WALK21

TORONTO 2007

EFFECTIVE PEDESTRIAN SURVEYS WITH EVERYDAY EQUIPMENT

Paul Cullen – August 2007

EFFECTIVE PEDESTRIAN SURVEYS WITH EVERYDAY EQUIPMENT

Paul Cullen – August 2007

1. Introduction

This note is intended to stimulate discussion during the *Measuring Walking* workshop at Walk21 Toronto, specifically under 'Relevant Dimensions' Topic B (Pedestrian Counts etc).

2. The need to demonstrate the variability of pedestrian activity

Pedestrian activity can be highly variable, changing rapidly in short time periods. Can we measure the variability of pedestrians' experiences? And can we do so economically?

This paper focuses on affordable collection of two pedestrian characteristics – *flows* and *travel times*.

The examples used are not intended to make statistically robust statements, but to prompt a discussion about the extent to which meaningful data can be collected cheaply using everyday equipment.

3. Walking entails both movement and stationary behavior

Walkers do much more than moving. They assemble, queue and wait, sit and talk, are distracted from walking by reading and using cell phones, and ignore constraints on their behavior where they can. Conventional methods of surveying vehicle movements – based on patterns of relative orderliness and gradual change – are insufficient by themselves to identify the way that walkers use streets and spaces.

Pedestrian behavior is characterised by:

- Movement
- Waiting and Assembly
- Unpredictability
- Wide variability of participant performance

Pedestrians need to be content with their environment.

4. 4. Pedestrian activity can fluctuate widely in short time periods

Foot traffic can vary continually, with large fluctuations of flows, density and waiting times. Some pedestrian space serves both as waiting space and movement space. Rapid, localised changes in foot traffic can be witnessed. Pedestrian behavior can be disorderly, for example where opposing flows share the same space. This can lead to anarchic choices, demonstrated through pedestrians ignoring attempts to manage them.

Occurrences of wide fluctuation in both occupation of space and the way it is used can be witnessed:

- at signalised street crossings, both while people queue and when opposing pedestrian crossing flows meet in the middle of a street
- at bus and streetcar stops, as queues obstruct the sidewalk and then as a surge of people exits a vehicle on its arrival at the stop
- at exits from rail stations
- outside theatres, stadia, workplaces etc., where people may surge from such venues

Surveys need to identify with sufficient precision, where and when such conditions may occur and potentially cause discomfort, distress and unsafe conditions for the wide variety of people going about on foot.

5. Surveying Pedestrian Flows

5.1 How can we capture the rapid variations in pedestrian flows?

Ideally, surveys would reflect the ‘real world’ environment in which there was no boundary between survey periods, and data were collected seamlessly. In practice however, surveys are usually divided into survey periods and such periods should be short enough to allow the variability of pedestrian activity to be observed in the collected data.

5.2 One-Minute and Fifteen-Minute survey periods compared

Vehicle surveys often use fifteen minute periods, and this period is not uncommon in pedestrian surveys. But survey periods of fifteen minutes offer no meaningful picture of pedestrian activity. ***Flow maxima, minima and fluctuation cannot be determined.***

The charts below show how variable characteristics of flows are masked by an over-long survey period. Not only are the peaks and troughs of activity masked, but the variability in the flows is also hidden.

