How about time use at work?

Multitasking, fragmentation and well-being

Baiba Pudāne (TU Delft)
Presentation at the 3rd Symposium on Activity-Based Modelling

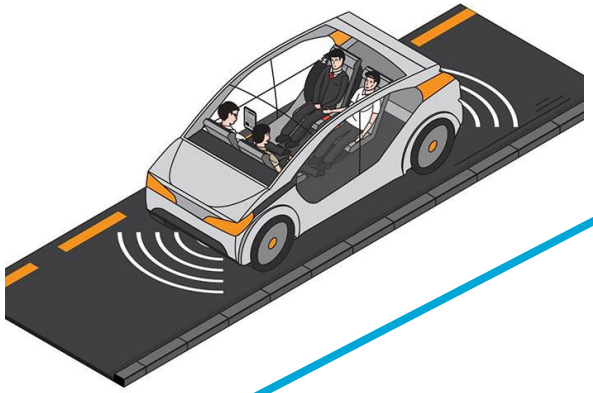
27-11-2024

https://www.rock.so/blog/myth-of-multi-tasking

Technology is impacting our daily time use

during travel

at work



at home

ChatGPT

https://www.smartnation.gov.sg/initiatives/autonomous-vehicles/
https://ayoubcomputers.com/eufy-clean-by-anker-robovac-g32-pro-robot-vacuum-t2259z11/
https://www.surgicalroboticstechnology.com/suppliers/modules-components/robotic-arms/

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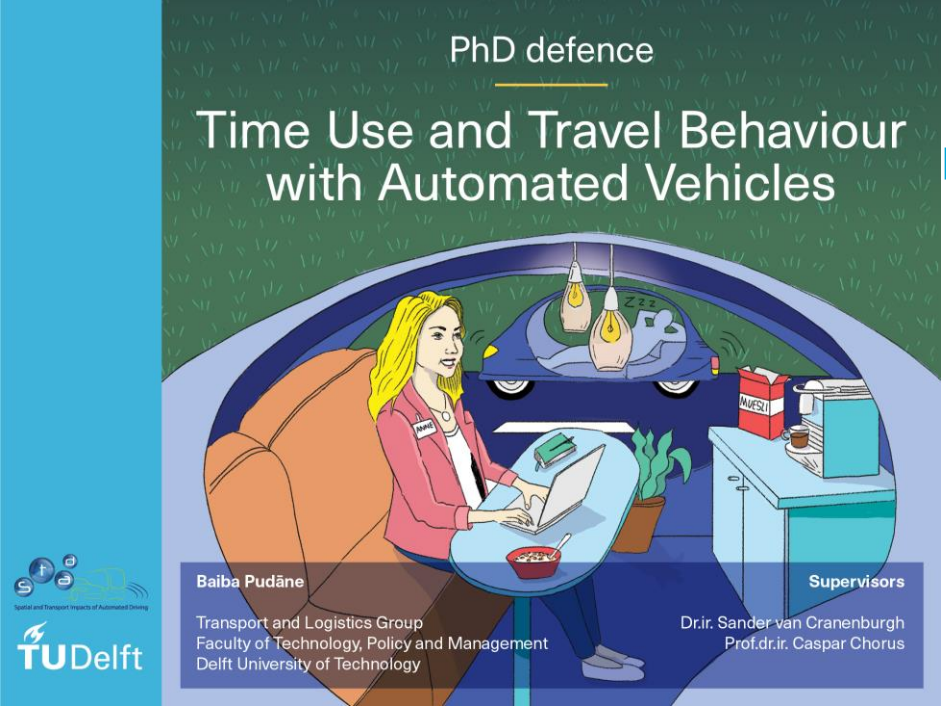
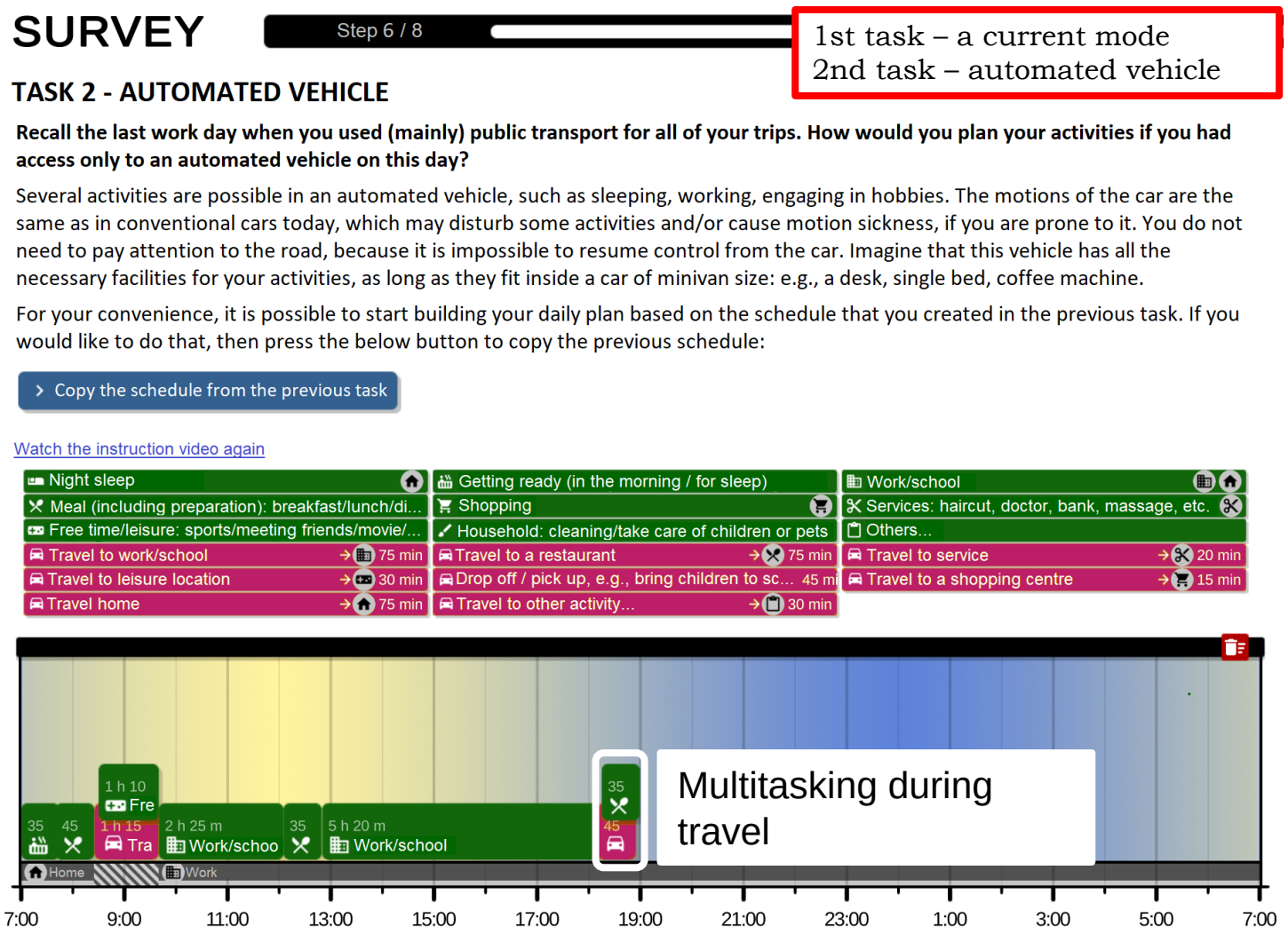


Empirical activity schedules



Pudāne, B. (2021). Time Use and Travel Behaviour with Automated Vehicles. https://pure.tudelft.nl/ws/portalfiles/portal/94080548/Baiba_Pudane_final_thesis.pdf

Debbaghi, F. Z., Kroesen, M., De Vries, G., & Pudāne, B. (2024). Daily schedule changes in the automated vehicle era: Uncovering the heterogeneity behind the veil of low survey commitment. *Transportation Research Part A: Policy and Practice*, *182*, 104006.

