

# MOVEMENT DYNAMICS IN OFFICE ENVIRONMENTS

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# Enhancing office architectural design to increase physical activity

## Currently

- The typical office worker worldwide spends a significant amount of time per day indoors.
- Only 36% of men and 24% of women in the UK meet public health recommendations.

***'Individuals are being encouraged to accumulate a minimum of 30 mins of brisk walking (4 METS) on five or more days of a week'.***

*British Heart Foundation, 1998, Department of Health, 2004, and U.S. Department of Health and Human Services, 1996.*

## The Future

- Medical estimations (2010)



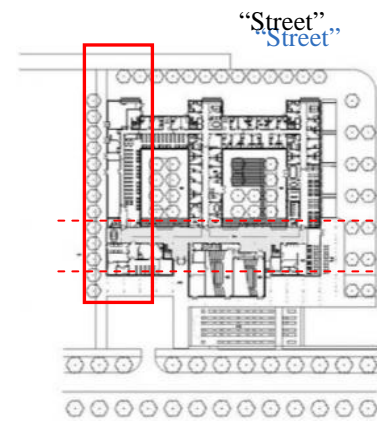
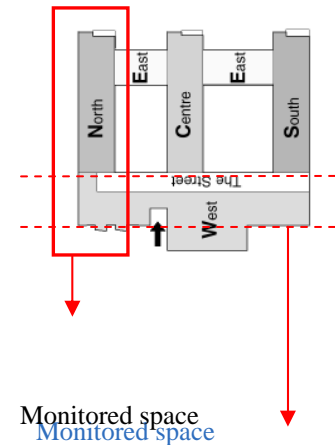
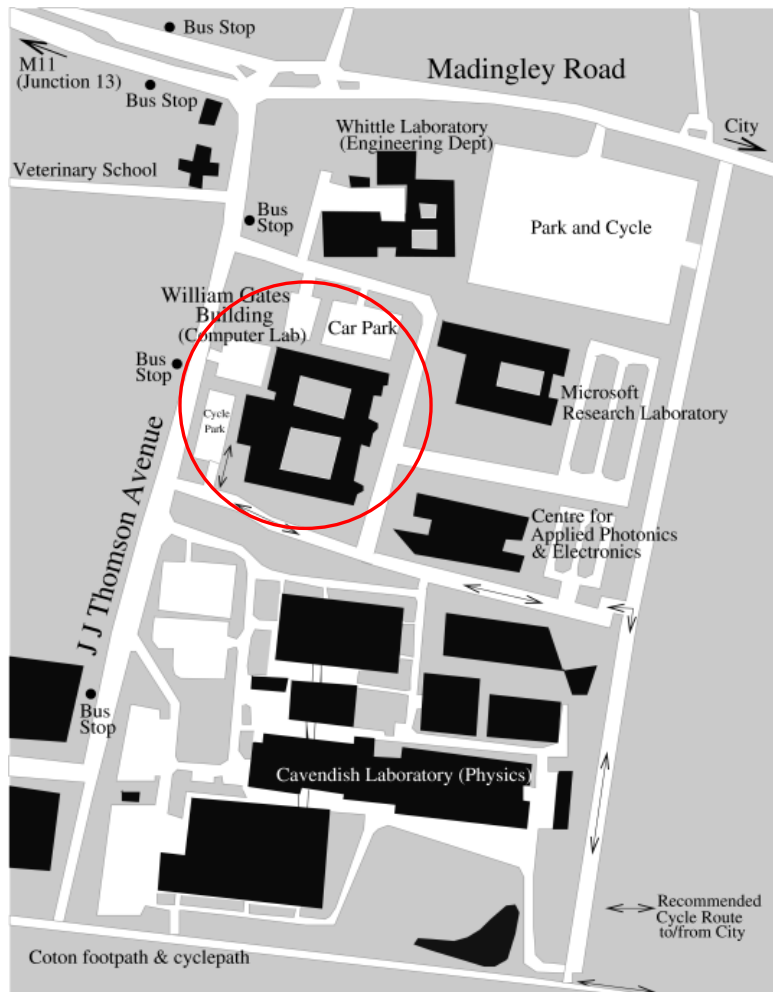
## Measuring

Relationship between human energy expenditure and the use of space

### Two models

1. Energy expenditure involved in moving inside the building
2. Identify the probability of journeys being made between office destinations

