

The Impact of Ventilation on Productivity

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CENTER FOR THE BUILT ENVIRONMENT

Project Overview

Objective
Investigate how ventilation and other environmental factors affect productivity

Issues

- ◆ Productivity measurement
- ◆ Impact of other factors



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Building

- ◆ 50,000 GSF
- ◆ 4 VAV HVAC systems
- ◆ No smoking
- ◆ 24/7 operation



Measurements

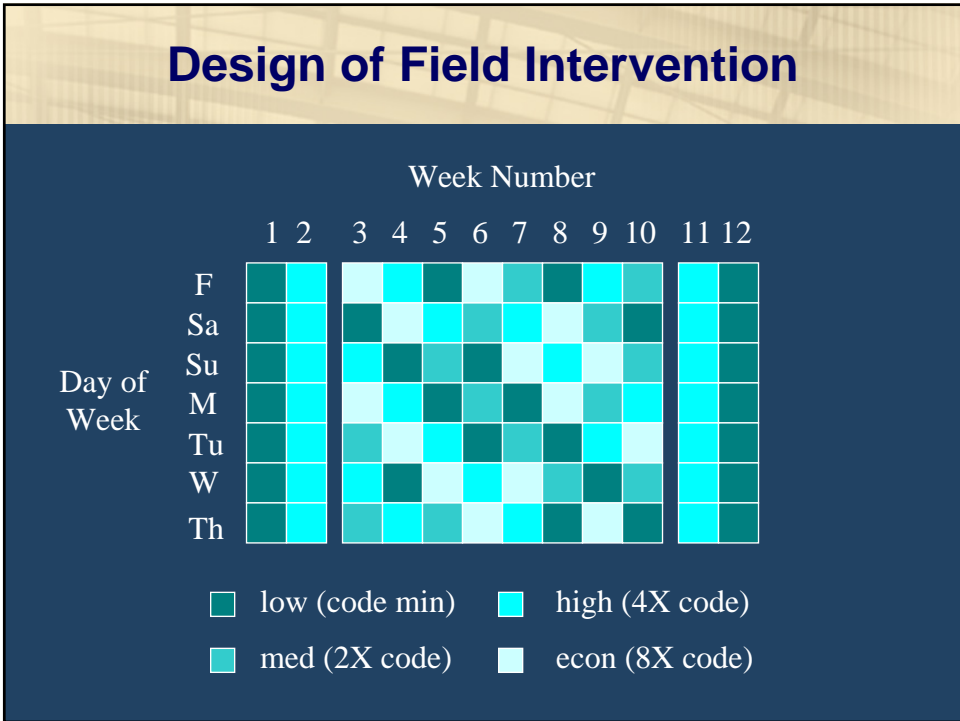
- ◆ ΔCO_2 (occupant-generated pollutants)
- ◆ Outdoor airflow rate
- ◆ Temperature
- ◆ Relative Humidity
- ◆ # agents working
- ◆ Under-staffing
- ◆ Shift Length
- ◆ Time of day
- ◆ Day of Week
- ◆ Number of calls per interval



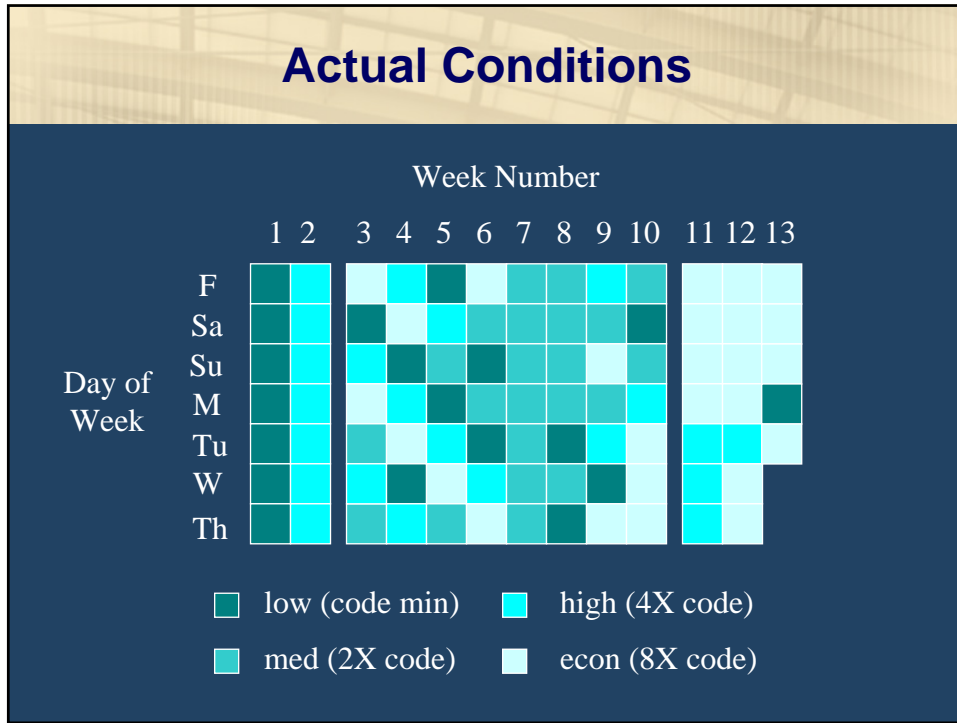
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Performance Data