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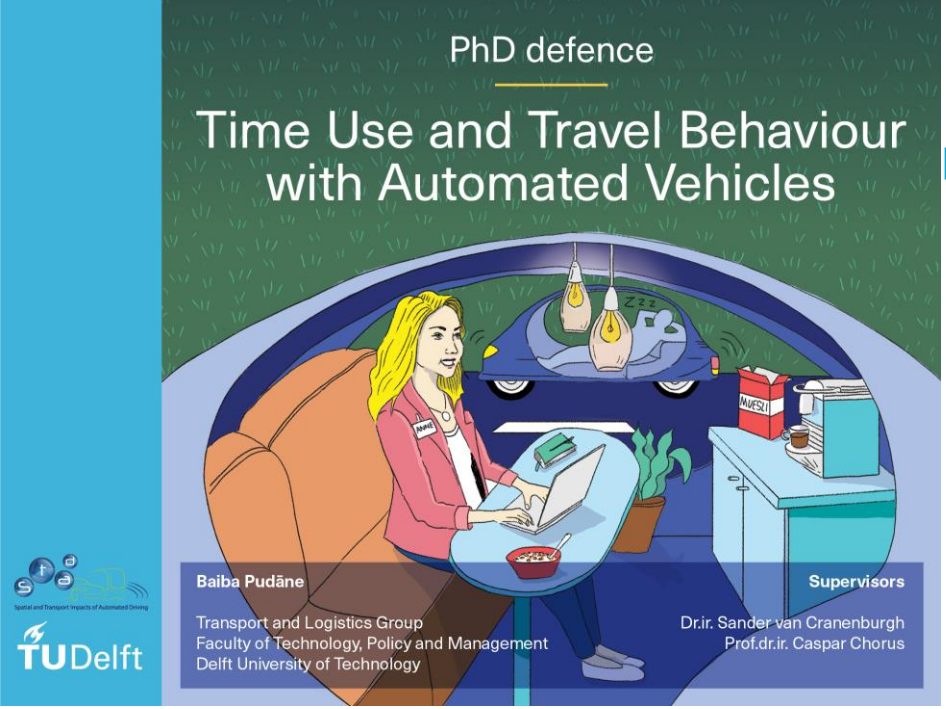

Empirical activity schedules

5 latent clusters

Debbaghi, F. Z., Kroesen, M., De Vries, G., & Pudāne, B. (2024). Daily schedule changes in the automated vehicle era: Uncovering the heterogeneity behind the veil of low survey commitment. *Transportation Research Part A: Policy and Practice*, *182*, 104006.

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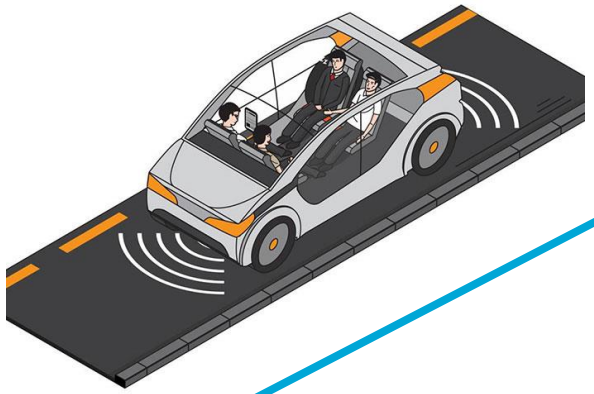
Technology is impacting our daily time use

during travel



at home

at work

Future of work*

ChatGPT

* Future of work - how work will get done over the next decade due to the influence of technological, generational, and social shifts.

(HR glossary: https://hrforecast.com/hr-glossary/future-of-work/)

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https://www.smartnation.gov.sg/initiatives/autonomous-vehicles/
https://ayoubcomputers.com/eufy-clean-by-anker-robovac-g32-pro-robot-vacuum-t2259z11/
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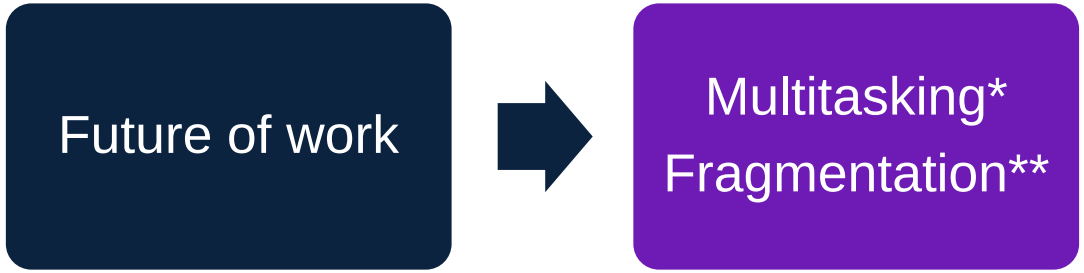
Time use in the future of work – what is changing?



*** Multitasking** - the performance of more than one task at the same time.

**** Fragmentation** - the process or state of breaking or being broken into fragments. [In transport: space and time fragments of activities.]

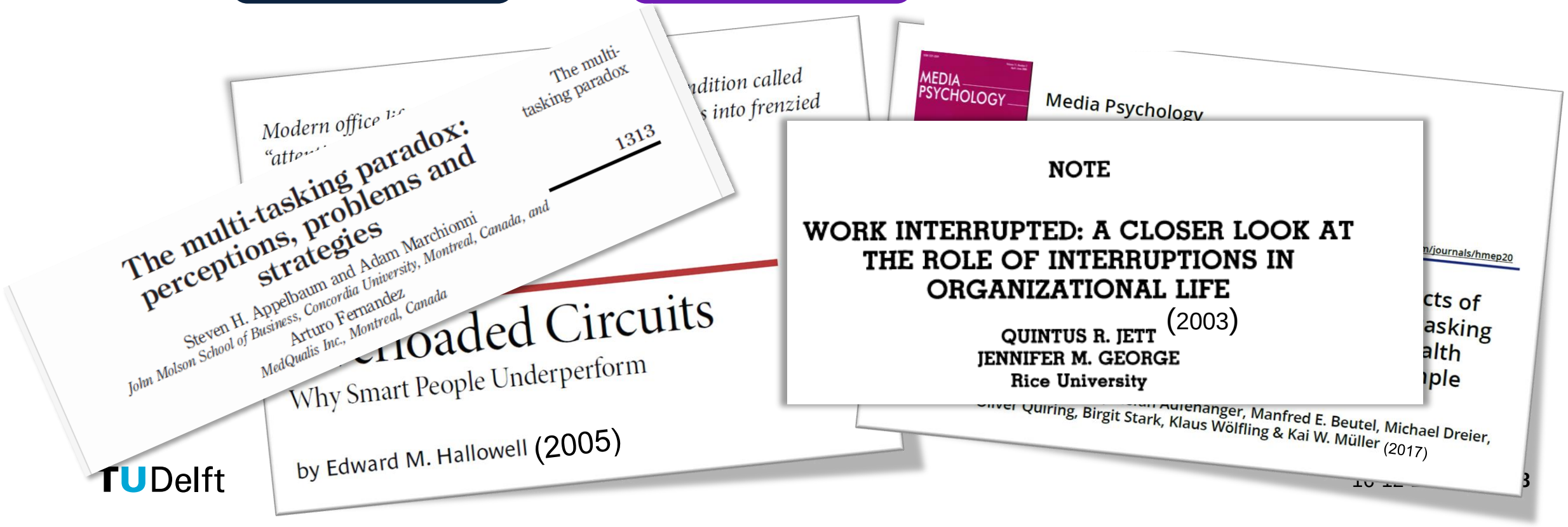
(Oxford dictionary)

