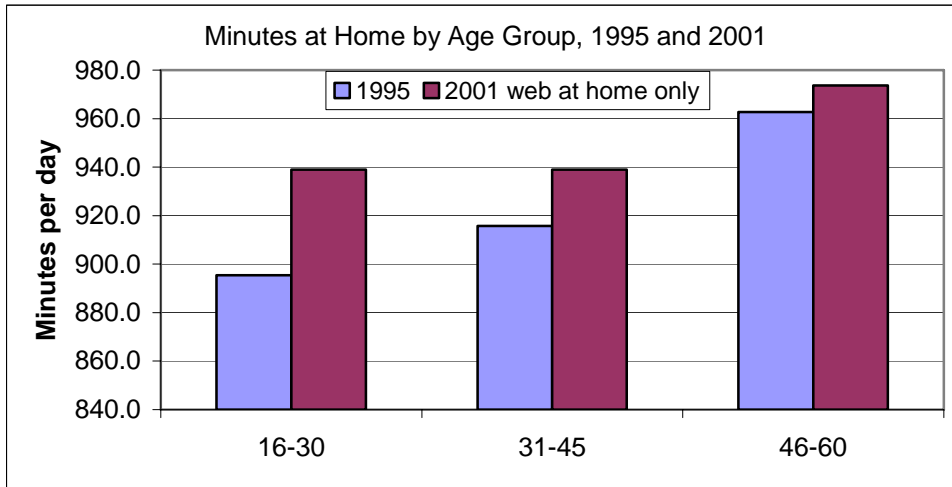
The shift in time came almost entirely from the minutes spent at destinations away from home as shown in Figure 6. This may reflect the use of the Internet, not only as a source of direct entertainment, but a source of information about off-line entertainment. The On-line Publishers Association (OPA) notes that in 2004, 40 percent of 18-34 year olds regularly used the web to help choose or find a movie, 42 percent obtained theater listings and times, and 33 percent used it to view local club and music venues. This intriguing finding may indicate the effect of researching online and therefore spending less time at brick and mortar establishments, possible changes in social activities, and perhaps shifts in the type of travel destinations.

Figure 6 - Minutes in Activities Away From Home by Age Group, 1995 and 2001 People who have Internet Access at Home
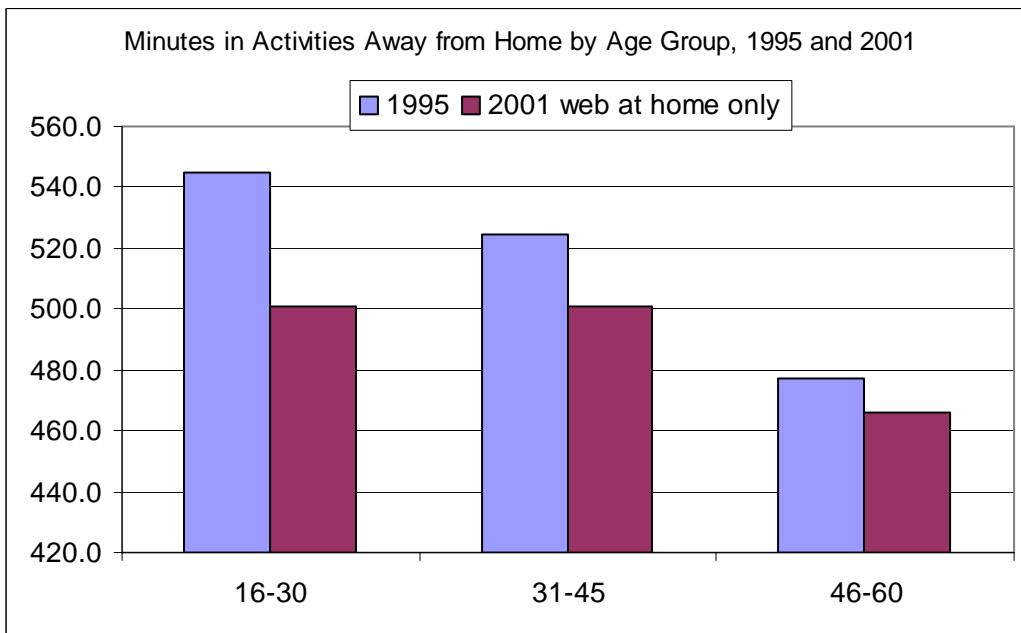
Analysis relating to time spent at specific types of destinations is complicated by the fact that the purpose coding of trip destinations changed in the NHTS between 1995 and 2001 to include more specificity in purpose categories. Due to these coding changes, the activity analysis presented here focuses only on trips for shopping and to visit friends, which had comparable coding for 1995 and 2001.

