INTRODUCTORY LECTURE
AT THE INSTITUTE OF TRANSPORT PLANNING AND SYSTEMS,
ETH, ZURICH

"Some Interesting Questions on Parking Systems"

Dr. Michael MacNicholas

November 2011

E-mail, mjmacnicholas@eircom.net

Lecture Objective

- The principal aim of the lecture is to outline in broad terms, by using a series of questions, the place of parking in the wider transportation planning area.

- While there are many interesting mathematical and technical aspects on collecting information from parking systems, on creating models to replicate behavior, or make decisions on parking policy and management of resources, the short time available is probably best used by a broad outline of the problems, rather than a detailed look at one particular model.

- I will try to stress three things in the lecture. Firstly, how transportation engineering/parking is different to other areas of civil engineering. Secondly, what we can learn from these other areas. Finally, that parking analysis is an important and neglected area of expertise.

WHAT ARE THE DISTINQUISHING FEATURES OF TRANSPORTATION PLANNING/PARKING?

- Parking is a subset of Transportation Engineering.
- It is a non-laboratory science, where in general one cannot control the variables as in other areas of civil engineering.
- You have as a consequence to deal with information that is thrown up by the system, rather like economics.
- The problem is usually that there is too must information available, rather than too little, and as a result information collection and modeling are crucial skills.
- Simulation is a must because as a rule analytical solutions to problems are often too difficult or are not available.
- Optimization techniques are also essential tools.

IS PARKING A NEGLECTED FIELD OF STUDY?

- Given its importance, parking has not received anything like the same scholarly attention as other aspects of Transportation Planning. It is often not even included in the standard textbooks.

- There has been more research and many more publications on minor elements of traffic engineering such as traffic assignment or trip distribution than in the whole field of parking.

- It is an intellectually demanding subject and ought to be attractive to students seeking a challenge.

HOW IMPORTANT IS PARKING IN TRANSPORTATION PLANNING?

- Crucial element in determining modal choice for urban terminating trips, and in central area accessibility.
- It is a large user of central urban space, typically occupying 30% to 40% of the plan area.
- On-street parking spaces are a competitor for traffic capacity, and in some circumstance may reduce it by up to 60%
- Overflow parking into residential areas has environmental consequences, and parked cars are responsible for about 25% of pedestrian accidents, mainly children.
- The correct balance between network capacity and the amount of parking is a crucial transportation planning decision.
- Control of parking supply and pricing is an alternative to “road pricing”.

HOW IMPORTANT IS PARKING AS A BUSINESS, AND IN COMMERCIAL PROPERTY DEVELOPMENT?

- Taking Dublin as an example, public sector gross revenue from on-street spaces is about 27m euro per annum. Private sector gross revenue is estimated to be more than 20m euro per annum.