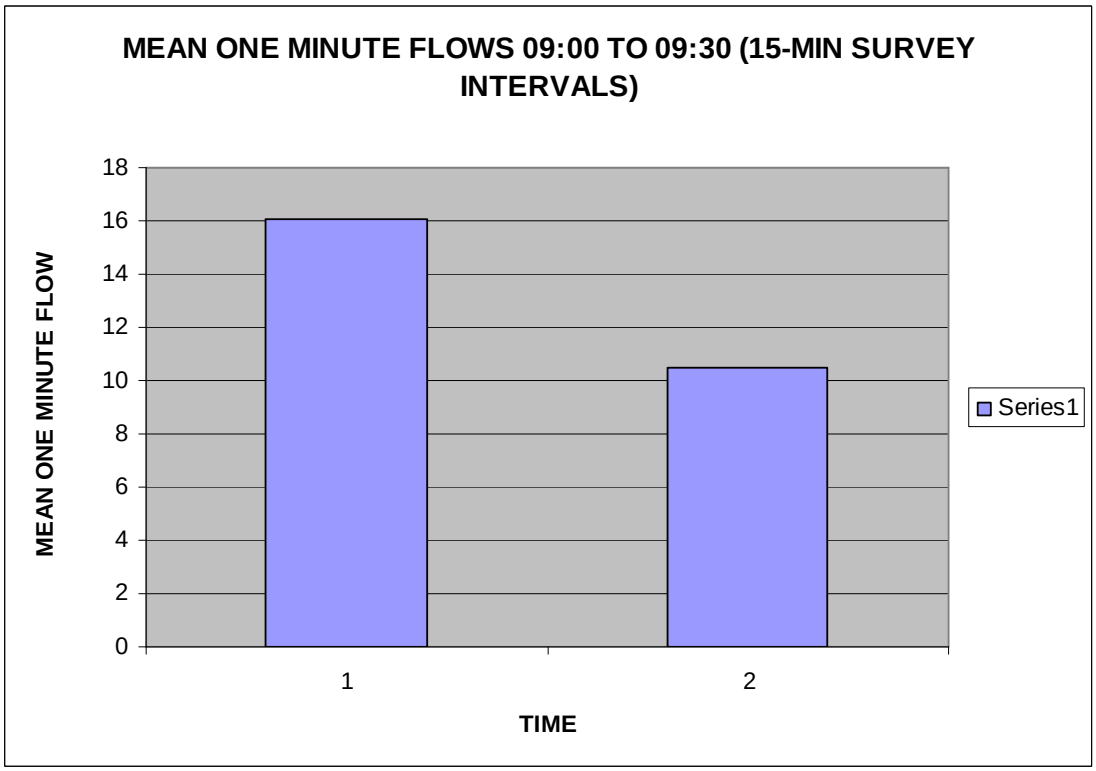

Fig. 1 Fifteen minute survey periods mask variability within data

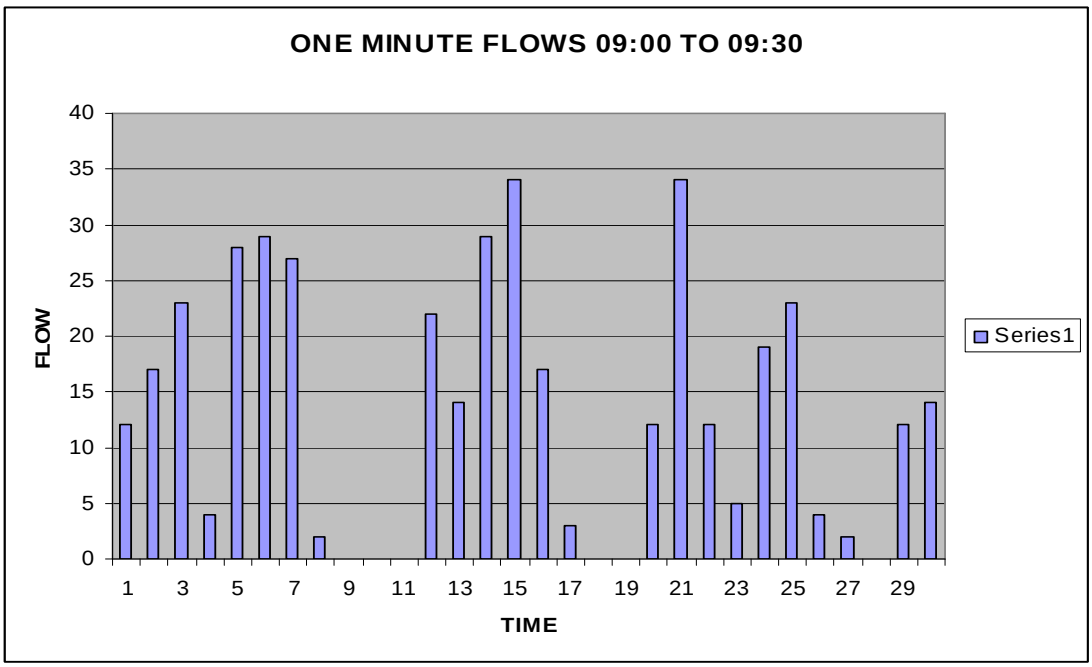

Fig.2 One minute survey intervals reveal maxima, minima, and variability

Clearly 15 minute survey periods are insufficient, and smaller survey periods are needed.

5.3 Can we survey flows on a minute by minute basis? If so, how can we do so using basic survey equipment?

Flows can certainly be measured on a minute by minute basis. Sophisticated software written for Personal Data Assistants and other data loggers enables surveyors to focus on the survey without having to concern themselves with time period boundaries.

This paper is however about how to enable surveys to be undertaken using readily available low cost equipment. Keeping it simple means that more surveys can be afforded, but this should not be at the cost of reducing measurement of the key elements of flow – its dynamic characteristics.

If simple counters without storage capability are used to survey one-minute periods, the surveyor will need to transfer data from the counters to a survey summary sheet during the survey. To do this means taking time out from surveying so as to transfer data from the counter to the record sheet. What are the effects likely to be of omitting, say, every fifth time period from the survey in order to transfer data from the counters?

5.4 Effects of Omitting Every Fifth One-Minute Count

For the surveyor to transfer data from counters to summary sheets, a one minute ‘data transfer interlude’ is introduced. Data are collected for four one-minute periods, and then in the fifth minute the data are transcribed to a recording sheet before surveying re-commences.

Are sufficient data collected if every fifth minute is not surveyed? The table below demonstrates the effects that might be observed from ignoring every fifth minute, or twenty per cent of activity. (Note that no statements are made here about confidence limits.)

For surveys to reveal flow fluctuations, the economic use of the surveyor in this way shows little effect (in the example) on the standard deviation as an indicator of flow fluctuation.