In conjunction with an increase in time spent at home, the average amount of time spent at destinations for shopping and to visit friends decreased between 1995 and 2001. Figure 7 shows the amount of time spent in an average day at destinations for shopping and visiting friends (all trips for each person). The time spent at destinations for to shop and visit friends dropped between 1995 and 2001 for every age group. Of greater relevance to the Internet-travel research area is the difference in time spent at destination for Internet High Users [2]. High users, especially in the age groups of 16-30, spend less time at destinations when shopping and visiting friends than average for all people in 2001.

Figure 7 - Minutes per Day Spent in Visiting Friends and Shopping, 1995 and 2001
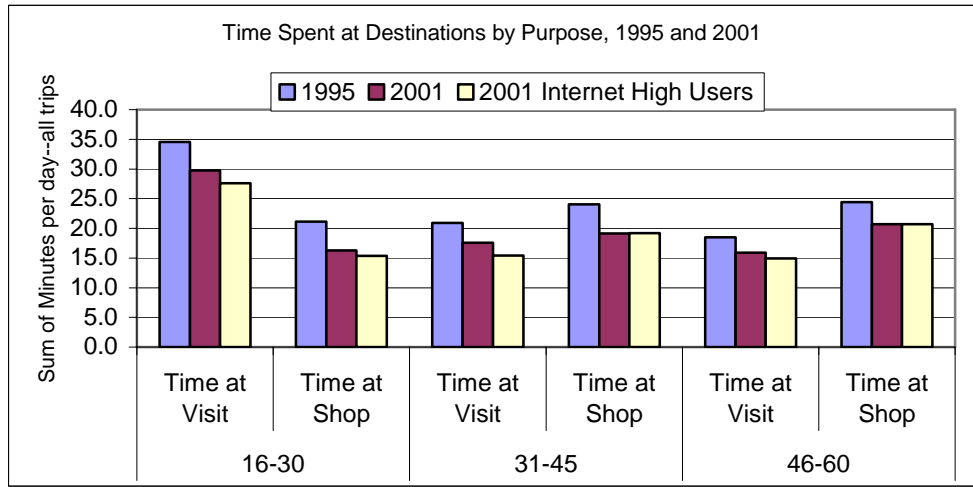
Between 1995 and 2001 the time spent in travel in a typical day also increased, but for different amounts across our age cohorts. The time increases were 5, 10, and 11 minutes for people aged 16-30, 31-45, and 46-60 respectively. This represents another shift in travel characteristics, though we are uncertain as to if and how it is related to Internet use. Similarly, the average number of trips per day decreased, but not in association with the availability of the Internet at home, as shown in Figure 8. These outcomes are consistent with the finding of the 2001 NHTS overall that people were making fewer trips, and spending more time in travel.

---

[2] Defined as people who said they use the Internet every day in the 2001 National Household Travel Survey (NHTS).

Figure 8 - Number of Person Trips per Day by Age Group, 1995 and 2001 all and 2001 with Internet Access at Home
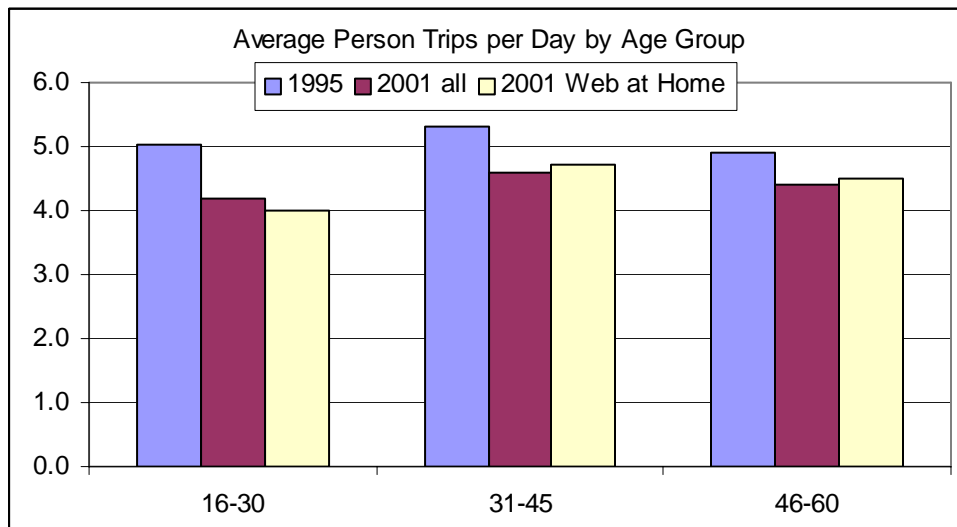
In examining trip distances, however, there are indications of fewer miles traveled for shop and personal business among our highest penetration cohort (age 16-30). We found significant differences (90 percent confidence) in the average distance young men travel for personal business, with an average trip length of 6.9 miles for those with the Internet access at home and 8.5 for those without Internet at home. Average trip distance for women's travel to shop was significantly different at the 68 percent level, with 6.9 miles for young women with the Internet at home versus 8.3 for those with access only somewhere else.

