CORE
Metadata, citation and similar papers at core.ac.uk
Provided by Elsevier - Publisher Connector

Available online at www.sciencedirect.com
SciVerse ScienceDirect
Procedia - Social and Behavioral Sciences 48 (2012) 712 – 721
Procedia
Social and Behavioral Sciences

Transport Research Arena– Europe 2012

# Telework/Workforce flexibility to reduce congestion and environmental degradation?

Adeel Lari[a*]

[a]*Univerisity of Minnesota, 130 Humphrey School-301 19 Avenue South, Minneapolis MN 55455, United States of America*

© 2012 Published by Elsevier Ltd. Selection and/or peer review under responsibility of the Programme Committee of the Transport Research Arena 2012 Open access under CC BY-NC-ND license.

Keywords: telework, eWorkPlace, telecommuting

## Background

The Urban Partnership Agreement is a program initiated by the U.S. Department of Transportation to reduce congestion. Metropolitan areas applied for funding for aggressive congestion management programs through 4 T's: Tolls, Transit, Technology, and Telecommuting, among which telecommuting requires usually the least amount of infrastructure input. On December 9, 2010, President Obama signed into law H.R. 1722, the "Telework Enhancement Act of 2010". This law directed federal agencies to develop telework policies and support the adoption of teleworking within federal agencies where possible. As a major initiative of telecommuting in Minnesota, eWorkPlace worked with 48 employers from different industries and over 4,000 of their employees to promote teleworking and flexible work scheduling and to reduce peak period commuting on congested roadways. The eWorkPlace project was administered by the Minnesota Department of Transportation (Mn/DOT), with the University of Minnesota's Humphrey School of Public Affairs (Humphrey School) managing the program. eWorkPlace provided assistance to employers regarding: setting up a telework project, formalizing telework policy and evaluating telework results for individual employers.

* Adeel Lari. Tel.: +0-612-860-1672; fax 952-898-2350.
*E-Mail address:* alari@unm.edu

1877-0428 © 2012 Published by Elsevier Ltd. Selection and/or peer review under responsibility of the Programme Committee of the Transport Research Arena 2012 Open access under CC BY-NC-ND license.
doi:10.1016/j.sbspro.2012.06.1049

## 1. Project Mechanism

The eWorkPlace program relied on employer commitment to include employees to participate in teleworking. Transportation Management Organizations (TMOs), the nonprofit organizations in the Metropolitan Twin Cities area served as the recruiter and the liaison between participating employers and the project manager. After assessment by the respective TMO, organizations who formally agreed to participate signed a commitment letter identifying a goal for a number of employees to participate. The TMOs, with assistance from the consultant team, then worked with these employers to establish pilot programs, receiving free or reduced price consulting services to implement and sustain employee participation.

A parallel part of the project, Results-Only Work Environment (ROWE), was conducted by CultureRx. CultureRx had been working on promoting their model of flexible work before the start of eWorkPlace which called for a workplace cultural shift concept that might include traditional telework or flexible schedules. The idea of ROWE was to move away from a focus on when and where employees work to one where only work results were looked at. After identifying the mutual benefits to be brought by participating in eWorkPlace, CultureRx agreed to carry over its potential client base to eWorkPlace and to provide its consulting services to interested employers.

Firm commitment from participating employers ensured the sustainability of telecommuting during the project period and in the long term. Employers submitted a letter of commitment from upper management prior to official entry in the project including participation criteria, level of commitment to telecommuting, company goal for number of telecommuters, readiness for telecommuting implementation/expansion, and willingness to participate in the evaluation process. In return, they received services including but not limited to: employee training, business strategy development and IT trouble-shooting.

## 2. Evaluation

This paper focuses on the evaluation of eWorkPlace results and tried to answer the question of whether teleworking realized its goal of reducing traveling and boosting productivity. Recurring online surveys with travel diary provided information on individual travel behavior and perceptions of teleworking, and it enabled a quantitatively intensive evaluation.

### *3.1 Survey*

The hub for surveys was called the Commute Tool site. It was a web application free to users through the eWorkPlace website which allowed employees to track their travel and calculate the Vehicle Miles Travelled (VMT) and cost savings of telecommuting from recurring surveys. A commute tool survey was sent to each participant 1 week, 3 months and 9 months after their registration on the Commute Tool site.