# William Gates Building, Cambridge



# Investigating and Measuring movement at the Computer Laboratory William Gates Building, University of Cambridge

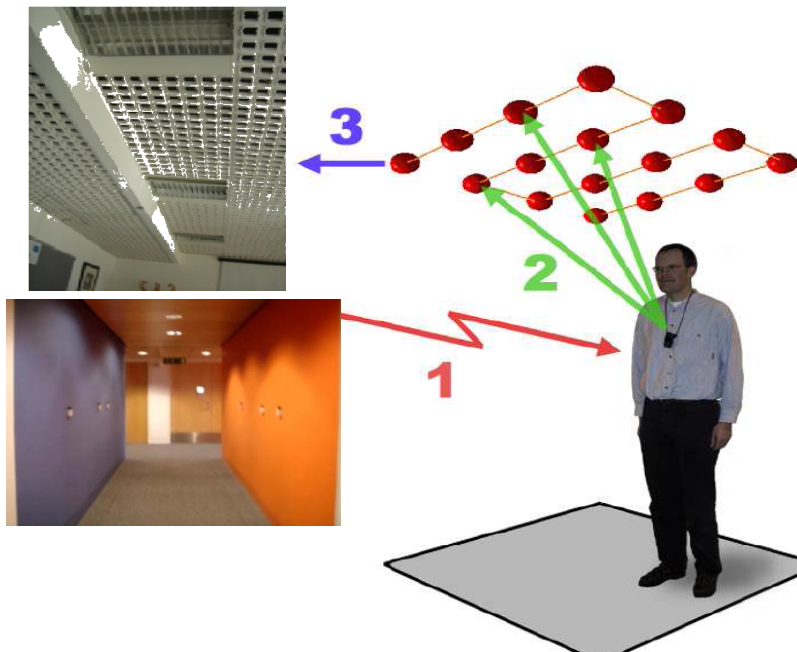
## Active Bat location tracking device

*Bat* System registers position of individual badges

1. Radio system triggers Bat
2. Bat emits burst of ultrasound - ceiling receivers measure it

3. *Bat* System estimates *Bat* position

Consented use by the participants: Ethics Approval



## The GTIM Actigraph

Movement sensor that measures physical activity intensity (approx. weight 40gr.)



## Energy consumption model

Actigraph: *Freedson et al. (1998)*

$$P = \frac{(0.00094(60c) + 0.1346m - 7.37418) \cdot 4184}{60}$$

Where,

$P$  is power in W

$c$  is counts/s

$m$  is mass in kg

**Active Bat: *Isaac Newton***

Kinetic energy

$$E_k = \frac{1}{2} \cdot m \cdot (\Delta v)^2$$

$\eta = 15\%$  to  $30\%$

Gravitational energy

$$E_g = m \cdot g \cdot \Delta h$$

## Energy consumption model

Ralston (1958)

$$E_w = 29 + 0.0053v^2$$

Where,

$E_w$  is energy expenditure in cal/min/kg  
 $v$  is velocity in m/min

**Converting to SI units, we obtain:**

$$P_w = \frac{\left( (29 + 0.0053 \cdot (60v)^2) \cdot 4.184 \right)}{60} \cdot m \approx (2.02 + 1.33v^2) \cdot m$$