While causality was not explored, our research shows important shifts in time, and in miles. Our findings offer intriguing clues for continued research. We found that American adults (16-65) may be spending more time at home, and overall men show more time difference than women. Most of the change in time at home came from the cohort that was nearly fully on-line in 2001— young people aged 16-30. The young men in this group also showed significant differences in the average trip distance for personal business and the young women for shopping based on whether they had Internet access at home or not. If this group of early adopter is a harbinger of changes in the way Americans spend time and conduct daily activities, then we may spend fewer miles in travel, perhaps less time at destinations, and spend more time at home.

Conclusions

It is clear that the Internet, like other paradigm-shifting technologies, is going to change travel behavior as it changes Americans lifestyles. A lot of research has been done on this topic, and perhaps partially as a result of the quick evolution of Internet technologies, the emerging picture is not at all clear. The relationship between Internet use and trip making is complex as there are several possible effects of new telecommunications technology on travel behavior including the substitution, addition, and modification of travel (Solomon, Ferrell, Niles, Mokhtarian). Many studies focusing on the effects of single applications of the Internet have found trip substitution effects, while much of the literature on on-line shopping suggests a net additive effect of Internet use on travel (12).

Building on Wachs contention that telecom will shift the space and time distribution of travel (4); we explored trip purpose, time use, and trip distance trends in the context of Internet use. Two potential impacts are discussed in this paper—the shift of VMT from residential-based to commercial, and the potential change in time-use that may show an increase in time spent at home.

Our findings offer intriguing clues for continued research. The paradigm of substitution, addition, modification, or neutrality of impact on travel seems simplistic given that Internet activity is purpose-driven, like trip making, and may have different travel impacts based on a complex interaction of changes in the purpose of activities, improvements in product delivery methods, cost and availability of on-line activities, congestion in the physical infrastructure, the adoption of broadband, and other factors. Activity analysis is helpful in describing some of the potential changes.

This research raises many questions that will require more current data, further study, and careful analysis to understand. We are standing on the shore of a sea change, and cannot forecast from our vantage the type and amount of change that will come during the electronic age. The fact that the NHTS has data on the availability and use of the Internet in the context of a daily travel survey is a good start. Future NHTS programs will help us track these complex interactions of travel activity in relation to Internet activity.

REFERENCES

1. Zmud, J., S. Bricka, and J. Casas. *Impact of Shopping via Internet on Travel for Shopping Purposes*. Submitted to Transportation Research Board 80th Annual Meeting, January 2001.
2. Hiltz, (Starr) R. Online Communities: A Case Study of the Office of the Future. Norwood, NJ: Ablex, 1984.
3. Niles, J. S. Technology and Transportation: The Dynamic Relationship. *Discovery Institute Inquiry*, Vol. X, No. II, September 2001.
4. Black, W. *Social Change and Sustainable Transport: A Summary of Workshop and Conference Activities, Research Needs and Future Directions*. Indiana University, January 2000.
5. Cubukcu, K. *Factors Affecting Shopping Trip Generation Rates in Metropolitan Areas*. Austin E. Knowlton School of Architecture, Ohio State University, December 2001.
6. Niles, J. S. *Considering Telecommunications for All Trip Types in a Metro Regions Transport Model*. Global Telematics, Seattle, WA, 1996.
7. Ferrell, C. Home-Based Teleshoppers and Shopping Travel. *Transportation Research Record: Journal of the Transportation Research Board*, No. 1984, TRB, National Research Council, Washington, D.C., 2004, pp. 241-248.
8. Solomon, I. Telecommunications and Travel Relationships: A Review. *Transportation Research*, Vol. 20A, No. 3, 1986, pp.223-238.
9. National Telecommunications and Information Administration. *A Nation Online: Entering the Broadband Age,* United States Department of Commerce, September 2004.
10. Gould, J. and T. Golob. Shopping Without Travel or Travel Without Shopping: An Investigation of Electronic Home Shopping. *Transport Reviews*, Vol. 17, No. 4, 1997, pp. 355-376.
11. Contrino, H. *The Impact of E-Commerce on Local Transportation Planning*. Submitted to 7th Annual Conference on Transportation Planning for Small and Medium Sized Communities, September 2000.
12. Mokhtarian, P. Telecommunications and Travel. *Journal of Industrial Ecology*, Vol. 6, No. 2, 2003.
13. Gould, J and t. Golob. *Consumer E-Commerce, Virtual Accessibility and Sustainable Transport*. University of California Institute of Transportation Studies, Center for Activity Systems Analysis, December 2002.
14. Jupiter Research. *Market Forecast: U.S. Retail 2004-2008*, January 2004.