**Commuting behavior**

Weekly Commuting Mode—question 1 of the survey asked about the commuting mode on each day of the week prior to the survey. Seven types of modes were identified: driver of a car, van or motorcycle; passenger in a car, van or motorcycle; public transit; active transportation like biking and walking; teleworking; taking the day off and being out of office for business or personal reasons.

Highway commuting—question 3 asked if the participants drove or carpooled in a vehicle during their commute, whether they used I-394 or I-35W. These highways were selected as they are among the most congested in the Twin Cities area, and are the only roads with MnPASS High Occupancy / Toll (HOT) lanes available for single-occupant vehicles that wanted to "pay their way" out of congestion.

**Perceptions about telework**

Optimal telework days per week—question 5 asked participants "to do your job best, how many days per week would you work from a location other than your company's office?" We measured the preferred telework intensity from responses to this question and using the calculated actual telework days from Question 1, the difference between the optimal and actual telework days per week could be obtained.

Productivity—question 9 asked participants how they feel about their productivity when they teleworked/participated in ROWE. Three answered were provided: decrease, does not change or increase. We could measure the perceived change in productivity from responses to this question.
Available work hours—question 10 asked participants how they felt about the change in available work hours when they teleworked/participated in ROWE.

3.2 *Travel diary*

The travel diary was composed of two identical sections asking about trips taken on the most recent day teleworked or the most recent day they worked in office. The participants could report up to 10 trips in each section in order to probe if any trips were taken on a telework day or additional trips were taken on an office day, to compare the travelling behavior on the two types of working day and to measure if teleworking actually led to less travelling and more time saving. All eWorkPlace participants were invited to register on the Commute Tool site and take surveys sent from the site. 23.9% of all participants were sampled in at least one survey. ArcGIS was used to map out the home locations and destinations of their commute of all participants, as shown in fig1 (a). The majority of participants lived in or close to the Metropolitan Area. Most of employers' offices were in the city centers. Fig 1b zoomed into the 7-county Metropolitan area and showed that I-35W and I-394 were the most likely to be used highways connecting participants' homes and offices. 62.6% of all employers' offices were within 3-mile buffer zone of I-35W and I-394.

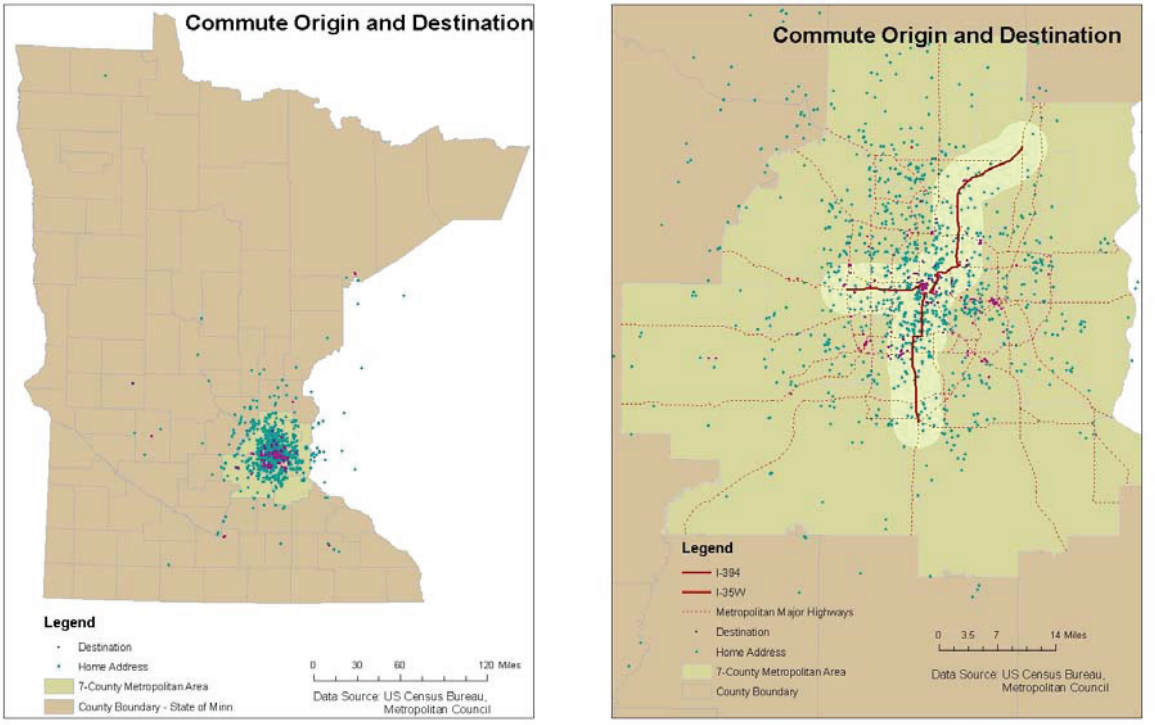


Fig 1. (a) Participants' home locations/destinations of commute (b) metro area participants' home