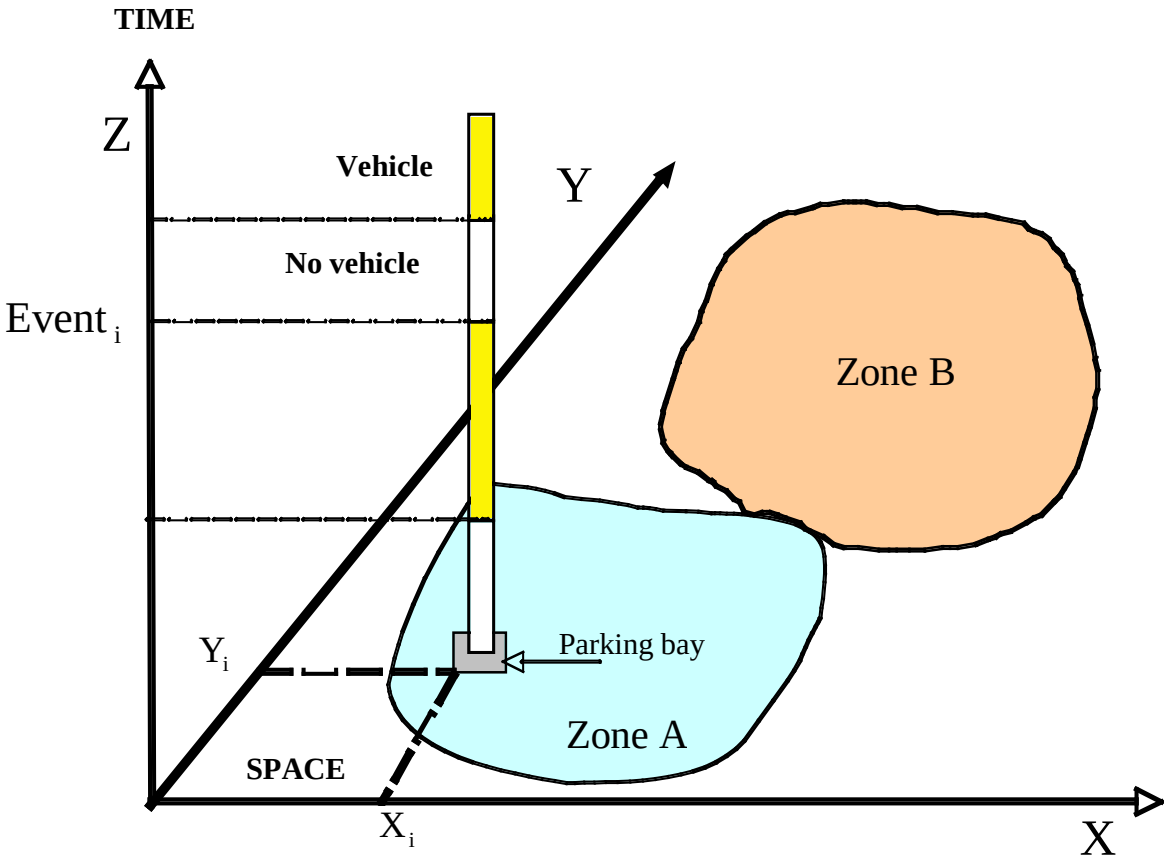
- Provision of adequate parking is generally essential for the achievement of adequate rent or capital values in a property development.

- Traffic intensive uses such as retailing might require 150 m^2 of parking per 100 m^2 of floor area. Offices would require less, perhaps 50 m^2 of parking per 100 m^2 of floor area. Airports, Hospitals and Universities generally have very large parking requirements (up to 6,000 spaces).

- A prime parking space might contribute 150,000 euro of retail turnover per annum. Total retail turnover, and parking activity are highly correlated.

- It is an interesting optimization problem to decide how parking is provided in a commercial development (i.e. Surface, Multi-storey or Underground).

HOW DO YOU DESCRIBE PARKING ACTIVITY AS A SERIES OF EVENTS IN TIME AND SPACE?



WHAT IS THE DISTINCTION BETWEEN PARKING USAGE AND DEMAND?

Usage

Pattern of parking events actually occurring in time and space. It is parking demand modified by availability of given spaces, and imperfect knowledge.

Demand

Pattern of parking events in time and space that would occur given the availability of spaces where and when required, and informed knowledge on the part of users.

Measurement

Invariably usage is measured because it is much easier, demand is inferred from usage.

WHAT TYPES OF PARKING MODELS ARE REQUIRED?

- Models to describe the time aspects of parking activity (i.e. as input-output system). This is very important, because it provides the link between urban traffic and parking. For example, a matrix representation would be, **GP=H**

- Models to deal with the bias created by periodic sampling of parking activity in a patrol survey.

- Models to assess the impact of price and time controls on parking activity.

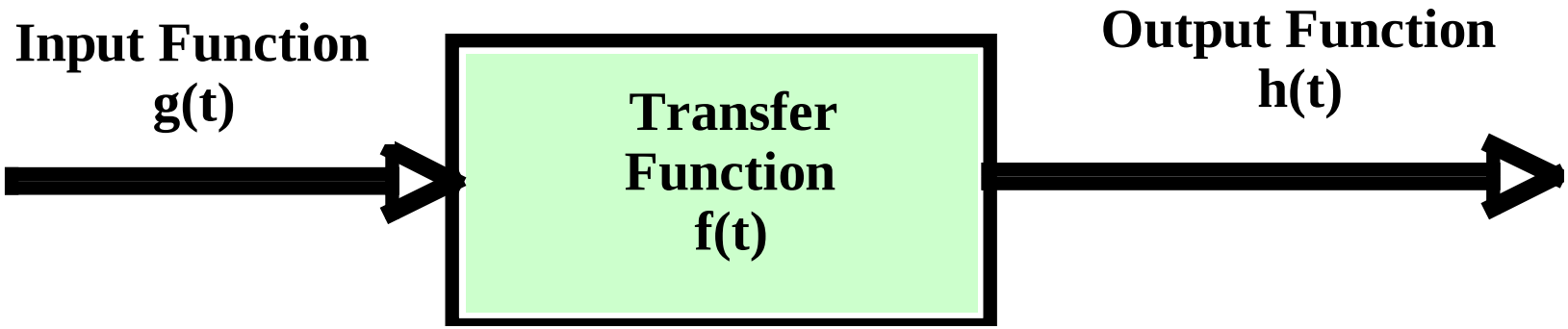
- Models to describe the spatial distribution of parking activity within a parking area.

