Unclear Definition

Origins:

The Telecommuting Transportation Tradeoff by Jack Nilles 1973

International Labour Organisation:

Work achieved outside the employer’s premises with the help of ICTs
not helpful in our context

Better:

Working from home with the help of ICTs

Rachel Pasini 2018: Virtual Vocations: A History of Telecommuting
Overview

Transportation related impacts

Widening the picture

COVID-19 and the future
Transportation related impacts

Focus on direct comparison of emissions caused by vehicles
The Telecommuting Pilot Project

Several californian state agencies

Focused on business advantages

Conducted 1987 - 1990

Mainly information workers

Use of telephone and local workstation computers
Calculating emissions

Introducing EMFAC(7F) and BURDEN(7F) models

Pollutant types:
- TOG  total organic gases
- ROG  reactive organic gases
- CO   carbon monoxide
- NOx  nitrogen oxides
- SOx  sulfur oxides
- PM   particulate matter

Car behaviour:
- VMT/VKT – Vehicle miles/kilometres traveled
- Engine starts (hot and cold)
- Modal behaviour (accelerations, decelerations, speed) – how you drive
- Park time
- ....

Brett E. Koenig et al. 1996: The Travel And Emissions Impacts Of Telecommuting For The State Of California Telecommuting Pilot Project
What do we need to measure?

We want to get comparable results between groups

Useful metrics (per person-day):

- VMT
- # of trips
- # of cold starts
- # of hot starts

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**Table 2. Primary emission-producing vehicle activities and emissions produced**

<table>
<thead>
<tr>
<th>Emission-producing vehicle activity</th>
<th>Type of process (pollutant)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vehicle-miles traveled</td>
<td>• Running exhaust (CO, TOG, NOx, PM)</td>
</tr>
<tr>
<td>Engine starts (hot and cold)</td>
<td>• Running evaporative emissions (TOG)</td>
</tr>
<tr>
<td>Engine shut-downs</td>
<td>• Start-up exhaust (CO, TOG, NOx, PM)</td>
</tr>
<tr>
<td>Modal behavior (e.g. accelerations, decelerations,</td>
<td>• Hot soak evaporative emissions (TOG)</td>
</tr>
<tr>
<td>average speeds)</td>
<td>• Running exhaust (CO, TOG, NOx, PM)</td>
</tr>
<tr>
<td>Park time</td>
<td>• Resting evaporative emissions (TOG)</td>
</tr>
<tr>
<td></td>
<td>• Diurnal emissions (TOG)</td>
</tr>
</tbody>
</table>

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Brett E. Koenig et al. 1996: The Travel And Emissions Impacts Of Telecommuting For The State Of California Telecommuting Pilot Project
Study design

2 Groups
• Telecommuters
• Control

2 Waves
• Wave 1 (161 days): no one is telecommuting
• Wave 2 (149 days): TC group has some TC days

Similar conditions

Bookkeeping (on weekdays)
Results – Different effects

Study design helped to investigate three different effects:

- Person effect
- Wave effect
- Day effect

Effective comparison helps to reduce variance in results

Brett E. Koenig et al. 1996: The Travel And Emissions Impacts Of Telecommuting For The State Of California Telecommuting Pilot Project
Results – Travel impacts

Note: values are per person-day

<table>
<thead>
<tr>
<th></th>
<th>Telecommuters</th>
<th>Controls</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>W1</td>
<td>W2 TC</td>
</tr>
<tr>
<td>VMT</td>
<td>44.8</td>
<td>10.2*</td>
</tr>
<tr>
<td># of trips</td>
<td>3.76</td>
<td>2.73*</td>
</tr>
<tr>
<td># cold starts</td>
<td>2.52</td>
<td>1.54*</td>
</tr>
<tr>
<td># hot starts</td>
<td>1.24</td>
<td>1.19**</td>
</tr>
</tbody>
</table>

- 77% decrease in VMT
- Numbers very similar for both waves when not telecommuting
- Number of trips and cold starts reduced by 1 when telecommuting...
- Some of the VMTs are now done on the extra trip on TC days (Shopping etc.)