### *3.4 Demographics*

Using responses to those questions and information from the 2006 American Community Survey [1], we were able to see if the participating population was different from the general population in the 13-county metropolitan area or the state of Minnesota. There was an over-representation of females in our participants. Over 75% of the respondents were working women. The survey respondents had more vehicles per household comparing to the general population—close to 30% had 3 vehicles or more available to family members. Over half of the survey respondents had a college degree and 67.64% of all survey respondents were married or partnered.

## 4. Longitudinal Comparison across Surveys

Because participating employers signed up for the project at different time, the date of their employee registration varied. This meant the three surveys were sent out to people in different months. We observed two peaks in early and late winter time. Looking at the proportion of participants who teleworked in a given week in each month, we did not see a seasonal pattern, but rather a continuously increasing trend, meaning that people who had been in the program for longer tended to telework more. For the longitudinal comparison across the surveys, we first took all responses and grouped them into Survey 1, Survey 2, and Survey 3 and compared the aggregated result to see if there is a change in behavior or attitude at different points of time upon being enrolled in the project. The findings included:

The percentage of respondents who teleworked at least once during the surveyed week and the average number of days per week teleworked increased. The proportion of respondents who teleworked at least once during the surveyed week increased from 44.59% in Survey 1 to 57.58% in Survey 2 to 58.45% in Survey 3. There was also an increase in the average number of days per week teleworked from 1.02 in Survey 1 to 1.24 in Survey 2 to 1.31 in Survey 3 (Fig. 2). This increase was statistically significant from Survey 1 to Survey 2 but not from Survey 2 to Survey 3.

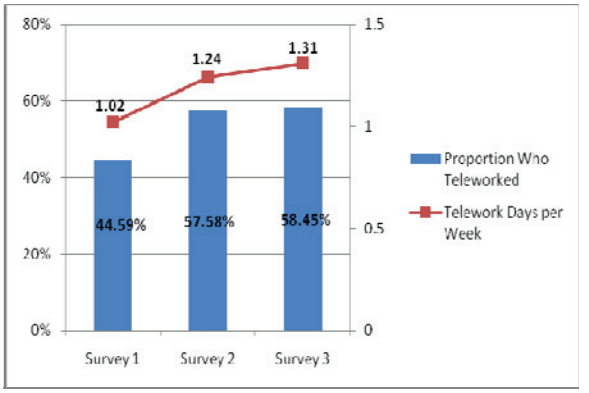


Fig 2 (a) proportion of respondents teleworking in a given week and average number of telework days in a week.

Available work hours after teleworking/participating in ROWE. We found a statistically significant change in available work hours from Survey 1 to Survey 3. In Survey 1, 41.10% respondents said their available work hours did not change after participating in the program, but the number dropped to 34.30%

in Survey 3 while the percentage of respondents feeling about increased work hours improved from 53.27% to 58.50%.

## 5. Final Results—Benefits of Teleworking

As shown above, the factors changing from Survey 1 to Survey 2 stabilized from Survey 2 to Survey 3. On one hand, we had good reason to expect the benefit may further increase if the program would have continued and we could have been able to measure participants' behavioral and attitudinal change beyond 9 months; on the other hand, we recognized the learning curve that new participants would be facing, i.e. the benefit at the beginning of their enrollment was not as high as it would be several months later. Taking both sides of the effect into consideration, in the Final Results section, we reported the numbers from Survey 3 and used that to present the benefit of eWorkPlace and predict its long-term impact.

### *5.1 Commuting behavior*

Proportion of participants teleworking in a given week; as mentioned in the previous section, there was an increase in the proportion of participants who teleworked at least once in a given week across three surveys. The percent in Survey 3 was 58.45%. The average number of telework days per week for all eWorkPlace participants is 1.31, but, if only looking at those who teleworked in a given week, the number increased to 2.25. Fig. 3 below showed that around 22.50% of those who finished all three surveys responded that they didn't telework at all in the week prior to each survey, while 32.5% teleworked at least once in all three weeks. For those who responded "had teleworked" in all three surveys, the average telework days per week was close to half of the weekdays.