WHAT IS AN INPUT-OUTPUT SYSTEM?

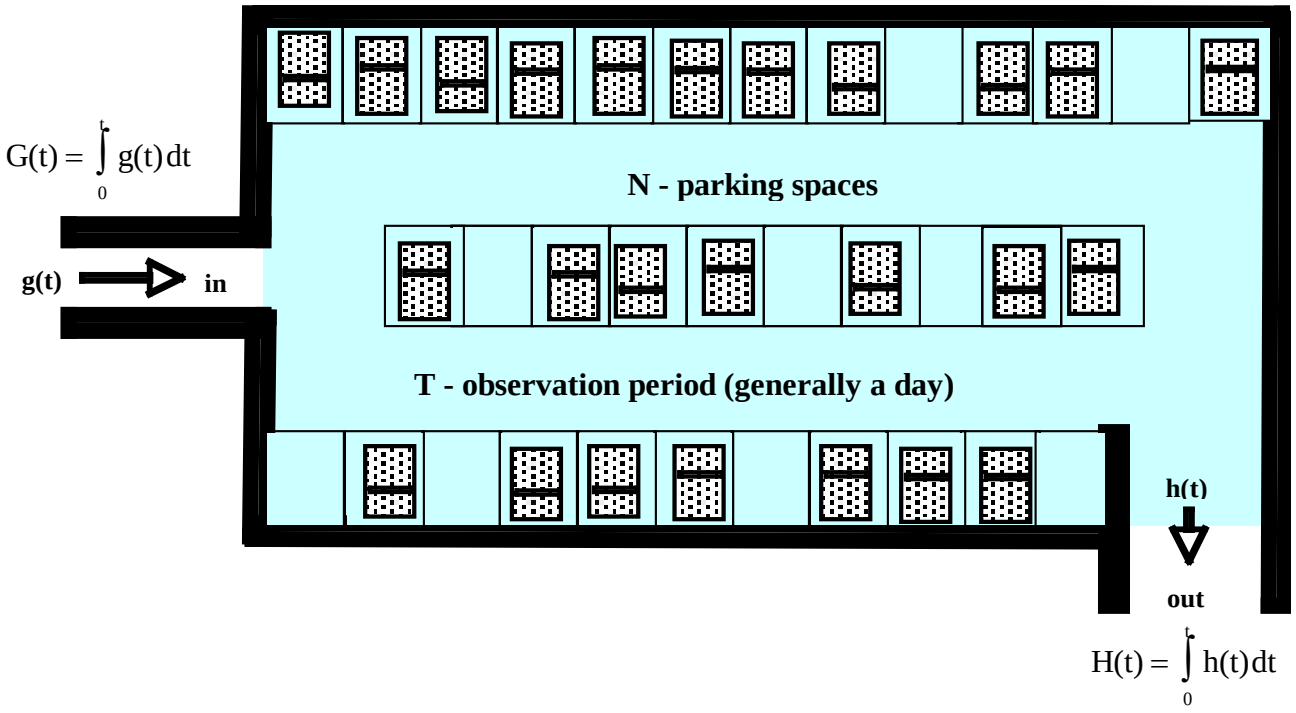
Examples

- Hydrology of a river catchment.
- Parking system.
- Electrical systems.
- Economics.
- Population Projection.

