Energy Demand and Efficient Use

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PROSPECTS OF ENERGY CONSERVATION IN TRANSPORTATION

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INTRODUCTION

The oil crisis has put on the foreground, among others, the problem of energy conservation in transportation. Several agenda for actions for decision makers have been prepared in the last years, touching more or less all the possible interventions from increasing the efficiency of each transportation means, especially the automobile, to increasing the use of public transportation.

To predict to which extent and with which dynamics the complex transportation system will respond to the several intervention is a difficult job. As is well known, complex systems do not respond to action as quickly and as linearly as the decision makers would like. "What-if" studies and analysis using system models are performed and hopefully could serve as an indication for actions. However the more complex and the more similar to reality the model is, the less clear is the answer.

Having accepted the task to present to you here the perspective of energy conservation in transportation, we found ourselves trapped in the tentative to get some general answers from the analysis of data and from comparing the many studies performed by experts of transportation systems.

After careful perusal of the literature one finds himself still unconfortable when asking simple, or apparently simple questions, such as: what could be the impact on energy conservation by shifting urban transportation from car to public modes?, or, could we really convince the market to shift to cars of lower fuel consumption but also of lower performance in terms of speed and acceleration?

The crux of the matter is that we are dealing with complex systems and that we try to understand the behaviour and dynamic response of the system which, because of its complex (homeostatic) mode of reaction and of the interconnection and non linearity of the effects, usually follows complex patterns difficult to predict. The temptation is large in this case to ask for some external compulsory feed-back to the system to assure desired changes but at the same time requiring to pass from a homoestatic system to a simplistic, external ("dictatorial"?) type of control.

It is therefore important to look for a more modest approach and try to understand the intrinsic dynamics of the system by observing its behaviour. We refer to the same approach of the astronomer in understanding the dynamics of the universe. Such an approach could be used as a paradigm for studying any complex system and in particular the transportation system.

The astronomers observe the universe by means of "snap shots" taken at the same terrestial time, and (apart from some very special cases of historical record of some past event like the Chinese observation of Super Nova) there is no hope to observe the time behaviour of the universe. Nevertheless the astronomer is able to gain insight in the dynamics of the universe because these "snap shots" refer to stars or stellar systems which are at different stages of their development. It is therefore possible to recognize different patterns of evolution, and with them as a guide to predict the future development of single stars or stellar systems.

By analogy, when we observe, at a certain time, the transportation system in different countries and different towns, we are considering different stages of development of the systems. The analysis of other complex systems, such as the economic development of a country, have shown that they follow typical patterns of development.

For instance a country GDP (Gross Domestic Product) developes along with a shift of society from agriculture to industry and to service. As another example, it is indeed fortunate for the automobile marketing people that the number of automobile per family in industrialized countries be strictly related to the GDP per capita.

By analyzing the data of transportation systems one could therefore hope that realistic answer on "what-if" analysis can be obtained, more than by analytical model, by observing the countries that have already realized the "if" condition.

Making decision that goes against the natural pattern of development of complex system requires, as already said, the capability of forcing strong global interactions changing the homoestatic development of the system, otherways they are bound to fail.

Actions that do not require a total system change but are limited to single components of the system (such as increasing the energy efficiency of the automobile) have higher probability to produce results as expected than when one tries to modify the entire system behaviour (such as shifting from one mode of transportation to another) against its "natural" pattern of development.

When observing "terrestrial" complex systems one might have the illusion that it is possible to keep track of the dynamics of the system by observing it at different times. Unfortunately the data available, collected at different times, are often not consistent and cannot be repeated. Standardized observation in the future with more reliable techniques and more detailed data will help the student of the system behaviour in the same manner as new observations of the universe with new techniques help the astronomer to refine his models of the universe's dynamics.

According to the described approach, in these lectures we will:

1 - present the data on transportation systems world wide in different countries

2 - try to reconstruct from such data, patterns of dynamic behaviour of the system in terms of some macro economic variables

3 - by reporting the case of a complex analytical model point out how interrelate is the transportation system with other societal systems

4 - examine two specific cases of actions at "component level" on energy conservation in transportation and specifically: impact of optimal traffic control and car efficiency improvement.

1 - THE TRANSPORTATION SYSTEM

According to Forrester "a system means a grouping of parts that operate together for a common purpose". In other words one can define a system as a "set" finalized to obtain a given purpose, subdivided into parts (subsystems), each one performing a different function harmonized to reach the system purpose.

The purpose of the transportation system is to satisfy the need of mobility as expressed by the mobility demand.

Mobility is one of the fundamental need of human being referring both to the need to move people and goods. It could be influenced by subjective motivations (like the desire to escape from a given environment or life style) and/or by objective motivations (such as the need to reach the work place or school) ranked according to a scale of priority. The mobility need is subdivided according to the subjective/objective motivations and it is structured and articulated by scale of values and priority.

The offer of transportation to match the mobility demand has to take into consideration the why, where and how which varies according to the individual, the society, the environment, etc. The difficult matching between demand and offer, because of the complexity of the transportation system, has to be taken into due consideration when analyzing the possible actions for energy conservation by modifying the transportation offer.

1.1 Transportation system morphology

We should first distinguish between the transport system and the transported people or goods. Three principal subsystems characterize the system (see Fig. 1.1):

. infrastructure (roads, railroads, ports, airports, waterchannel, etc.)

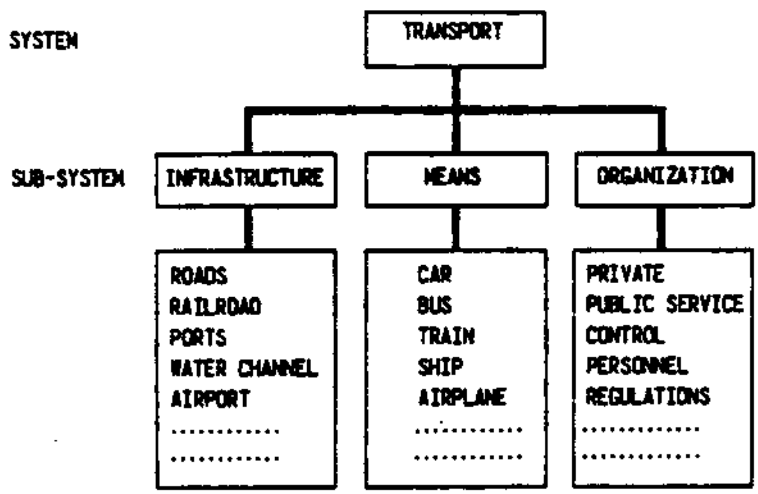

Fig. 1.1 Transportation System Morphology