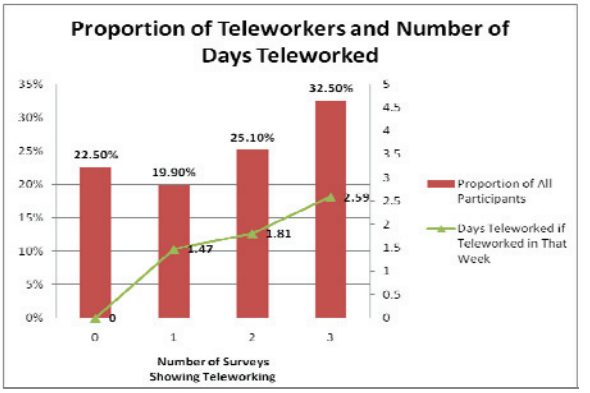


Fig. 3 (a) proportion of teleworkers and Number of Days Teleworked.

### *5.2 Modes of commuting used and their distribution*

Fig. 4 showed the commuting modes used in the week prior to Survey 3, the most common commuting choice was driving alone at 47% of the workdays with teleworking was the second popular choice.

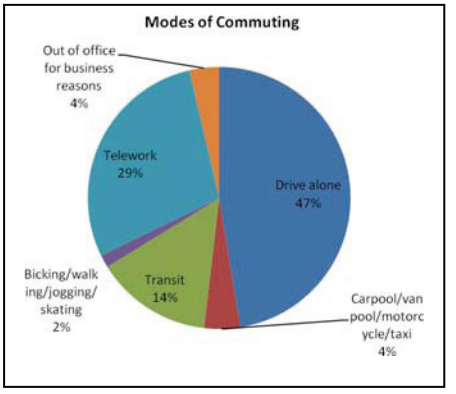


Fig 4. (a) Distribution of commuting mode

*5.3 Highway usage on I-394 and I-35W*

35.3% of the respondents stated that they use I-394 and I-35W for commuting. The peak-hour trips made on an office day on these two highways were 0.744 across all respondents, while that on a telework day was 0.024. Teleworking helped reduce traffic on these highways during the peak hours.

*5.4 Employee Perception of Telework*

Optimal number of telework days per week and Available work hours. The average number of telework days per week preferred by respondents "to do their job the best" was 2.29 while the average of actual telework days was 1.31. 67.1% respondents felt their productivity increased when they teleworked or participated in ROWE while only 1.9% feeling there was a decrease.

*5.5 Trip Diary Result*

Proportion taking additional trips on a telework/office day—people did not seem to take more trips during the day just because they teleworked at home. 63% of our respondents reported that they didn't leave home at all while teleworking. This was the same as the proportion of people who did not leave office during the day they worked in the office.

Trips saved—participants reported an average of 0.15 peak-hour trips on a telework day and 2.13 peak-hour trips on an office day. These statistically different average numbers indicated that 1.98 peak-hour trips were reduce by replace traditional office day with teleworking. 0.26 non-peak-hour trips were taken on a telework day across all respondents while the number was 0.25 on an office day. However, the difference was not significant. Therefore, the total trips saved were mainly contributed by the peak-hour trips saved, and averaged to 1.99 trips per day (these two trips were likely to be the round-way commute trips).

VMT saved—since more trips were taken on an office day comparing to a telework day, not surprisingly, a longer distance was travelled on an office day. The average VMT saved by replacing a traditional day in office with teleworking was 27.96 miles per individual per day.

I-394 and I-35W usage for additional trips—we did not find more trips taken on highway 394 and 35W on an office day. However, there were more peak-hour trips happening on these two highways on an office day compared to a telework day. About 0.72 peak-hour highway trips were saved per day per person if teleworking and this saving were statistically significant. Longer distance was also travelled on these two highways an office day, probably because the commute trips were usually the longest trips people took on a typical weekday. The average distance saved by teleworking that could have been travelled on these two highways was 2.68 miles per person per day.