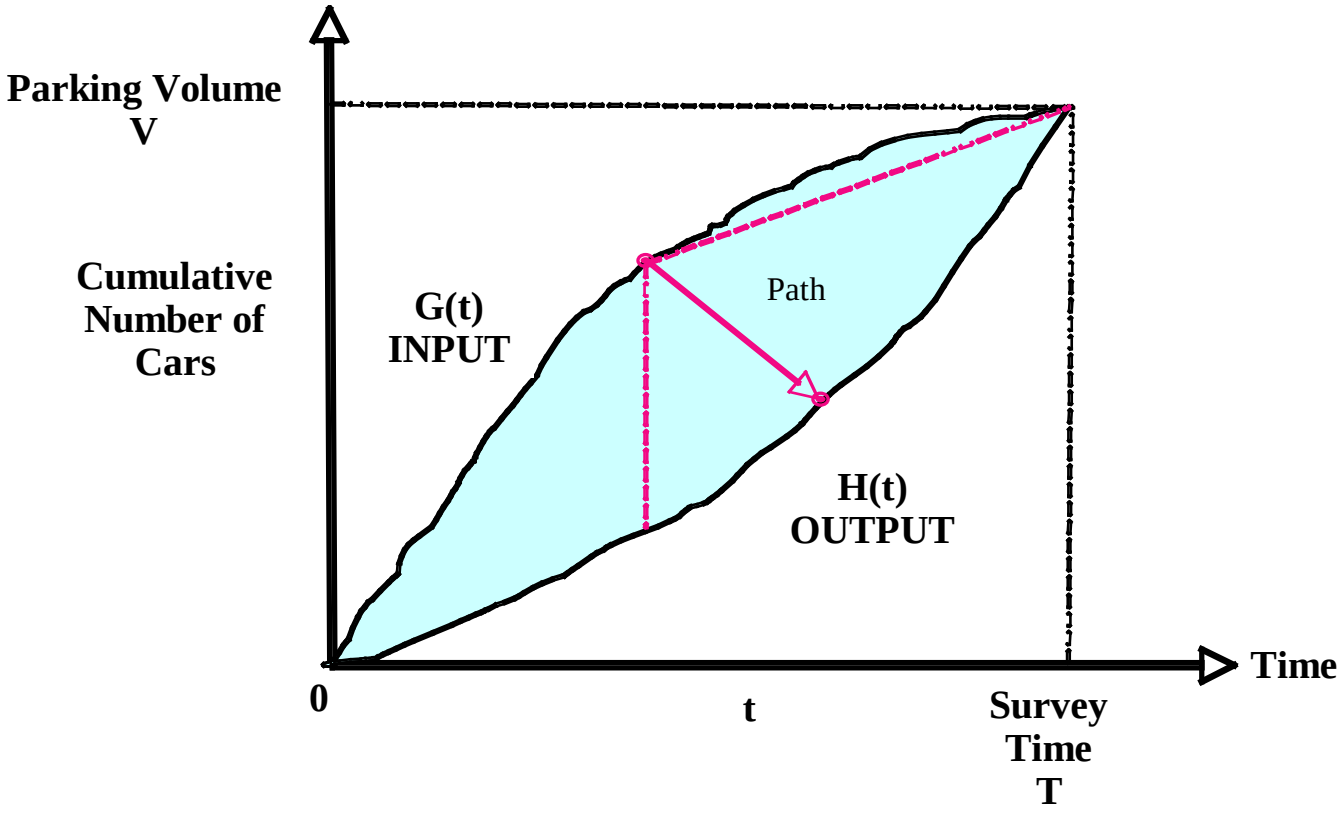
Transfer Function can depend on physical laws, or be just behavioral.



WHAT ARE THE ELEMENTS OF A "CLOSED SYSTEM" PARKING ZONE?



IS THERE A SIMPLE DESCRIPTION OF A “CLOSED SYSTEM” PARKING AREA?



WHICH PRACTICAL MEASURES ARE FREQUENTLY USED TO DESCRIBE PARKING USAGE?

$$\text{Parking Volume} = V$$

$$\text{Parking Accumulation} = A(t) = G(t) - H(t)$$

$$\text{Parking Load} = L = \int_0^T A(t)\,dt$$

$$\text{Peak Flows} = g(t)\max., h(t)\max.$$

$$\text{Average Duration } \bar{t}_f = \frac{L}{V}$$

$$\text{Average Turnover } \bar{d} = \frac{V}{N}$$

Parking Duration Distribution?