- ◆ **Agents**
 - ◆ RNs (medical advice)
 - ◆ TSRs (call screening; appointment scheduling)
- ◆ **Individual**
 - ◆ Talk time
 - ◆ Wrap-up time
 - ◆ Handle time
- ◆ **Group**
 - ◆ Handle time
 - ◆ 30-minute averages
 - ◆ RNs separated from TSRs



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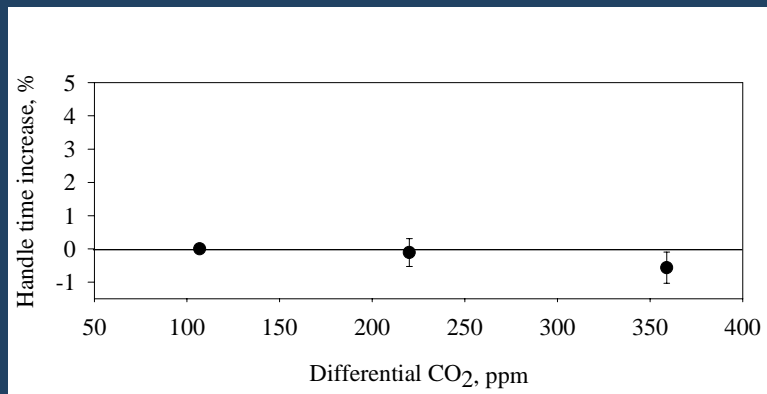
Results: Group

Descriptive statistics of explanatory variables

	ΔCO_2 ppm	Vent l/s-m ²	Temp °C (°F)	RH, %	Occ (RNs)	Over-staffing
range	28-475	0.62 – 8.4 0.12 – 1.7	22.6 - 24.0 72.7 – 75.2	45.2 - 48	26 - 115	-0.48 - 0.35
average	242	2.1 0.41	23.2 73.8	46.4	68	0

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Group Performance: Ventilation



- Slightly decreasing trend
- Not statistically significant

Group Performance: Other variables

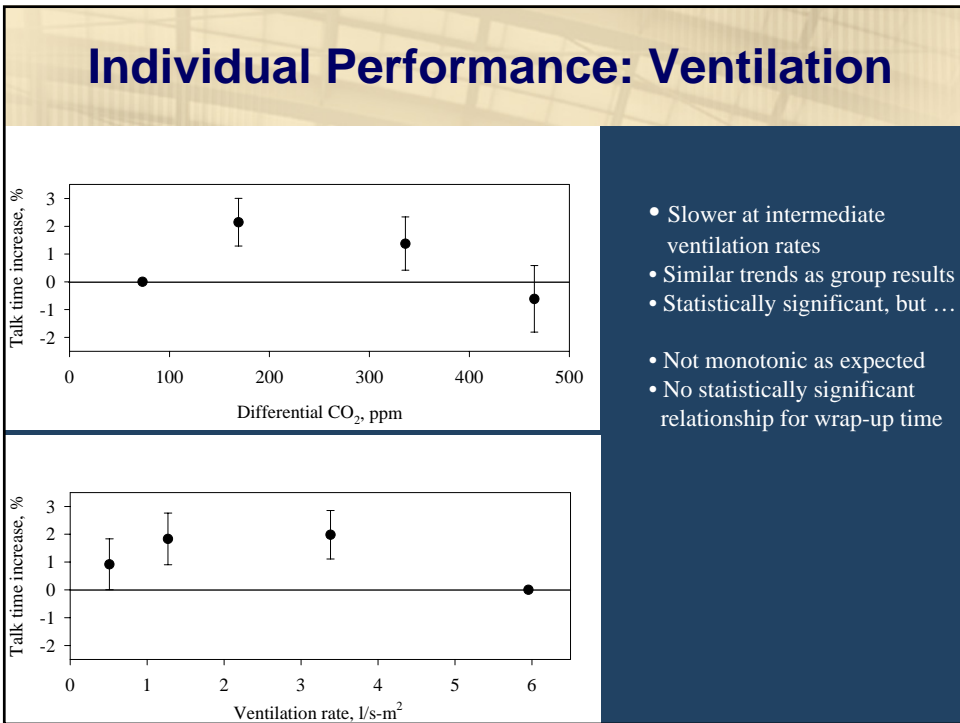
- ◆ Overstaffing
- ◆ Software change
- ◆ Number of RNs working
- ◆ Temperature and RH range too small