*5.6 Benefit Summary*

Based on the average number of day's teleworked of all participants and the average daily reduction per person for all factors of interest, we were able to estimate the annual savings of eWorkPlace:

- 7.46 million Vehicle Miles Travelled were reduced by teleworking, which was the total vehicle miles travelled by 678 individuals in one year [3]. Half of these miles would have been travelled on I-35W or I-394.
- 580,000 peak-hour trips were saved, equivalent to about five weekdays' vehicle trips carried by I-394.

- 240,000 trips on I-35W and I-394 were reduced by eWorkPlace participants, a significant contribution to congestion mitigation on these two highways.
- Assuming the average commuting speed by driving was 40 mph, each eWorkPlace participant saved 44 hours of commuting every year. That was a whole week of working time.
- Based on 1.10 pounds of carbon dioxide emissions per mile traveled (5), eWorkPlace participants saved 8.14 million pounds of CO2, equivalent to planting 1,000 acres of trees (1).

In addition there is abundant literature discussed about the benefit of telework, including but not limited to:

- Improvement in emergency responsiveness and continuity of operations(6)
- Office space and operating cost savings
- Reduction of energy consumption and the associated carbon footprint
- Reduction of vehicle tear-and-wear, congestion and commuting time
- Improved employee performance, work morale and employer staffing and retention
- Improved accommodation for persons with disabilities and those with domestic obligations

These benefits could be categorized and understood in different ways. First, they were enjoyed by different parties, including employers, employees, employees' family members, the community and the broader society. Second, they were reflected in different aspects of life, economically, psychologically and socially. In addition, they were intertwined instead of separated. For instance, the improved accommodation for persons with domestic obligations and the time-savings aspect of telework might be important causes of improved employee performance. Last but not least, some of benefits, such as reduction in travelling time, were quantifiable while others, such as productivity increase, could hardly be converted into a number.

All these add to the complexity of conducting a cost-benefit analysis of teleworking. In our study, we focused on the quantifiable trip reduction and VMT reduction and calculated accordingly the vehicle savings, time savings and emission savings. We meanwhile recognized there were other unquantifiable but demonstrated benefits, such as productivity and available work hour increase explained in the previous sections.

The same issues presented in the cost analysis of telework, which included participant recruitment and training, hardware procurement and maintenance, home office set-up, and data collection and evaluation. A prominent feature of cost estimate was that it varied across employers and employees with different job responsibilities. We did not break down the components of eWorkPlace cost, but instead used the total project input as a general assessment of such cost.

Minnesota Department of Transportation's instruction on benefit-cost analysis (4) stated several principles for selecting the timeframe for which project benefits were compared and evaluated, including 1) the timeframe should be long enough to capture the majority of benefits, but not so long as to exceed capabilities to develop good traffic information; 2) it should be consistent with that used for other analysis being undertaken for the project; 3) it should be consistent for all alternatives.

Based on these standards, we decided to use five years as the timeframe for our benefit projection. Unlike typical transportation improvement projects involving infrastructure building, telework projects did not require major construction but rather continuous employer interest and input in such initiatives. EWorkPlace recruited, developed telework plan and provided technical consultancy for over 40 employers in the past three years. The depreciation period for hardware such as computers and printers

was expected to be around five years and the software such as telework plan; policy as well as management tools could be continuous utilized. The eWorkPlace website, an important information hub for the project would be managed for another three years by the professional consultant group. Several TMOs stated that they would continue having telework as a key component of their work and that some employers had showed interest to extend the current project over planned eWorkPlace project time. In sum, we deemed the five year time frame consistent with the actual impact of the project and other analysis being conducted.

Table 1-1 showed the summarized program benefits, consisted of vehicle and time savings to the participants and emission savings to the whole community. Table 1-2 separated out the benefits to each individual participant. Based on VMT savings calculated and the 2010 IRS mileage deduction of $ 0.5 per mile, each teleworker saved $886 in fuel and vehicle maintenance cost per year. In addition, based on Mn/DOT Office of Planning and Programming's data on FY 2011 value of travelling time ($13.8 per hour), each eWorkPlace participant saved 44 hours of commuting each year. As to the environmental externality of eWorkPlace, the Federal Register refers to an estimate of $33 per metric ton of carbon (6). This means $120,000 worth of carbon emission was saved each year by eWorkPlace. This brought the total projected benefit of eWorkPlace to $32 million.