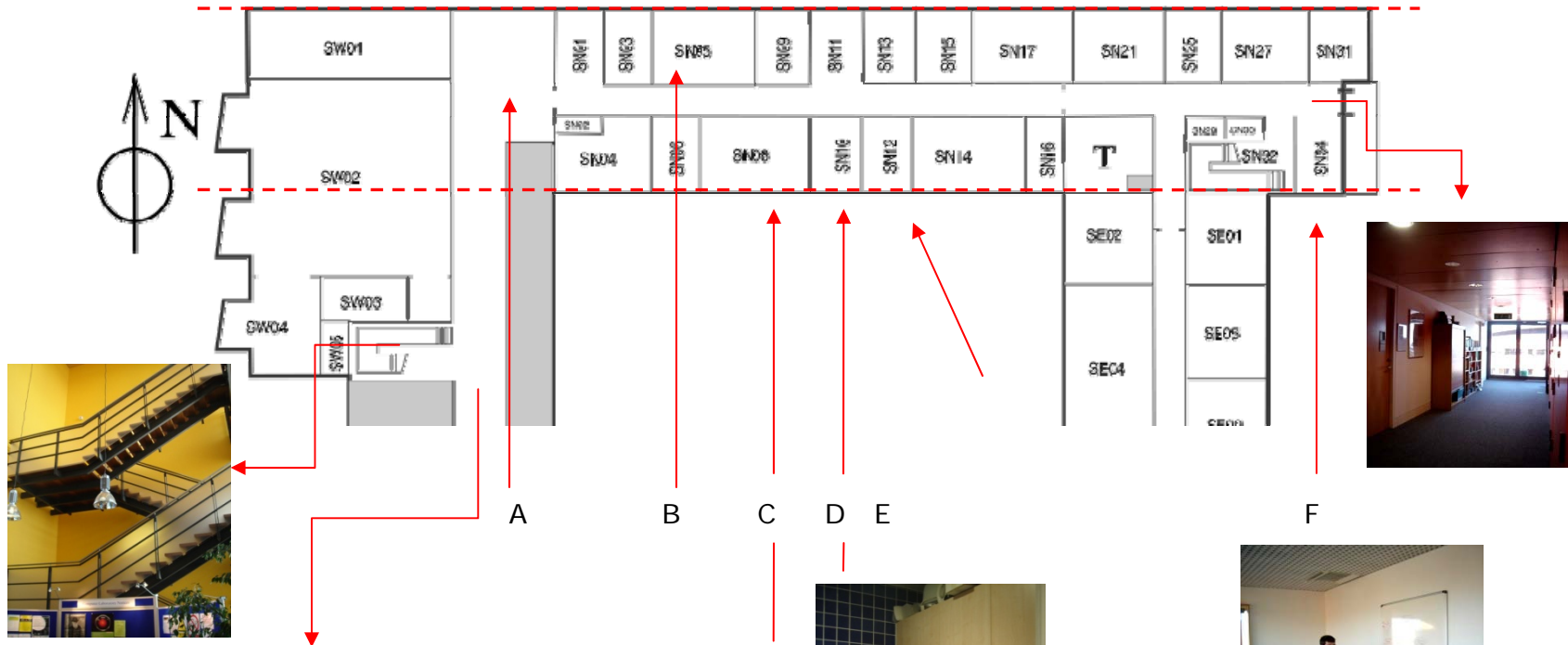
Where,

$P_w$  is power in W  
 $v$  is velocity in m/s  
 $m$  is mass in kg

# Reasons for movement

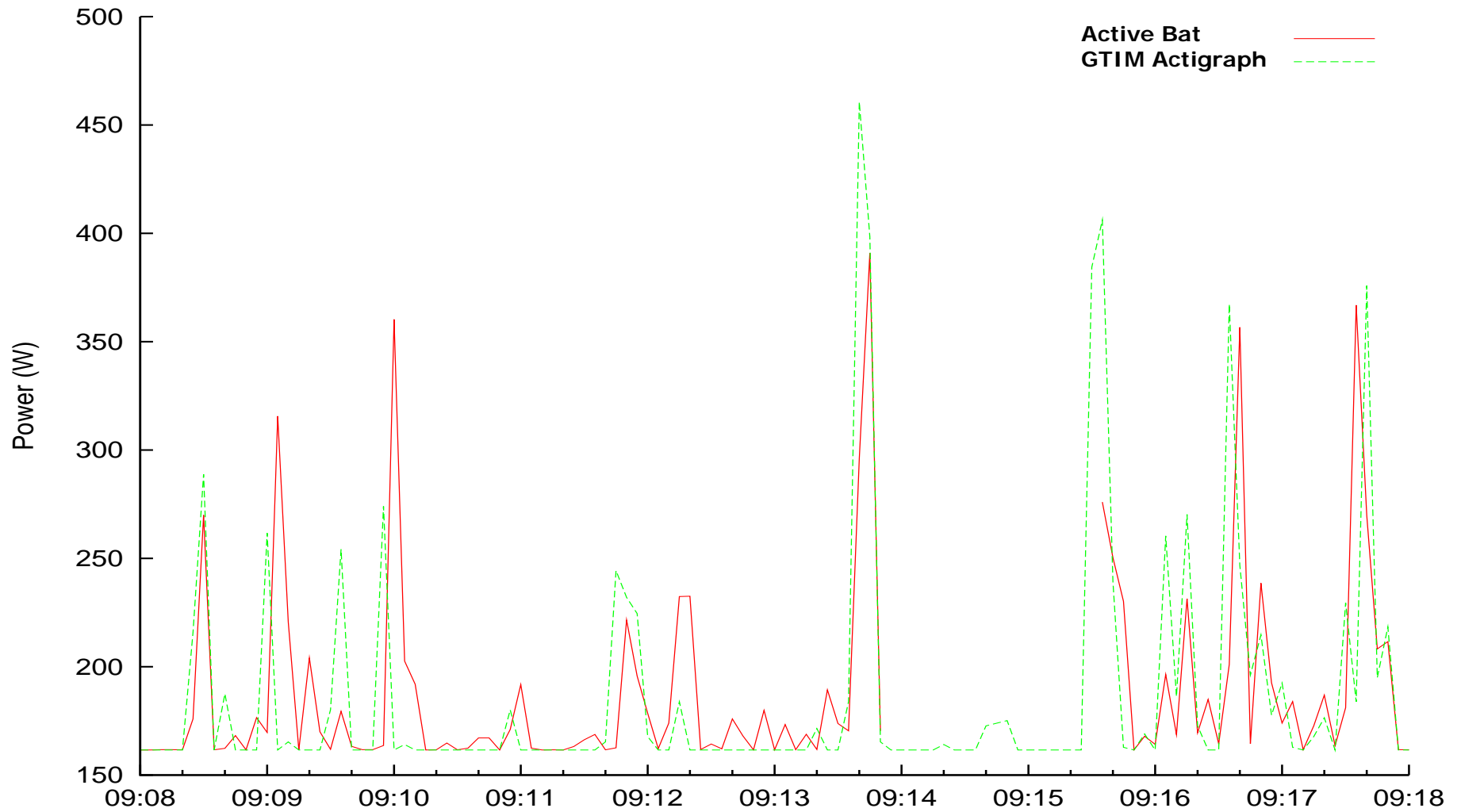
William Gates Building

Second Floor



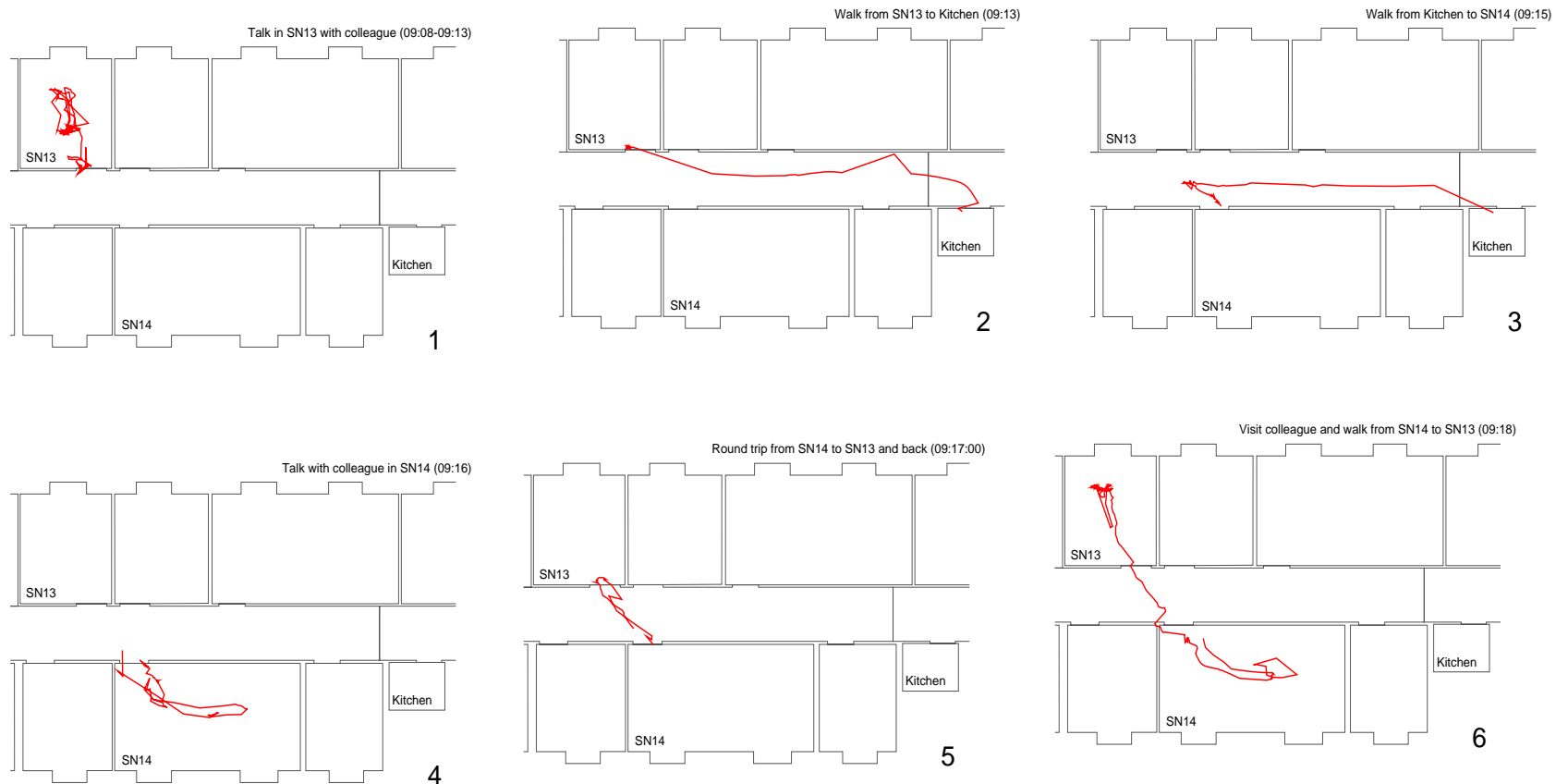
- A: Printers
- B: Managing director
- C: Meeting room
- D: Kitchen
- E: Toilet
- F: Open plan meeting room with view to the outside


## Model evaluation



# Model evaluation

*Trips made by an example individual between 09:08 and 09:18*





ESRC MRC Epidemiology Unit

Computer Laboratory, Cambridge

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