ENERGY AND TRANSPORT DEMAND CONTROL FOR SUSTAINABLE TRANSPORT

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ABSTRACT
The objective of this project is to create methods and techniques that will allow for the design of transport systems that can function within energy constraints. The motivation for this research is the realisation that energy constraints will occur in the near future and will affect urban transport systems and access to activities. Current methods and techniques do not allow transport planners to design transport systems to function within energy constraints. This project will propose a sustainable transport energy system design for an existing urban area. The sustainable transport energy system will make use of engineering controls that allow energy consumption to be dynamically matched to a possibly fluctuating energy supply. Input from residents living in the urban area of interest will be used to qualitatively assess and compare the hypothetical sustainable transport system to their current situation.

RESUMO
O objetivo deste projeto de pesquisa é o desenvolvimento de métodos e técnicas que permitam que sistemas de transporte possam funcionar em cenários de restrição de energia. A motivação para esta pesquisa é a percepção que essas restrições devem ocorrer em futuro próximo, o que afetará os sistemas de transporte e o acesso às atividades urbanas. Dado que as técnicas atuais não permitem que planejadores de transporte projetem sistemas capazes de funcionar dentro de restrições de energia, este projeto proporá um sistema sustentável de transporte, do ponto de vista de consumo de energia, para uma área urbana existente. O sistema será baseado em controles dinâmicos capazes de permitir que o consumo de energia seja ajustado de acordo com uma oferta flutuante de energia. Registros de residentes vivendo na área urbana de interesse serão usados para avaliar qualitativamente o sistema hipotético e para compará-lo com o sistema de transporte atual.

1 INTRODUCTION

Current transport energy supply is finite; it will peak and decline (Deffeyes, 2001). Transport systems will soon be subject to energy supply shortages and increasing constraints. Urban land-use patterns and transport systems will need to be redesigned to function within energy constraints.

Traditional transport modelling represents travel cost as an impedance to travelling. Generalised travel cost is a function of distance, time, travel taxes and fuel costs. As cost increases, trip lengths decrease, altering the trip length distribution. However, transport systems reliant on energy are independent from an impedance function, because all residents need to continuously perform trips from their house to required activities regardless of travel cost. If a required activity is inaccessible, system failure has occurred.

The specific sustainability issue of interest for this research is transport energy. A background review will be provided of the current situation and then the project and its current state will be described in more detail.

2 REVIEW OF PAST RESEARCH

Methods for reducing energy use include: changing mode share, reducing spatial separation of activities and utilisation of information technology. Energy reduction methods are explained further in the following subsections.

2.1 Energy use and transport mode

The first 'modal' energy models where created and implemented during the 1970s oil crisis (Nix and Mayes, 1983). 'Modal' models focus on how transport mode changes affect total energy consumption. They can be used to assess the effect on energy use with the introduction of a new mode, e.g. buses, to the transport system.

2.2 Transport energy use and spatial patterns

Certain combinations of spatial patterns of land-use and population density can lead to less transport energy per capita for cities (CAE, 1994). Urban sprawl accounts for much of the increase in energy required for new spatial settlements because these spatial patterns consume more energy than the more compact traditional settlements (Silva *et al*., 2001). Compaction of urban and suburban areas through land-use planning and policy is debated as a means of increasing transport sustainability and reducing energy reliance (Cooper *et al*., 2002).

2.3 Transport energy use and information technology solutions

Information technology offers solutions that would reduce congestion through utilisation of intelligent information systems and by lessening the need for physical travel through telecommuting (Illegems *et al*., 2001). The reduction in physical travel also reduces energy use and pollution.

2.4 Transport energy use and pollution

Pollution constraints are related to energy constraints. Increased energy use and transport growth are directly related to increased hydrocarbon emissions (Johansson and Martensson, 1999). Air pollution from motor vehicle exhaust is considered a major health hazard and the World Health Organisation (WHO) considers that vehicle emissions are responsible for a substantial proportion of total air pollution (Whitelegg, 1993).

2.5 Energy supply constraints

To consider both current and future energy constraints requires effective means for projecting these scenarios which implies a large role for suitable methods of modelling (Harris, 1983). In the future, integration of environmental sub-models for air quality, energy, traffic noise, land-take and biotypes are likely to play a prominent role.

2.6 Oil constraints and Hubbert's Peak

As oil supplies are depleted, constraints will cause intense competition for what is left, this is likely to bring dramatically higher prices around the world and shortfalls are likely to become more common (Deffeyes, 2001). Recent price fluctuations and production data of crude oil point to the fact that oil constraints may have already begun.

3 METHOD

The project will be applied to the city of São Carlos, in the state of São Paulo, Brazil. The project consists of a new design for a transport system that is operated by a control system so that it remains within the boundaries of sustainable energy use. All parts of the project are still

under development, as the research has recently begun. Specific aspects of the project are summarised in the following sections.

3.1 Control system

Controls will be placed on the transport system that only allows individuals to use the system in a certain way. However, the transport system will be designed to allow as much freedom of choice to the individual as possible. The motivation to control the transport system is so that energy consumption can be consistently matched to a possibly fluctuating energy supply.

3.2 Available energy supply

Research and review will be carried out to determine the current and future feasible amount of energy supply for São Carlos. It is expected that renewable energy will be in the form of bio-fuel, wind-power, micro-hydro, solar or a combination of technologies. Analysis of capital costs will be used in part to determine the maximum amount of feasible energy supply from these technologies.

3.3 Transport system design

Care will be made to keep as much of the existing infrastructure intact and a cost analysis and management plan will be proposed. Simulations of possible designs will be carried out to ensure that the transport system can only be used in such a way as to be continually sustainable in its energy use and access to activities. At the current state of this research, it is believed that personal rapid transit (PRT) offers the most compatible design for operation within energy constraints. PRT systems can be constructed to use electrical energy, reducing the need for use of finite fossil fuels (Lowson, 2002). Renewable energy from wind, solar and hydro is easily and commonly converted to electrical energy.

Solutions will be visually represented through use of maps and flowcharts explaining the transport control system. The energy source(s) and where they would be located in relation to the urban area will also be described.

3.4 Qualitative assessment

Input from interviews of a selection of urban residents (focus group) will be required to assess how they thought the proposed transport system would compare with their current urban life and access to activities. Maps of the transport system and other visual aids will be used to explain the operation of the transport system to the focus group(s). Alterations to the final transport system design may need to be made to satisfy the outcomes from the focus group(s).

4 FINAL REMARKS

The research project presented in this paper is in early development; however, the idea of the transport control system has been further defined. A control system that matches transport demand to the available fluctuating energy supply is proposed. This will require system users to ‘book’ future travel. Availability of travel will change daily, as the renewable energy supply available to the transport system will fluctuate.

The overall goal for most transport planners is to achieve a sustainable transport system in every sense. This project will develop a valid option for São Carlos and qualitatively and quantitatively compare it with the current unsustainable transport system. The quantitative analysis will involve a basic cost comparison, including environmental costs. The qualitative

analysis will aim to gauge the perceived quality of service that the proposed transport system offers to residents.

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