Table 1-1 Program Benefit Summary

| Program Benefit Summary | Per Week | Per Year | 5-Year |
|---|---|---|---|
| Vehicle Savings (miles) | 155,407 | 7,459,521 | 37,297,603 |
| Value of Vehicle Savings ($) | 77,703 | 3,729,760 | 18,648,801 |
| Time Savings (hours) | 3,885 | 186,488 | 932,440 |
| Value of Time Savings ($) | 53,615 | 2,573,535 | 12,867,673 |
| Emission Savings (pounds) | 170,947 | 8,205,473 | 41,027,363 |
| Value of Emission Savings ($) | 2,518 | 120,884 | 604,422 |
| Total | $133,837 | $6,424,179 | $32,120,896 |

Table 1-2 Individual Participant Benefit Summary

| Participant Benefit Summary | Per Week | Per Year |
|---|---|---|
| Vehicle Savings (miles) | 36.90 | 1,771 |
| Value of Vehicle Savings ($) | 18.45 | 886 |
| Time Savings (hour) | 0.92 | 44 |
| Value of Time Savings ($) | 12.73 | 611 |
| Total | $31.18 | 1,497 |

As part of the UPA, the State of Minnesota provided $3.2 million to fund eWorkPlace. It took about half a year to recover such investment. Mn/DOT Office of Capital Programs and Performance Measures provided in its Benefit-Cost Analysis Standard Value Tables the discount rate for the year of 2009 at 2.9

percent. Using this number, we were able to estimate the present value of program benefit for the starting year of 2009.

$$\text{Present Value of Benefit} = \sum \frac{Annual\ Benefit}{(1 + Discount\ Rate)^{Number\ of\ Years}} = \$29.5 \text{ million}$$

Therefore, the Benefit-Cost Ratio was 9.22 ($29.5 million/$3.2 million), which was much larger than 1, meaning eWorkPlace was economically justified.

### *6. Conclusion*

The evaluation of eWorkPlace showed the positive results generated by teleworking through reduction in peak-period trips taken and vehicle miles travelled. More importantly, these reductions led to three-folded benefits to individual employees, employers and the community at large. Employees reported increased productivity and available hours to work. Productivity boost could obviously transform into benefits for employers and this was actually confirmed by our employer survey results which were not included in this paper (employer reported benefits included higher retention and more work morale). For the community, congestion reduction was a key piece and the main goal of UPA project. Less trips taken on the mostly congested highways in the metropolitan area during the peak period was beneficial to the community economically, socially and environmentally.

**Acknowledgement**

We would like to acknowledge John Doan and others at SRF for providing project management consultation to eWorkPlace. We would also like to acknowledge Transit Management Organizations, without whose help the recruitment and retention of eWorkPlace employer participants would not have been such a success. We acknowledge the Minnesota Department of Transportation for the funding and technical support. EWorkPlace was an Urban Partnership Agreement funded project.

### References

[1] Coloradotrees. (Accessed on June 16, 2011). *Benefits of Trees in Urban Areas*. http://www.coloradotrees.org/benefits.htm#carbon.

[2] Federal Highway Administration. (Accessed on May 25, 201).*Minnesota Partnership Agreement National Evaluation: Surveys, Interviews, and Focus Groups Test Plan*. http://ntl.bts.gov/lib/32000/32500/32527/chap11.htm.

[3] Minnesota Department of Transportation. (Accessed on June 11, 2011). *2010 Vehicle Miles of Travel Trends by District in Minnesota* http://www.dot.state.mn.us/traffic/data/reports/VMT%20Trends%20by%20District%20in%20Minnesota.pdf

[4] Minnesota Department of Transportation. (Accessed on June 20, 2011).*Benefit-Cost Analysis for Transportation Projects*. http://www.dot.state.mn.us/planning/program/benefitcost.html

[5] Sightline Institute. (Accessed on June 16, 2011). *Carbon Dioxide Emissions Per Mile Traveled*. http://www.sightline.org/maps/charts/pollu_co2transp_ooh

[6] Telework Exchange. (Accessed on June 17, 2011). *The Benefits of Telework*. http://archive.teleworkexchange.com/pdfs/The-Benefits-of-Telework.pdf

[7] U.S. Census Bureau. (Accessed on May 20, 2011). *Minnesota Selected Social Characteristics in the United States*, 2006. http://factfinder.census.gov/servlet/ADPTable?_bm=y&-geo_id=04000US27&-qr_name=ACS_2006_EST_G00_DP2&-context=adp&-ds_name=&-tree_id=306&-_lang=en&-redoLog=false&-format=