HOW DO YOU COLLECT INFORMATION FROM A PARKING SYSTEM?

BASIC SURVEY TYPE	REQUIREMENTS FOR SURVEY	INFORMATION COLLECTED	LIMITATIONS OF METHOD
Simple Cordon Survey	Closed system.	Continuous count of entry and exit flows.	Information content missing.
Detailed Cordon Survey	Closed system	Continuous identification of individual vehicles on entry and exit.	Technology governs maximum survey flow.
Patrol Survey	Any system.	Periodic identification of parked vehicles.	Must allow for missed parkers.

WHAT IS SYSTEM IDENTIFICATION APPLIED TO A PARKING SYSTEM?

- In general it is the following: Given any two of the three functions, representing input, transfer and output, how do you determine the third function?

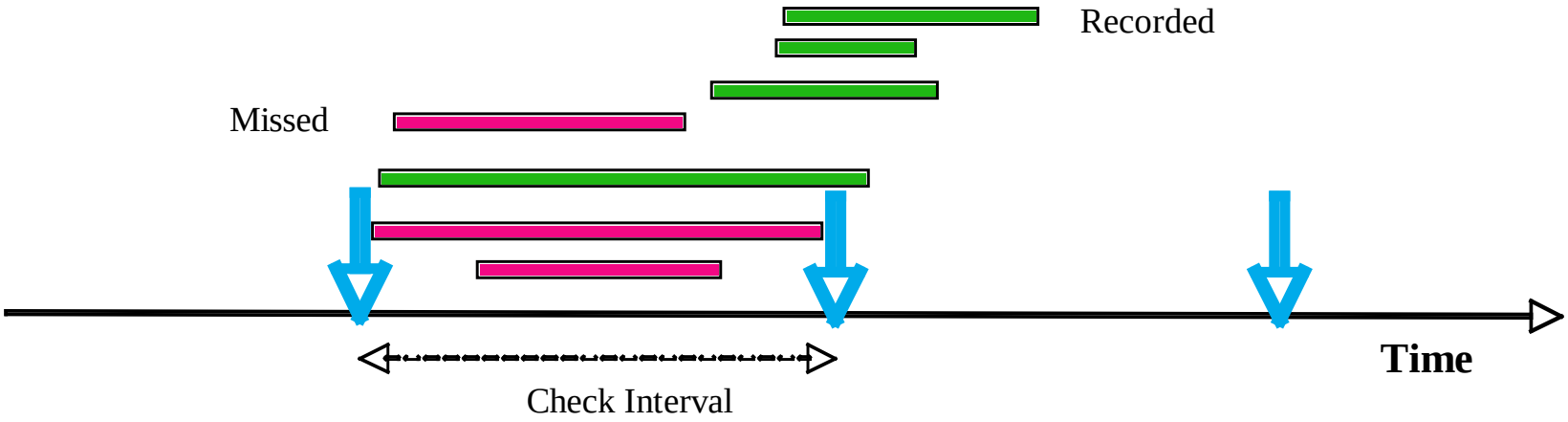
- For example, the most common application would be, given g(t) and h(t), which are easy to measure, how do you determine an approximate f(t), which can be very difficult to measure?

- Or in matrix notation, given **G** and **H** how do you determine **P**?.