Brett E. Koenig et al. 1996: The Travel And Emissions Impacts Of Telecommuting For The State Of California Telecommuting Pilot Project
Results – side effects

Brett E. Koenig et al. 1996: The Travel And Emissions Impacts Of Telecommuting For The State Of California Telecommuting Pilot Project
Widening the picture
**Overall effectiveness**

Study from 2005, teleworking infrastructure energy savings (US and Japan)

< 15% teleworking:
0.01 – 0.4% and 0.03 – 0.36% respectively [a]

Assume 50% teleworking:
Estimated total energy savings of about 1% in both cases [a]

Work related travel only produces small share of overall emissions [b]

What about the rebound?

[a] H. Scott Matthews, Eric Williams 2005: Telework Adoption and Energy Use in Building and Transport Sectors in the United States and Japan

[b] Christian Fuchs 2005: The implications of new information and communication technologies for sustainability
Another view on transport

Paper from 1998 lets us doubt effectiveness

Many study designs are flawed/biased

Average savings likely to be less

Trip generation effects would increase

Real benefits are about increasing travel flexibility

Picture: http://www.china.org.cn/photos/2015-10/07/content_36752799_3.htm
Rebound – Office floorspace

Offices may require less floorspace, heating, IT infrastructure on-site

Now needed at home

Research shows that transportation impacts dominate however Office infrastructure savings even less important overall

Kurt W. Roth, Todd Rhodes, Ratcharit Ponoum 2008: The Energy and Greenhouse Gas Emission Impacts of Telecommuting in the U.S.
New relationships may arise through telework
- Business
- Private, Social

Travel will remain necessary to maintain relationships

“What is needed is a conscious commitment of business and individuals to reduce the amount of travels by car and plane. ICTs alone don’t solve the problem.”

Christian Fuchs 2005: The implications of new information and communication technologies for sustainability
Speculation on mass-adoption

Assume teleworking becomes the norm

Let us speculate:
• companies move more IT infrastructure to “the cloud”
• not everyone commutes by car -> some public transport routes become less attractive
• no need to live close to city/workplace
• cars will change (EV etc.)
• autonomous driving, sharing economy
• less traffic (morning commute) -> better distribution, speed efficiency
• You will have more to say in the discussion...
COVID-19 and the future
Fast telework adoption

MIT Study: [a]
From less than 15% telework
To nearly 50% telework in March 2020

There is a caveat
BLS unemployment definition and politics

Survey, Workplace Evolutionaries: [b]
From 31% of respondents part time telework
To 77% full time and 88% at least part time in April 2020

## Sudden demand for cloud infrastructure

Great scalability and flexibility

Impossible a few years ago

**MS Teams:**

<table>
<thead>
<tr>
<th>Month</th>
<th>Users/day</th>
<th>Meetings/day</th>
<th>Meeting-minutes</th>
</tr>
</thead>
<tbody>
<tr>
<td>July 2019</td>
<td>13 million</td>
<td>75 million</td>
<td>4.1 billion</td>
</tr>
<tr>
<td>Nov 2019</td>
<td>20 million</td>
<td>200 million</td>
<td></td>
</tr>
</tbody>
</table>

**New record in April 2020:**

75 million users/day  
200 million meetings/day with 4.1 billion meeting-minutes

**Measures:**

- Reduce prefetching  
- Prioritize health related workloads  
- Reassign traffic to other regions  
- Reduce video resolution and framerate

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Mark Russinovich, CTO MS Azure June 2020: Advancing Microsoft Teams on Azure—operating at pandemic scale:  

Update #2 on Microsoft cloud services continuity: https://azure.microsoft.com/en-us/blog/update-2-on-microsoft-cloud-services-continuity/
Long term impacts - Adoption

Cloud provider learned a lot

Increased preparedness

Reduced managers’ fears

Awareness for potential savings

41% part time telework after crisis

Lister Kate 2020: Global Workplace Analytics: Work At Home After COVID-19, Our Forecast
Long term impacts – Emissions/Energy Use

25% increase in energy use in NYC households

10% reduction overall

17% reduction in CO2 emissions, April 2019/April 2020

50% from transport (8.5%)

Prospected 2.6 – 8.4% reduction for 2020

Quere et al. 2020: Temporary reduction in daily global CO2 emissions during COVID-19 forced confinement
NYTimes, Henry Fountain: The City That Never Sleeps Is Waking Up Later
Virtual general assembly
• live streamed
• no real interaction

Challenges
• discussions
• voting
• security
• ...

23

Neue Luzerner Zeitung 11.11.2020
Summary

Certain reduction in transport emissions

Overall savings negligible

Very dependent on technological/societal changes

Many chances and pitfalls

Learned a lot during pandemic

Many impacts to investigate