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Results: Individual

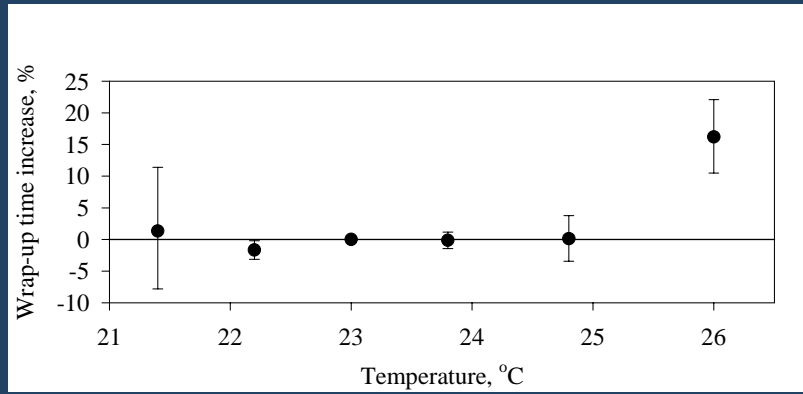
Descriptive statistics of explanatory variables

	ΔCO_2 ppm	Vent l/s-m ² (cfm/sqft)	Temp °C (°F)	RH, %	Occ	Over- staffing	Shift hours
range	13 – 611	0.26 – 10 0.05 – 2	21.0 – 26.6 69.8 – 79.9	20.2 – 55.3	67 – 254	-11 – 17	0.48 – 12.4
mean	253	2.07 0.41	23.1 73.6	42.4	159.6	2.7	6.8



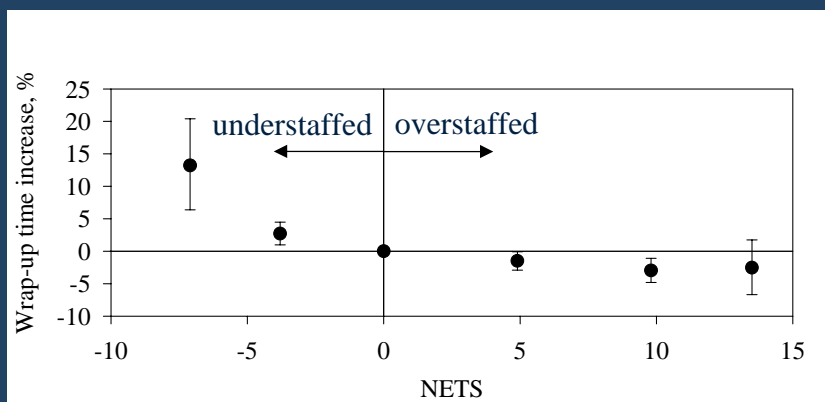
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Individual Performance: Temperature



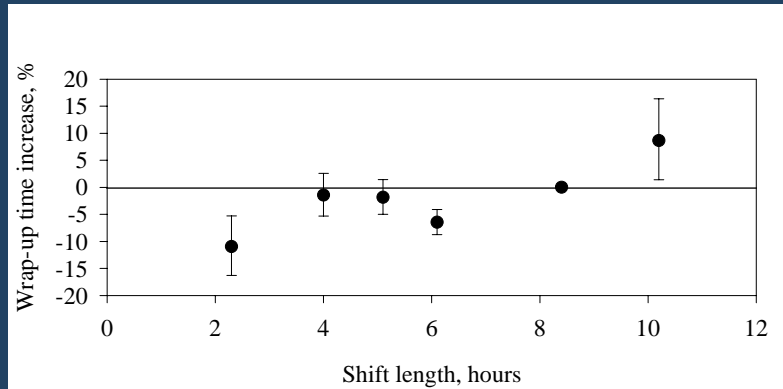
High temperature is largest effect with $p < 5\%$

Individual Performance: Staffing



Agents get no rest between calls when severely understaffed

Individual Performance: Shift Length



Linear term has a positive coefficient and is statistically significant

Individual Performance: Other variables

- ◆ 20% slower at max occupancy than at min occupancy ($p=0.07$)
- ◆ Software change
 - ◆ increased talk time (4.2%)
 - ◆ decreased wrap-up time (7.5%)

Conclusions

- ◆ There is some evidence that ventilation rates less than 100% outdoor air are associated with lower work performance, but the results are not conclusive.
- ◆ Agents work slower at high temperature (> 25.4 C, 77.7 F).
- ◆ There is evidence that agents work slower when the occupant density is higher.
- ◆ Agents work slower when the call center is understaffed.
- ◆ Agents work slower when they work longer shifts.

Questions?

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