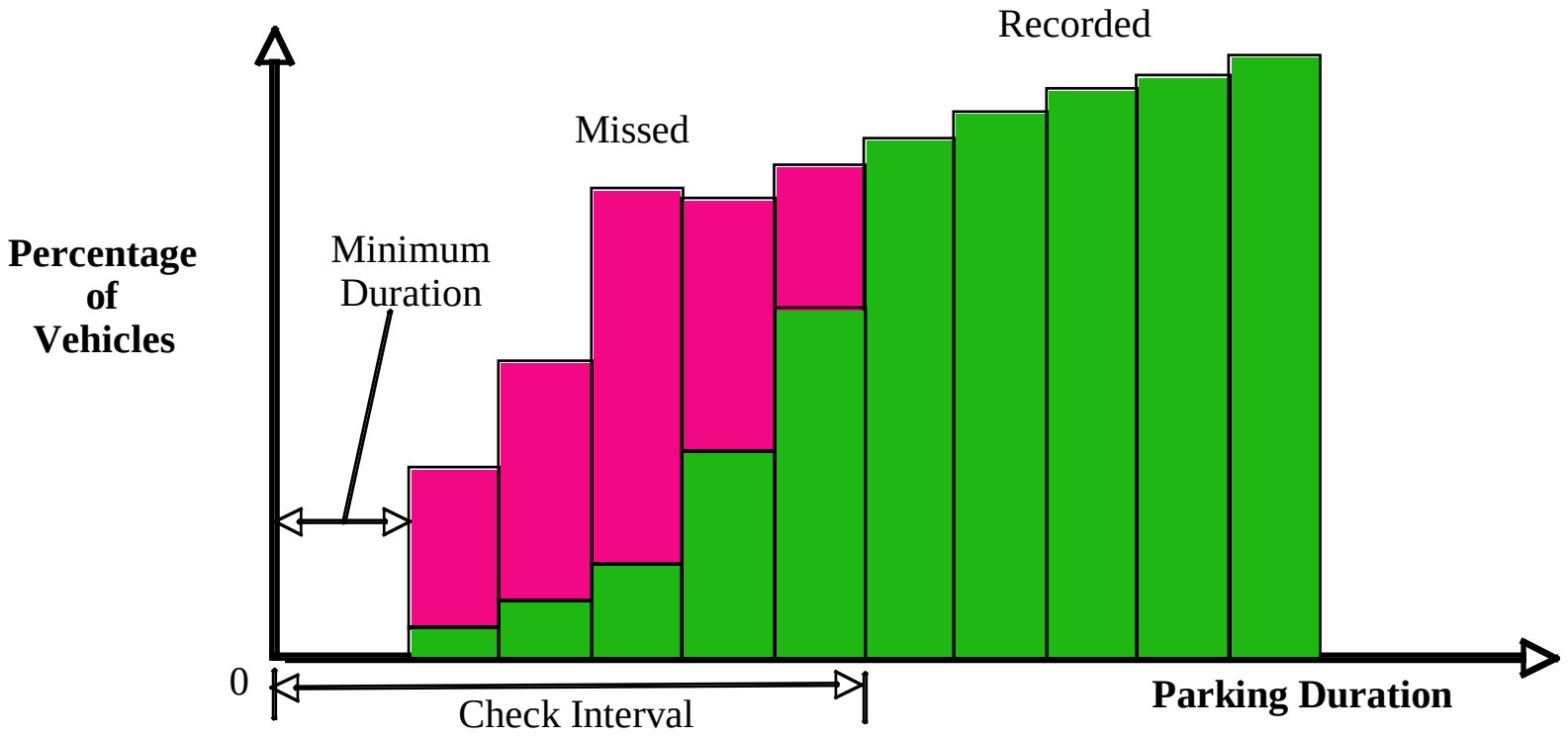
WHERE DO YOU REQUIRE A PATROL SURVEY AND WHAT DIFFICULTIES DOES IT PRESENT?

- Where a cordon survey picks up a lot of extraneous information on through traffic, which masks that collected on parking activity, a patrol survey is required.
- It is very labor-intensive to collect information at each check interval on the registration numbers of all parked vehicles.
- There is an obvious trade-off between the length of the check interval and the amount of manpower required.
- The longer the check interval the more short-stay vehicles are missed and the more bias in the sample collected.

HOW DO YOU COLLECT INFORMATION IN A PATROL SURVEY?



OUTPUT FROM A PATROL SURVEY?