Circella et al. (2012): they are the ‘same’

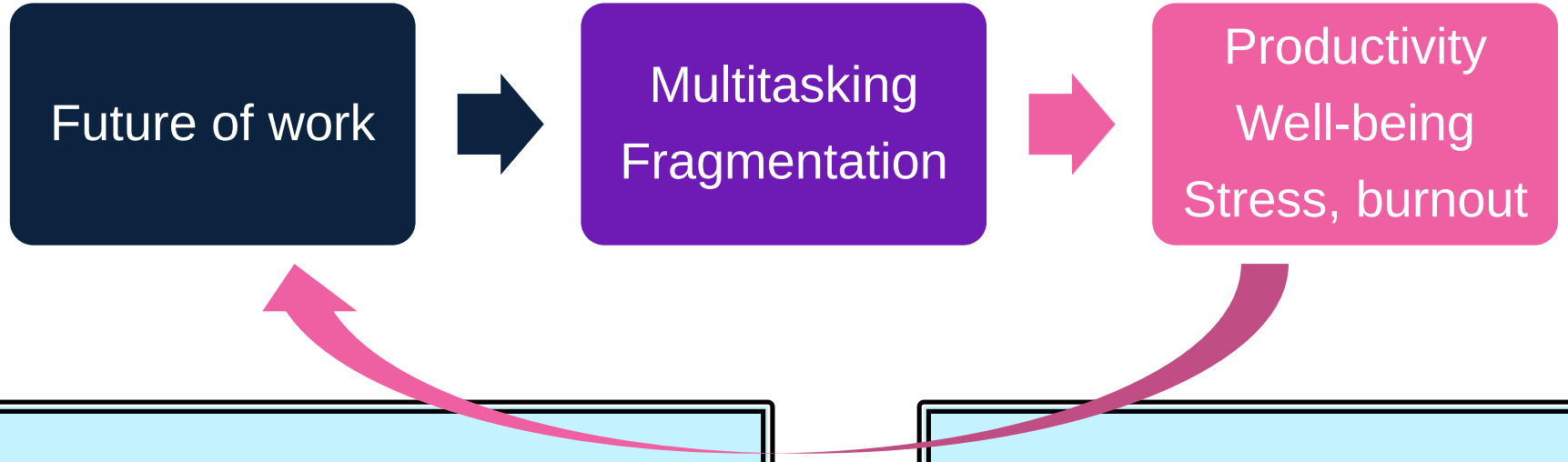
Circella, G., Mokhtarian, P. L., & Poff, L. K. (2012). A conceptual typology of multitasking behavior and polychronicity preferences. Electronic International Journal of Time Use Research, 9(1).

Time use in the future of work – why care?

Future of work → Multitasking Fragmentation



Time use in the future of work – why care?



General goal:

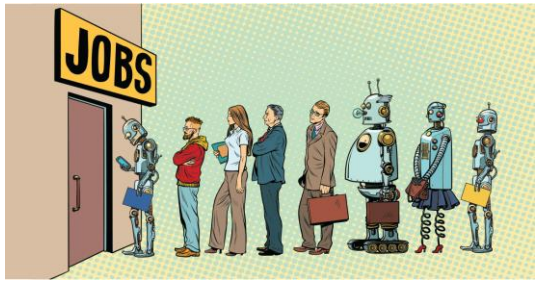
Design such future of work environments, flows and policies that improve productivity and well-being, and reduce stress and burnout

Transport-related goal:

Understand how environmental work-from-home or hybrid work policies may influence productivity and well-being

Time use in the future of work – what changes?

Physical work
automation, shift to supervisory role



https://blog.spjain.org/thought-leadership/disruptive-technologies/adapting-creating-jobs-age-ai

Knowledge work
ICT, AI, home-office, post-COVID

https://www.rock.so/blog/myth-of-multi-tasking

	Example: Accounting
Activity **durations** ↓	Tax preparation – from hours to seconds
Resource use ↓	No more manual calculations
Activity **fragments & interruptions** ↓↑	Notifications from accounting systems; lower dependence on approvals
Nature: different	From manual record-keeping to financial advisor role

In and out of work
connectedness, flexibility expectation

https://martech.org/sms-marketing-often-forgotten-goldmine-good-mobile-strategy/

Multitasking
Fragmentation

Today: theoretical demonstration

Imagined work activity list

Utility; time; (mental) resources share	Multitasking penalties for utility & time	Fragmentation penalties for utility

Time-use model

Productivity objective = min Working hours	Satisfaction objective = max Activity utility	**U = max Satisfaction + α * Productivity**

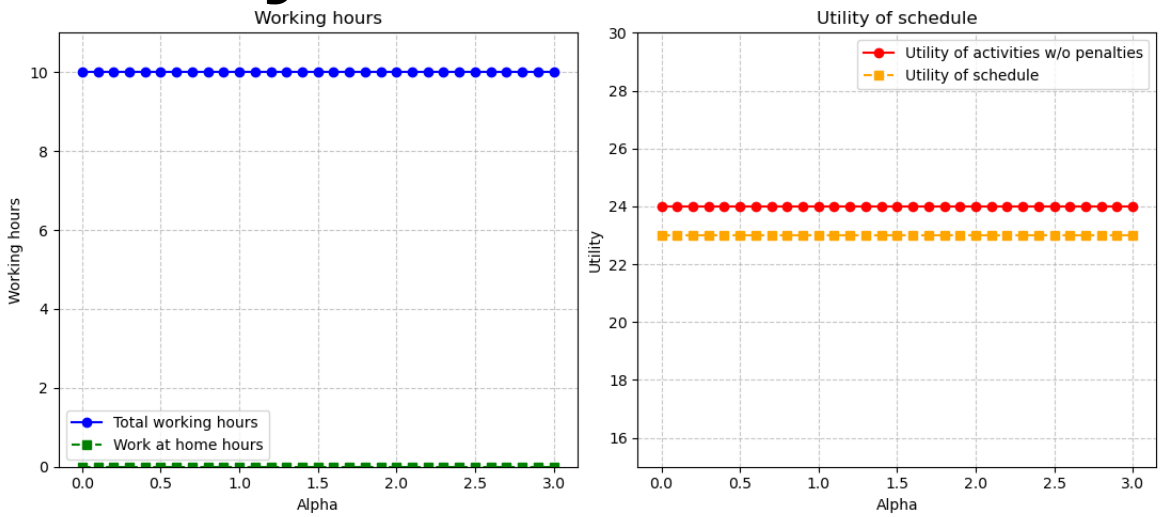
Working hours & Schedule utility: vary α