One minute survey periods, with and without the ‘fifth minute’, both offer a similar picture of the maxima and minima. This is coincidental in the example, but it is of course possible that the actual maximum or minimum could occur during the one minute ‘data transfer’ period when counts were not being taken.

However, both one-minute methods demonstrate the variability of the flows, and the ‘data transfer interlude’ should still enable the key characteristics of flow to be observed.

	Mean one minute flow	Minimum observed one minute flow	Maximum observed one minute flow	Standard Deviation
TWO 15 MINUTE COUNTS	13.3	-	-	-
30 ONE MINUTE COUNTS	13.3	34	0	11.4
24 ONE MINUTE COUNTS (every fifth minute missed)	12.0	34	0	11.0

Table 1. Observations available with different survey techniques

6. Surveying Travel Times

6.1 Travel Time and Waiting Time Variability

Travel-time surveys help determine not only the time spent walking, but also that spent waiting, at different stages of a walk. Analysis will reveal not only those places where free flow is impeded, but also the *variability* of such conditions. Increasing pedestrian density manifests itself in reduced walk speeds, increased discomfort and deteriorating safety, with increased risk-taking, such as stepping off the footway to attain greater space.

The travel-time survey can help determine the extent and variability of travel times, and confirm the factors influencing the travel-time reliability of a walk. The time taken to walk directly between two points, if used as a proxy for pedestrian crowding, can help reveal the extent and variability of such crowding.

Travel-time survey routes comprise:

- Distance stages, between two fixed points (enabling travel time variations between those points to be determined)

- Stopping points, where the pedestrian is likely to stop and then restart, for example at the curb side by a pedestrian street crossing (enabling wait time variations to be determined)

6.2 Readily available travel-time survey devices

As with flow surveys, there are readily available tools for surveying travel times. Such surveys can be carried out using multi-stage (or lap-counting)

chronometers. These can be found as an accessory on many cell phones and Personal Data Assistants.