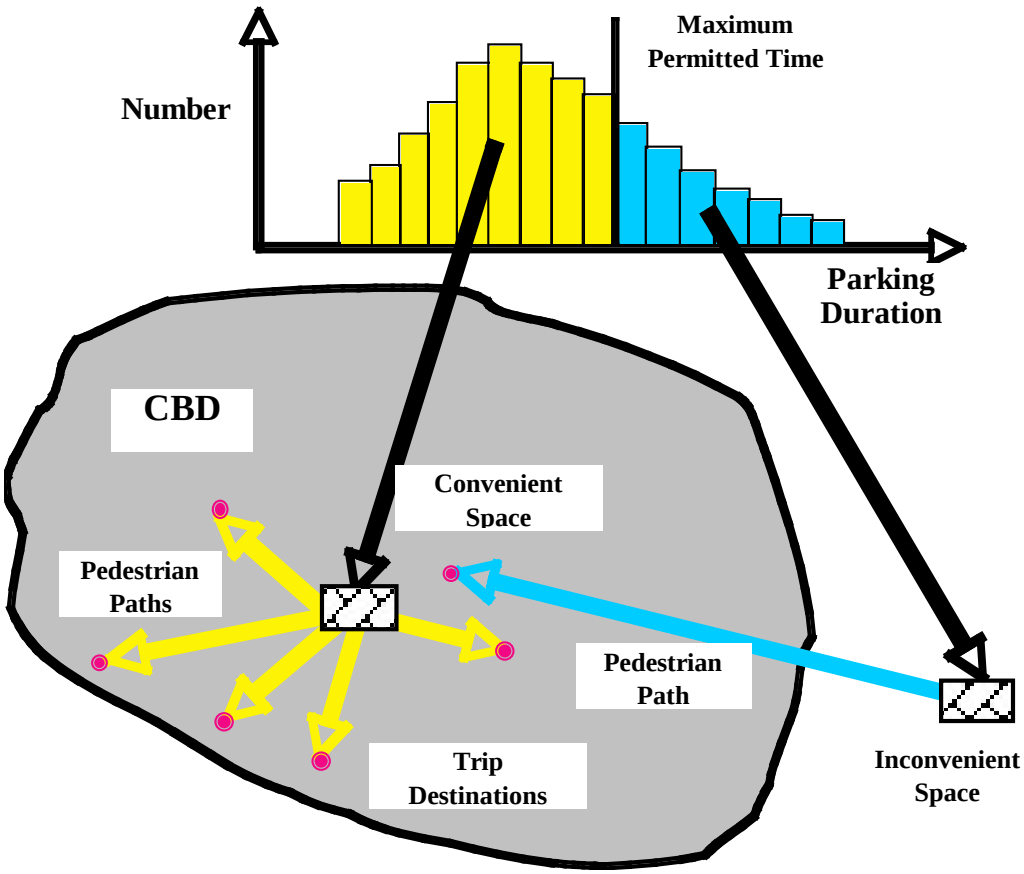
WHAT IS THE PRINCIPAL PROBLEM WITH A PATROL SURVEY?

- You have to determine or infer the characteristics of the parent population (for example, the Parking Volume and the Parking Duration Distribution) from information obtained in a biased sample.

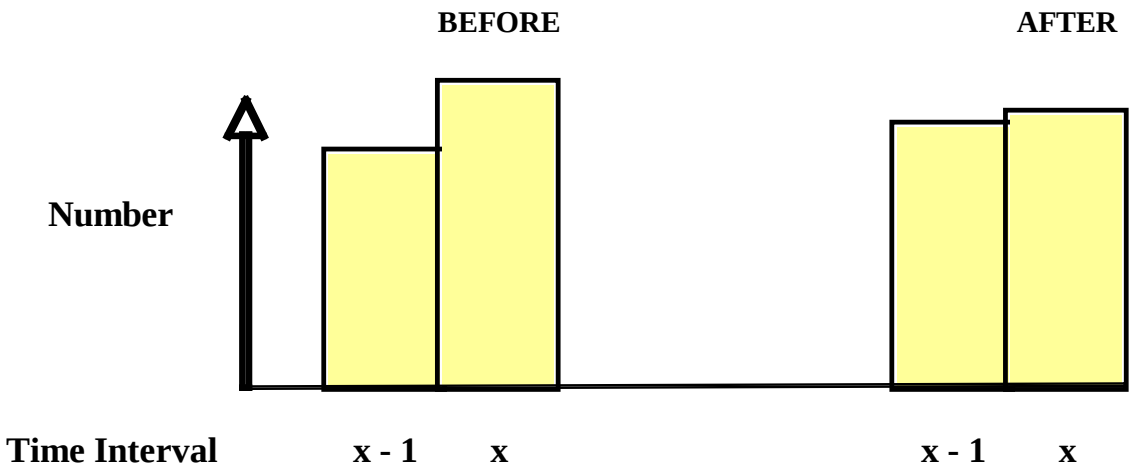
- Not the usual problem in statistics.

- Empirical solution, derived from a range of parking systems?