Office	Office + home	Office + ICT	Office + home + ICT

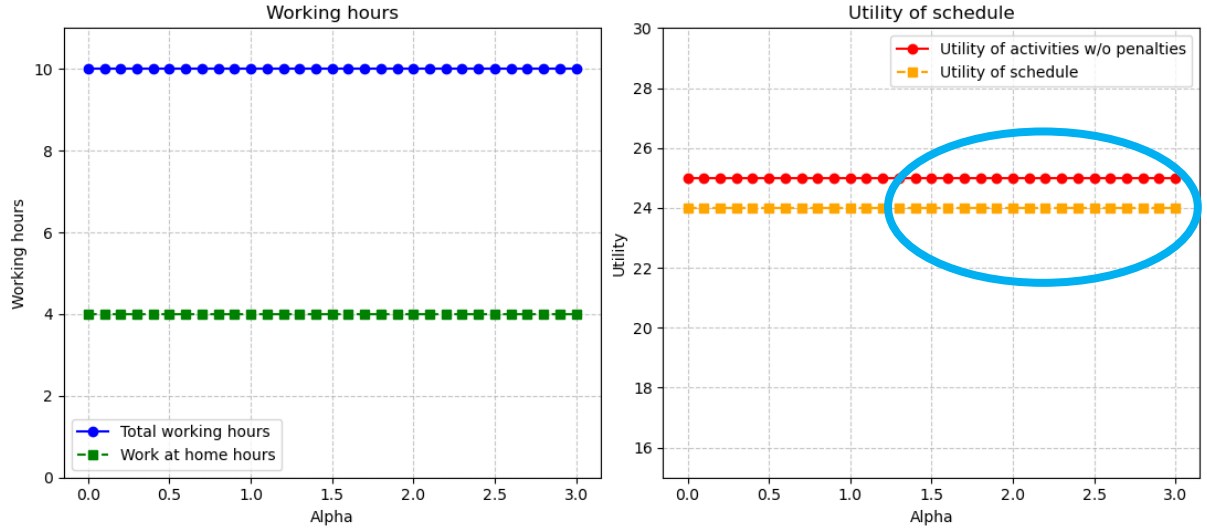
Activity	With limited ICT use					With extended ICT use				
	Utility		Time		Resources	Utility		Time		Resources
	At work	At home	At work	At home		At work	At home	At work	At home	
Meeting	5	-10	1.2	2	1	1	1	1	1	1
Creative work	5	6	3	4	1	6	7	3	4	0.8
Routine work	3	3	3.5	3.5	0.5	2	2	1	1	0.1
Planning	2	2	0.3	0.5	0.5	2	2	0.2	0.25	0.5

Doing act. ↓ simult. with act. →	**Meeting**		**Creative work**		**Routine work**		**Planning**	
	Utility penalty (ϕ)	Time efficiency (η)	Utility penalty (ϕ)	Time efficiency (η)	Utility penalty (ϕ)	Time efficiency (η)	Utility penalty (ϕ)	Time efficiency (η)
Meeting	0	1	-0.5	1	-0.5	1	-0.5	1
Creative work	-0.3	0.05	0	1	-0.3	0.8	-0.3	0.2
Routine work	0	0.9	0	0.9	0	1	0	0.5
Planning	0	0.3	0	0.4	0	0.5	0	1

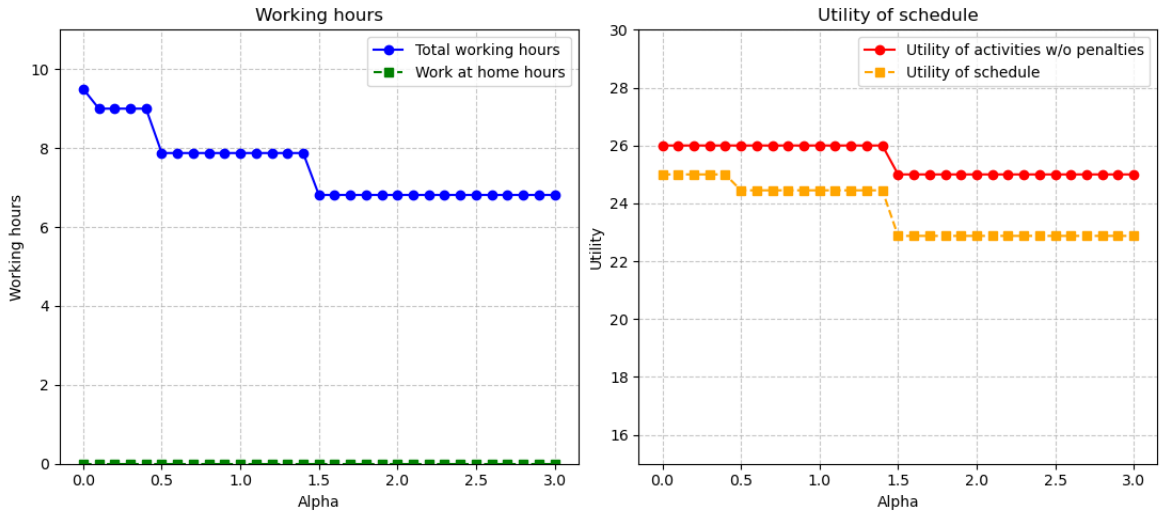
Today: theoretical demonstration



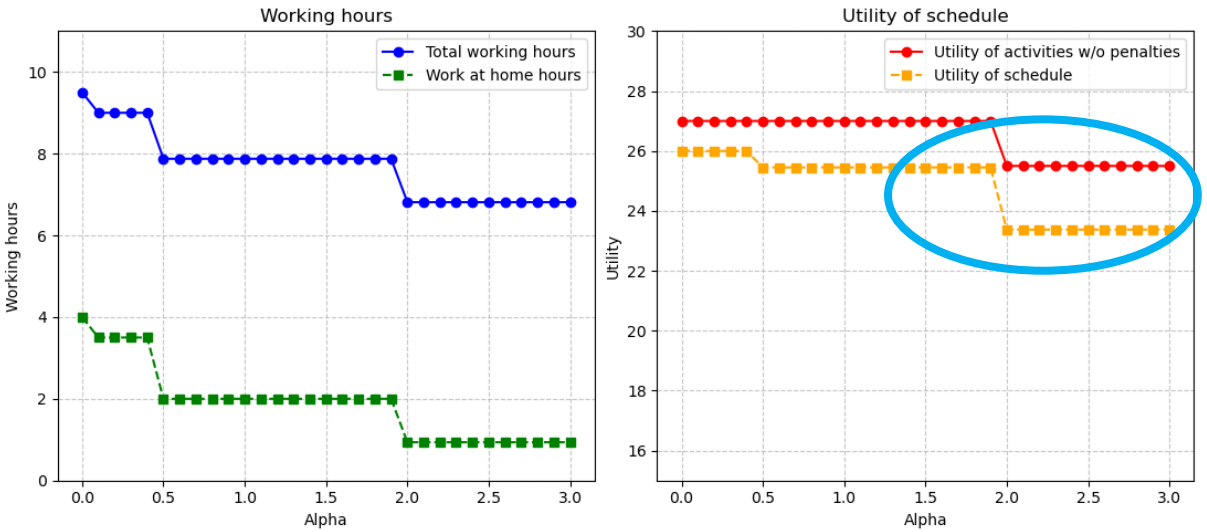
Workplace only; limited automation / ICT