The survey process will reveal the way the surveyor, acting as a typical foot traveller, is affected by conditions experienced along the pre-determined walk route. (Surveyors should be trained to simulate the behavior of other street users, so as to minimise bias that could come about through repeatedly using the surveyor's own walking habits rather than reflecting the mix of people in the observed walking population.)

6.3 Travel-Time Survey Analysis

A key output of surveys is the demonstration of travel time variability in observed conditions, to demonstrate not only where pedestrian stress occurs, but also how often and for how long.

The two examples below show how the variability of waiting times at a queuing point, and of walk times between two fixed points, can be presented.

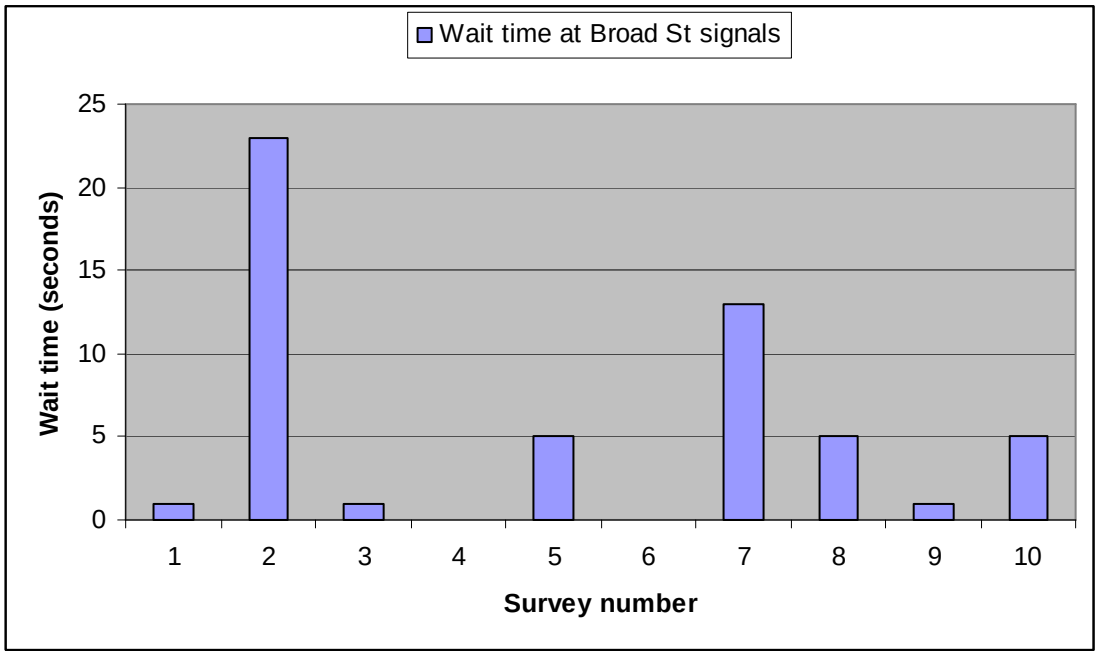

Fig. 3 Pedestrian wait time (seconds) at one location during each of ten travel-time surveys

Fig. 4 Pedestrian travel time between two fixed points during each of ten travel-time surveys

As with pedestrian flow surveys, the surveys should reveal the variability of pedestrian travel experiences. The figure below shows how analysis of standard deviations along a walk route can indicate where the pedestrian experiences greatest inconsistency in the time elements of a walk journey.