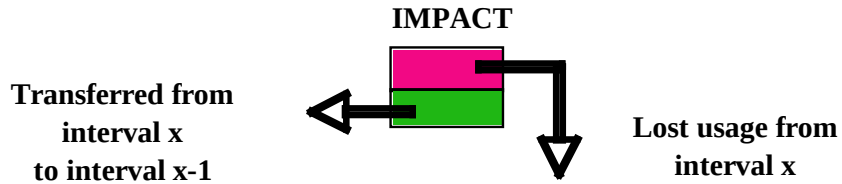
PRIMARY PURPOSE OF TIME CONTROLS?



IMPACT OF A PRICE INCREASE?



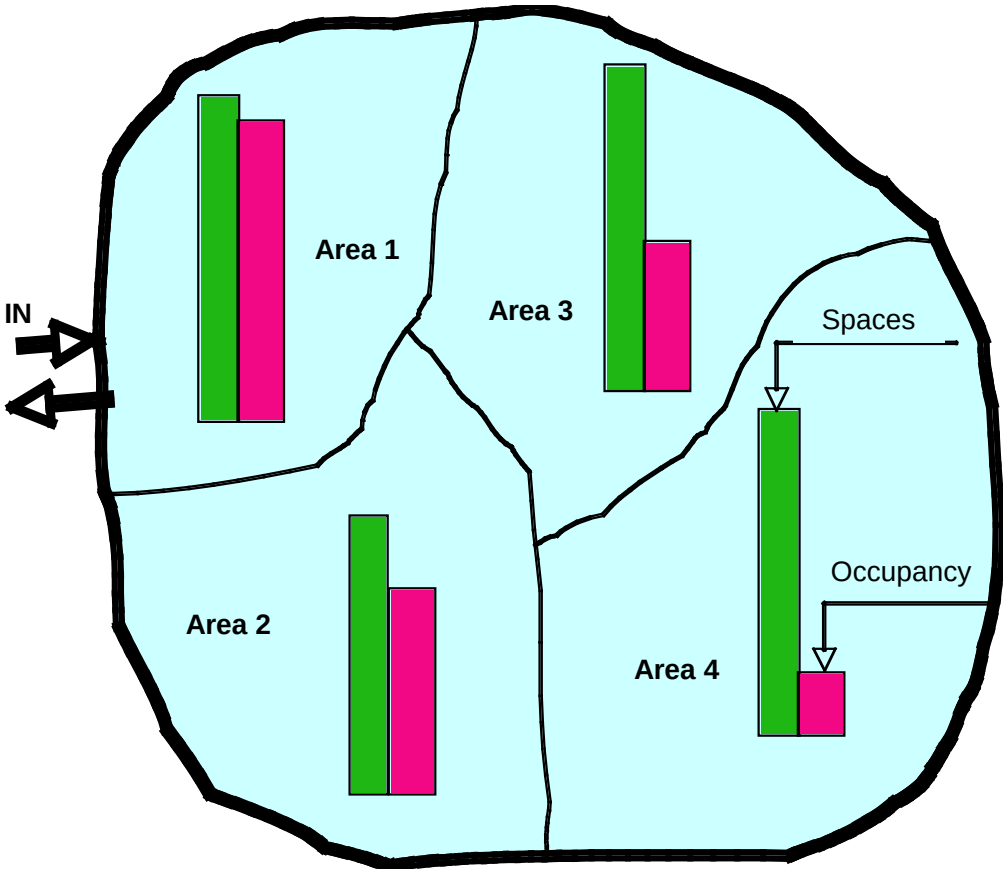
PRICE INCREASE IN INTERVAL X
FROM P(1) TO P(2)



FACTORS DETERMINING THE IMPACT OF PRICE CHANGES ON REVENUE?

- Elasticity with respect to number reduction in response to a price increase.
- Elasticity with respect to average duration in response to a price increase.
- Short-term and long-term sensitivity to price.
- Imperfect knowledge, and random effects.

SPATIAL DISTRIBUTION OF PARKING?



ADDITIONAL IDEAS FOR DISCUSSION?

- Collection of additional information from Pay-on-Foot machines with new technology.
- Use of variable pricing throughout the day or week to maximize revenue.
- Use of different time bands in a parking fee structure and its implications for revenue.