Workplace and home office; limited automation / ICT



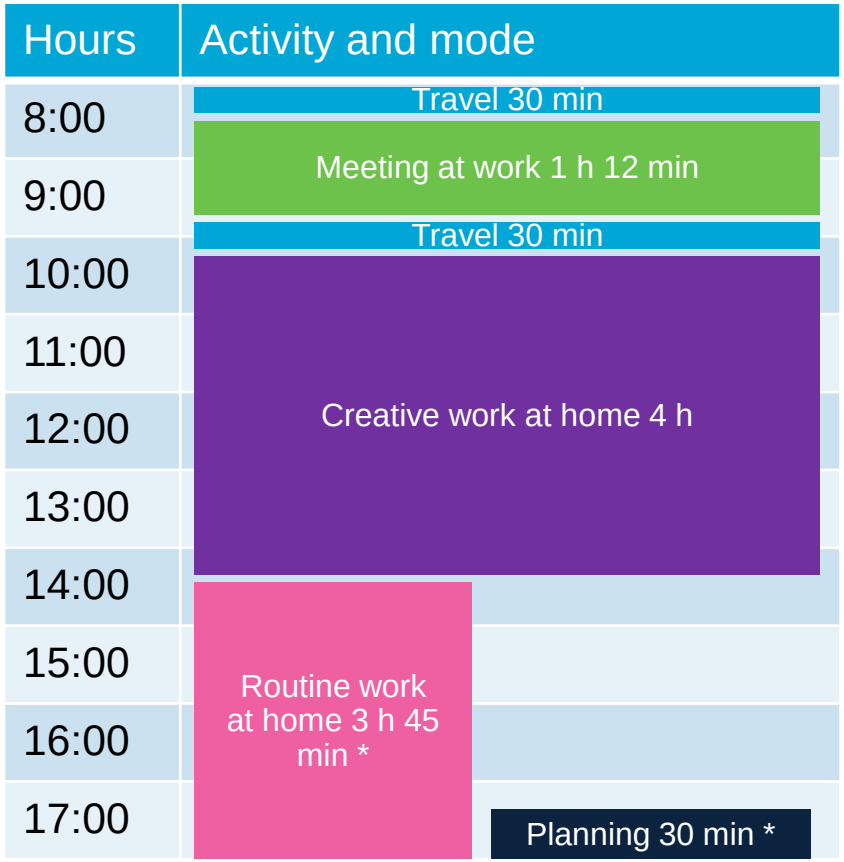
Workplace only;
extended automatin / ICT options



Workplace & home office;
extended automation / ICT options

Time-use model: results illustration

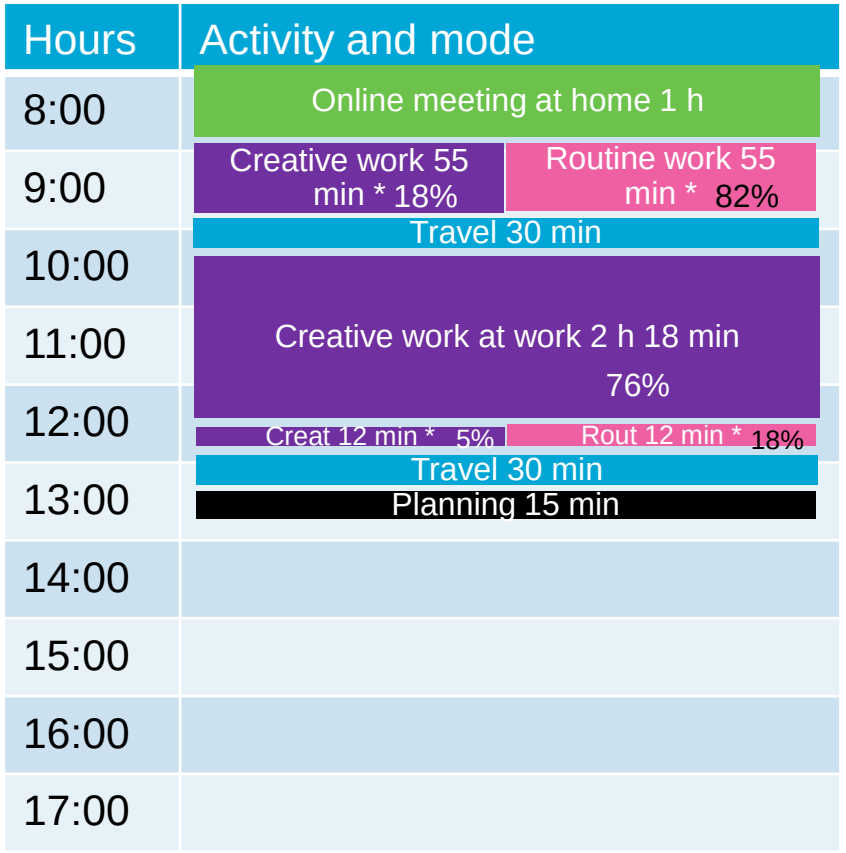
$\alpha = 0$



Duration: 10 h

Schedule utility: 13

$\alpha = 20$



Duration: 5.7 h

Schedule utility: 6.3

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FAQ – how about data?

1. Time-use data
   - Multitasking, fragmentation at all times
   - Telework & COVID. Isolate the well-being impact of multitasking/ fragmentation from (lack of) commute, social contacts, etc.
2. Data from (physical) work settings
   - Introduction of automation, new machine, automated reporting, etc.
   - Isolate the well-being impact of the change in time-use from the reduction physical work, from the change in management
3. Qualitative:
   - How has your time-use changed over the years?
   - Isolate from life-events
4. Decision utility:
   - How people choose and adjust (automation, ICT) tools anticipating their time-use impacts?
   - Employees' and employers' perspectives

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Ultimately: derive guidance for future of work developments & policies!

To sum up…

Baseline daily activity patterns are evolving

- Some evolution directions are known (i.e., more multitasking & fragmentation)
- Travel behaviour implications depend on home & workplace characteristics
- Possibility for well-being losses
- How can our modelling expertise help to design remedies?

Interested to collaborate?

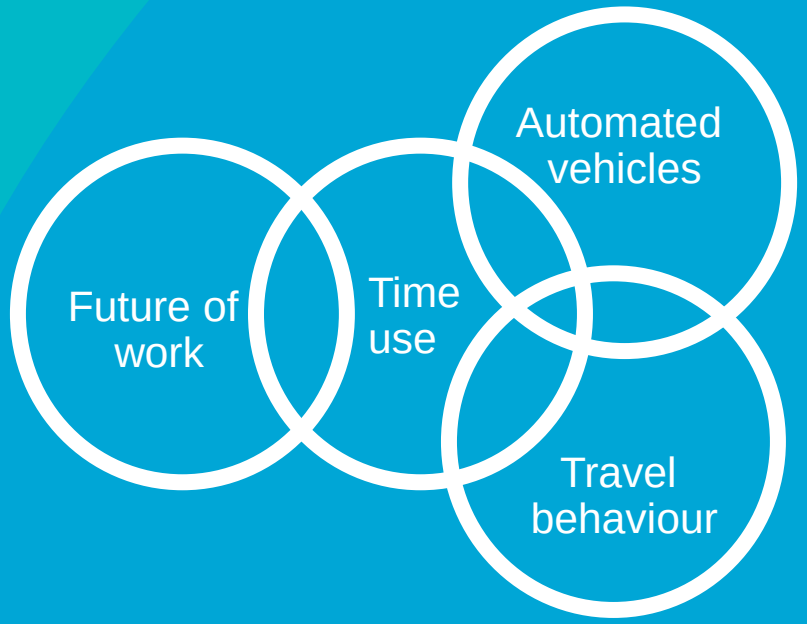
Suggestions & comments?

→ *b.pudane@tudelft.nl*

Your perspectives,

experiences,

and ideas!



Thank you!