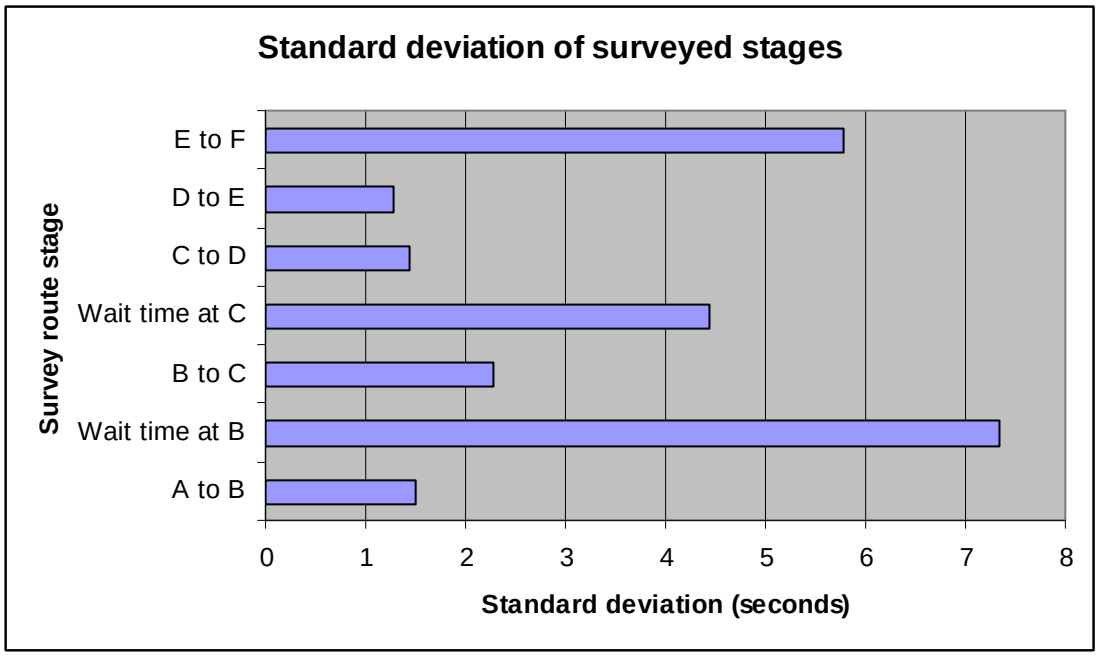

Fig.5 Standard deviations of travel time on each stage of a travel-time survey route, using ten survey results for the route

The confidence limits underpinning such statements are of course subject to the number of survey samples undertaken.

7. Desk Studies are a necessary prelude to pedestrian surveys

7.1 Survey preparation

An important objective of surveys is to determine where and when the interaction between people, possibly combined with other risk factors such as the location of street furniture creates discomfort and/or risk leading to distress or unpredictable/irregular behavior.

Survey preparation includes forecasting the extent to which these conditions occur within the study area, so as to reduce unnecessary surveying and data processing.

Hence before undertaking a program of surveys, a desk study should be undertaken to identify those space- or time-based factors which may modify people's walking experiences:

- the key pedestrian stress points and times in a study area, including where, when and how quickly groups form, reshape themselves and decay.

- where pedestrian behavior involves discomfort and/or risk taking, e.g. through:

    - High pedestrian densities
    - Conflicts between different flows
    - Obstacles to desire lines
    - Time delays

7.2 Assembling Data to assist Survey Planning

The survey plan should enable the following to be identified:

- **Sources and sinks** - locations at which foot traffic, cycle traffic, motor traffic enters and leaves the study area
- **Space and time allocation** – space and time allocated to different traffic groups - motor vehicles, buses, bicycles, pedestrians - including traffic signal/ pedestrian crossing phase timings
- **Arrival/departure rates** - time based (minute by minute if appropriate) variability in arrivals of vehicles that deliver or collect pedestrians, with bus/streetcar arrival/departure and boarding/exiting patterns identified
- **Potential congestion spaces** – those spaces where volumes, density, conflicts, delays experienced by pedestrians (and other user classes)

may modify pedestrian behavior; and the potential nature of the behavior change.

8. Summary

To collect meaningful pedestrian data we need techniques that reveal the high variability that pedestrian activity can exhibit. Surveys need to be cheap and easy to organise. That needs to be backed up by the statistical tests to give confidence to statements made on the basis of collected data.

This note is intended to take forward the discussion about how to achieve that.

Paul Cullen
August 2007
d_paul_cullen@ntlworld.com