Appendix

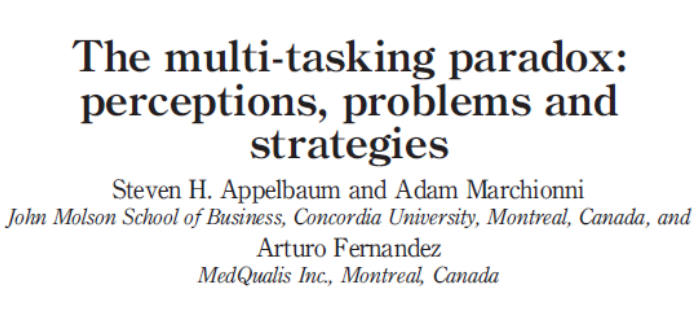
Time-use model: wishlist

- Other emerging time-use behaviours
  - Irregularity / variability / flexibility
  - Fragmentation due to interruptions
  - Procrastination

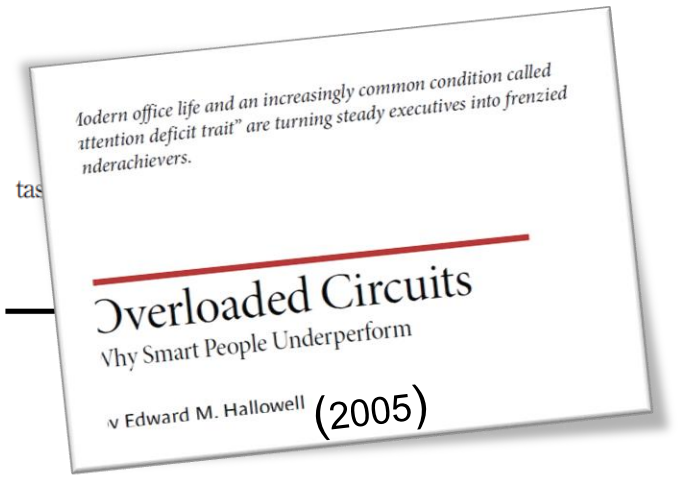
- Continuous partial attention

- Role of time-use preferences –
  e.g., integration or segmentation of life domains

- Differentiation between helpful and harmful breaks

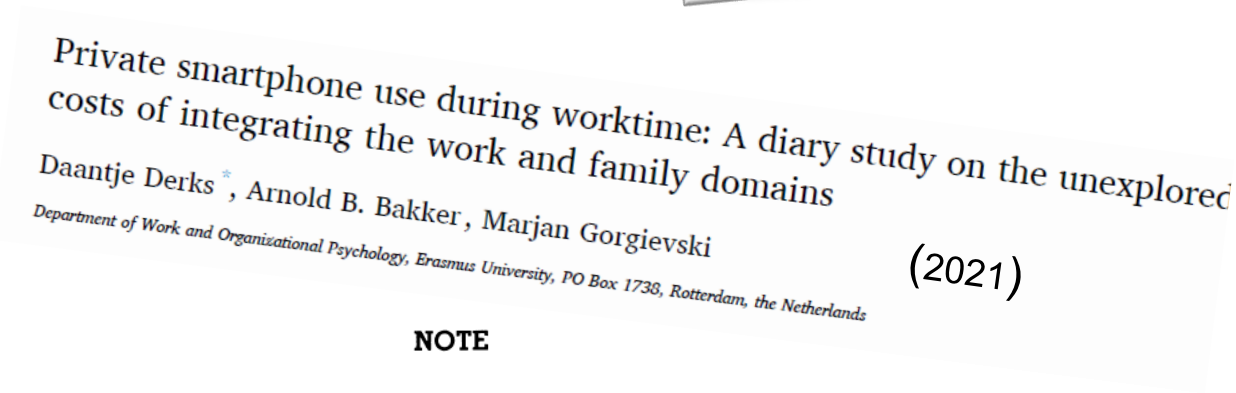

The multi-tasking paradox: perceptions, problems and strategies

Steven H. Appelbaum and Adam Marchionni
John Molson School of Business, Concordia University, Montreal, Canada, and
Arturo Fernandez
MedQualis Inc., Montreal, Canada


lodern office life and an increasingly common condition called ttention deficit trait" are turning steady executives into frenzied nderachievers.

Overloaded Circuits
Why Smart People Underperform

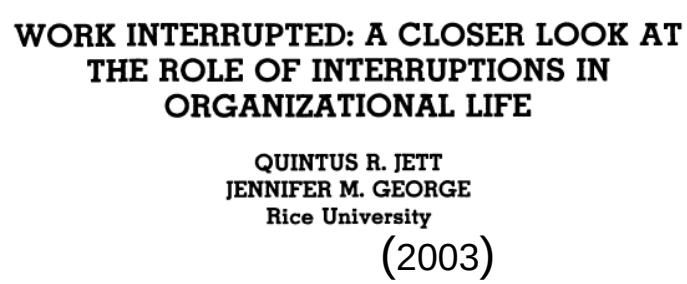
by Edward M. Hallowell (2005)


Private smartphone use during worktime: A diary study on the unexplored costs of integrating the work and family domains

Daantje Derks *, Arnold B. Bakker, Marjan Gorgievski

Department of Work and Organizational Psychology, Erasmus University, PO Box 1738, Rotterdam, the Netherlands

(2021)


NOTE

WORK INTERRUPTED: A CLOSER LOOK AT THE ROLE OF INTERRUPTIONS IN ORGANIZATIONAL LIFE

QUINTUS R. JETT
JENNIFER M. GEORGE
Rice University

(2003)

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Time-use model: FAQ

- What is productivity?
  - Definition: the ability to do as much work as possible in a particular period
    https://dictionary.cambridge.org/dictionary/english/productivity
  - Current operationalisation: time taken complete all work tasks
  - Focus on quantity, not quality

- Can we truly multitask?

- Are activities completed or have diminishing returns?

- Are we as individuals optimising? → Bounded rationality
  - Technology → expanding choice sets. Choice overload

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Cluster profiles – schedules with AVs

Cluster profiles.

	Cluster 1	Cluster 2	Cluster 3	Cluster 4	Cluster 5	Sample average
Schedule changes	None	Small stationary	Work in AV	Spare time in AV	Various activities in AV	
Commitment to survey	Low	Low	Appropriate	Appropriate	Appropriate	
Cluster size	55.26%	15.59%	13.20%	10.14%	5.88%	
Duration changes per minute of travel (minute/minute of travel)						
Work on board	0.0000	0.0000	**0.3988**	0.1920	0.0823	0.0765
Spare time on board	0.0000	0.0000	0.1453	**0.5062**	**0.1271**	0.0775
Getting ready on board	0.0000	0.0000	0.1340	0.0000	**0.1294**	0.0108
Meal on board	0.0000	0.0000	0.1340	0.0000	**0.1293**	0.0251
Work stationary	0.0000	0.0683	**−0.3124**	0.0053	−0.0486	−0.0173
Spare time stationary	0.0000	0.0341	**0.2268**	0.0124	0.1380	0.0418
Sleep stationary	0.0000	0.0407	0.1323	−0.0022	0.0354	0.0255
Getting ready stationary	0.0000	0.0242	−0.0151	0.0000	−0.1509	−0.0052
Meal stationary	0.0000	−0.0125	−0.0464	0.0002	**−0.2250**	−0.0359
Departure time changes per minute of travel (minute/minute)						
Difference work trip	0.0002	0.0319	0.0577	0.0000	**−0.1830**	0.0023
Difference home trip	0.0000	−0.0587	**−0.2545**	0.0010	**−0.5620**	−0.0744

Covariates						**p-value**	**Sample**
Gender						0.002**	
Man	66.67%	64.93%	58.35%	52.01%	48.49%		62.75%
Woman	33.33%	35.07%	41.65%	47.99%	51.51%		37.25%
Education						0.001**	
No education \Primary education to MAVO \HAVO and VWO \VMBO	16.82%	13.30%	1.60%	5.58%	6.95%		12.55%
MBO 2, 3, 4 of MBO old structure[a]	31.93%	35.66%	12.01%	22.43%	28.86%		28.74%
HAVO and VWO \HBO\WO	9.34%	8.93%	4.67%	7.12%	7.01%		8.30%
HBO[b] \WO (University) bachelor	27.52%	27.91%	37.52%	36.86%	32.90%		30.16%
HBO\WO (University) master, or doctoral	14.38%	14.20%	44.20%	28.00%	24.27%		20.24%
Travel time						0.002*	
10–30 min	59.77%	49.62%	26.15%	35.21%	41.55%		50.20%
30–60 min	33.58%	41.06%	52.22%	49.55%	48.24%		39.68%
>60 min	6.65%	9.32%	21.63%	15.25%	10.21%		10.12%

Cluster profiles – schedules with AVs

Cluster profiles.

	Cluster 1	Cluster 2	Cluster 3	Cluster 4	Cluster 5		Sample average
Schedule changes	None	Small stationary	Work in AV	Spare time in AV	Various activities in AV		
Commitment to survey	Low	Low	Appropriate	Appropriate	Appropriate		
Cluster size	55.26%	15.59%	13.20%	10.14%	5.88%		
Expectation of AV usage frequency						0.001**	
For (almost) all of my trips	33.05%	41.60%	58.81%	50.27%	66.80%		41.50%
For many of my trips	14.75%	16.98%	15.57%	16.16%	15.35%		15.38%
For some of my trips	18.48%	19.57%	12.85%	16.74%	9.48%		17.21%
For (almost) none of my trips	19.90%	9.67%	9.14%	11.10%	6.01%		15.18%
I don't know	13.82%	12.18%	3.62%	5.74%	2.35%		10.73%
Consider purchasing an AV						0.023*	
Yes	23.13%	35.65%	49.90%	37.18%	46.08%		31.38%
Maybe	37.72%	40.50%	33.97%	37.61%	37.81%		37.65%
No	35.39%	17.21%	14.57%	23.28%	13.91%		27.33%
I don't think I will ever buy a car	3.76%	6.65%	1.56%	1.93%	2.19%		3.64%
Daily time pressure						0.022*	
Very low time pressure	3.02%	3.09%	0.79%	2.93%	1.44%		2.63%
Low time pressure	17.36%	13.03%	3.34%	16.03%	8.30%		14.17%
Not low, not high time pressure	51.90%	51.54%	32.82%	46.23%	45.51%		48.38%
High time pressure	25.47%	31.22%	53.33%	31.74%	40.91%		31.58%
Very high time pressure	2.25%	1.12%	9.73%	3.07%	3.84%		3.24%
Ability to work in the car						0.037*	
Yes, all or almost all of my work tasks	8.36%	7.86%	19.33%	20.08%	18.99%		11.54%
Most of my work tasks	14.61%	21.69%	33.17%	26.35%	26.45%		20.04%
Some of my work tasks	34.71%	33.04%	37.06%	35.01%	35.21%		34.82%
No, none or almost none of my work tasks	42.32%	37.40%	10.44%	18.55%	19.35%		33.60%
Introduction screen time						0.019*	
Mean	37.64	44.85	53.92	45.51	74.97		43.89
Activity fragments						0.000**	
Mean	7.31	7.30	8.11	8.32	7.96		7.55
Copy current schedule						0.076	
False	0.37%	74.07%	33.70%	3.94%	41.71%		19.03%
True	99.63%	25.93%	66.30%	96.06%	58.29%		80.97%

Instruction video times: 119.1 s (cluster 1), 113.5 s (cluster 2), 167.7 s (cluster 3), 176.6 s (cluster 4), 149.4 s (cluster 5)

Research agenda

- **Theoretical.** Understand (and model) what new time-use patterns emerge in the future of work
- **Empirical.** Understand when / for whom / in what contexts the new patterns (e.g., multitasking & fragmentation) are beneficial for productivity and well-being
- **Methodological.** Find ways to estimate thorny microeconomic time-use models; include multitasking and fragmentation in activity-based models

Interested to collaborate?

Suggestions & comments?

→ *b.pudane@tudelft.nl*

Schedule when $\alpha = 0$ – maximise satisfaction

Activity parameters:

Activity	With limited ICT use					With extended ICT use				
	Utility		Time		Resources	Utility		Time		Resources
	At work	At home	At work	At home		At work	At home	At work	At home	
Meeting	**5**	-10	**1.2**	2	**1**	1	1	1	1	1
Creative work	5	6	3	4	1	6	**7**	3	**4**	**0.8**
Routine work	3	**3**	3.5	**3.5**	**0.5**	2	2	1	1	0.1
Planning	2	2	0.3	0.5	0.5	2	**2**	0.2	**0.25**	**0.5**

Multitasking parameters:

Doing act. ↓ simult. with act. →	**Meeting**		**Creative work**		**Routine work**		**Planning**	
	Utility penalty (ϕ)	Time efficiency (η)	Utility penalty (ϕ)	Time efficiency (η)	Utility penalty (ϕ)	Time efficiency (η)	Utility penalty (ϕ)	Time efficiency (η)
Meeting	0	1	-0.5	1	-0.5	1	-0.5	1
Creative work	-0.3	0.05	0	1	-0.3	0.8	-0.3	0.2
Routine work	0	0.9	0	0.9	0	1	**0**	**0.5**
Planning	0	0.3	0	0.4	**0**	**0.5**	0	1

7%

100%

- Overlapping time prolongs activity (with $1/\eta$)

Schedule when $\alpha = 20$ – maximise productivity

Activity parameters:

Activity	With limited ICT use					With extended ICT use				
	Utility		Time		Resources	Utility		Time		Resources
	At work	At home	At work	At home		At work	At home	At work	At home	
Meeting	5	-10	1.2	2	1	1	**1**	1	**1**	**1**
Creative work	5	6	3	4	1	**6**	**7**	**3**	**4**	**0.8**
Routine work	3	3	3.5	3.5	0.5	**2**	**2**	**1**	**1**	**0.1**
Planning	2	2	0.3	0.5	0.5	2	**2**	0.2	**0.25**	**0.5**

Multitasking parameters:

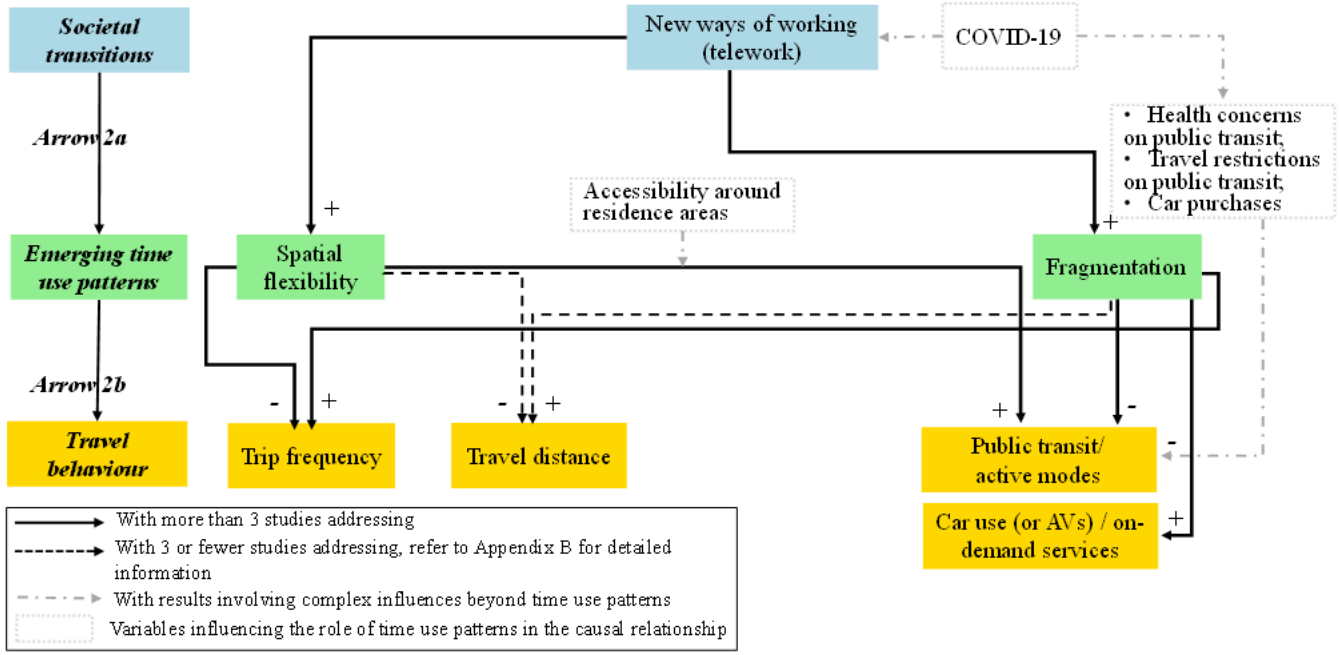
Doing act. ↓ simult. with act. →	Meeting		Creative work		Routine work		Planning	
	Utility penalty (ϕ)	Time efficiency (η)	Utility penalty (ϕ)	Time efficiency (η)	Utility penalty (ϕ)	Time efficiency (η)	Utility penalty (ϕ)	Time efficiency (η)
Meeting	0	1	-0.5	1	-0.5	1	-0.5	1
Creative work	-0.3	0.05	0	1	**-0.3**	**0.8**	-0.3	0.2
Routine work	0	0.9	**0**	**0.9**	0	1	0	0.5
Planning	0	0.3	0	0.4	0	0.5	0	1

7%

100%

Hours	Activity and mode
8:00	Online meeting at home 1 h
9:00	Creative work 55 min * 18% / Routine work 55 min * 82%
10:00	Travel 30 min
11:00	Creative work at work 2 h 18 min 76%
12:00	Creat 12 min * 5% / Rout 12 min * 18%
13:00	Travel 30 min / Planning 15 min
14:00	
15:00	
16:00	
17:00	

- Overlapping time prolongs activity (with $1/\eta$)


Societal transitions
Arrow 2a
Emerging time use patterns
Arrow 2b
Travel behaviour
New ways of working (telework)
COVID-19
• Health concerns on public transit;
• Travel restrictions on public transit;
• Car purchases
Accessibility around residence areas
Spatial flexibility
Fragmentation
Trip frequency
Travel distance
Public transit/ active modes
Car use (or AVs) / on-demand services
With more than 3 studies addressing
With 3 or fewer studies addressing, refer to Appendix B for detailed information
With results involving complex influences beyond time use patterns
Variables influencing the role of time use patterns in the causal relationship

Time-use model: wishlist

Jett, Q. R., & George, J. M. (2003). Work interrupted: A closer look at the role of interruptions in organizational life. Academy of management Review, 28(3), 494-507.

Each Interruption Type and Its Potential Consequences

Type of Interruption	Negative Consequences for the Person Being Interrupted	Positive Consequences for the Person Being Interrupted
Intrusion	Insufficient time to perform time-sensitive tasks, stress and anxiety associated with heightened feelings of time pressure, and/or a disruption in a person's state of total involvement in the task being performed	Informal feedback and information sharing unlikely to occur through other, more established means
Break	Procrastination (i.e., excessive delays in starting or continuing work on a task) and/or significant amounts of time spent relearning essential details of the work being performed	Alleviation of fatigue or distress, a rhythm and pace of work enhancing job satisfaction and performance, and/or opportunities for incubation of ideas on creative tasks
Distraction	Mediocre performance when the person's work is complex, demanding, and requires learning and one's full attention and/or when the person has particular traits that make him or her more vulnerable or sensitive to distractions (e.g., lack of stimulus-screening capabilities or a Type A personality)	Enhanced performance when the distraction helps filter out other irritating environmental stimuli and/or increases stimulation levels on routine tasks
Discrepancy	An intense, paralyzing negative emotional reaction or continuous automatic processing of task-related information, if the discrepancy is suppressed or denied	Mindful, effortful, and controlled processing of information and/or the recognition of the need for change and stimulation of action

Time-use model: an illustrative example

Activity parameters:

Different utility (satisfaction) and time requirements (efficiency)

Choice of activity location

Activity	With limited ICT use					With extended ICT use				
	Utility		Time		Resources	Utility		Time		Resources
	At work	At home	At work	At home		At work	At home	At work	At home	
Meeting	5	-10	1.2	2	1	1	1	1	1	1
Creative work	5	6	3	4	1	6	7	3	4	0.8
Routine work	3	3	3.5	3.5	0.5	2	2	1	1	0.1
Planning	2	2	0.3	0.5	0.5	2	2	0.2	0.25	0.5

4 activities

Choice of technology support

Technology support saves (mental) resources

Multitasking parameters:

Doing act. ↓ simult. with act. →	Meeting		Creative work		Routine work		Planning	
	Utility penalty (ϕ)	Time efficiency (η)	Utility penalty (ϕ)	Time efficiency (η)	Utility penalty (ϕ)	Time efficiency (η)	Utility penalty (ϕ)	Time efficiency (η)
Meeting	0	1	-0.5	1	-0.5	1	-0.5	1
Creative work	-0.3	0.05	0	1	-0.3	0.8	-0.3	0.2
Routine work	0	0.9	0	0.9	0	1	0	0.5
Planning	0	0.3	0	0.4	0	0.5	0	1

Any 2 (but not 3) activities may be 'multitasked' resulting in lower utility and time efficiency (Time*1/η)

Penalty for fragmentation

Not in the model: interruptions due to ICT use → multitasking & fragmentation underestimated

Time-use model: two objectives

Minimise work time WT

(Max. productivity, leisure time)

$$\min WT(X) = \sum_{l \in L} \sum_{\substack{i,j \in I \cup \tilde{I}, \\ i \leq j}} \left(x_{ij}^{l} T_i^{l} \frac{1}{\eta_{ij}} \right),$$

locations

technology support and MT-ing

share of activity i together with j

time requirements given Mt-king

Maximise utility U

(Max. satisfaction, well-being)

$$\max U(X) = \sum_{l \in L} \left[\sum_{i,j \in I \cup \tilde{I}} x_{ij}^{l} \left(U_i^{l} + T_i^{l} \frac{\phi_{ij}}{\eta_{ij}} \right) + \sum_{\substack{i,j \in I \cup \tilde{I}, \\ i \leq j}} \psi y_{ij}^{l} + z_l U_{TT} TT_l \right]$$

utility of i

Mt-king penalty per time unit

Fragmentation penalty

Travel time disutility

Disutility of working hours with productivity weight α

Parameter α determines the balance between objectives:

satisfaction → productivity

0 ——— α

Time-use model: constraints

	(Mental) resources not exceeded	$\forall i, j \in I \cup \tilde{I}, \forall l \in L,$
	Tasks are completed	$\forall i \in I \cup \tilde{I},$
Technical constraints		$\forall i, j \in I \cup \tilde{I}, \forall l \in L,$
		$\forall i, j \in I \cup \tilde{I}, \forall l \in L,$
		$\forall i, j \in I \cup \tilde{I}, \forall l \in L,$
		$\forall l \in L,$
		$\forall l \in L,$
		$\forall i \in I, \forall l \in L,$
		$\forall i \in I, \forall j \in I, \forall l \in L,$
		$\forall i \in I, \forall j \in I, \forall l \in L.$

TU Delft

show me a large unicorn and a princess riding it

Here is the image of a majestic unicorn being ridden by a princess in a magical forest setting. Let me know if you'd like any adjustments!