LOGISTICS FOR CITY PLANNING

HERMANN KNOFLACHER
Institute for Transportation Planning and Traffic Engineering
Technical University of Vienna
Gusshaustrasse 30/231, A-1040 Vienna, Austria
Hermann.Knoflacher@tuwien.ac.at

ABSTRACT

Logistics in transport considers the physical structure of a city as given and tries to optimise the performance of companies or the transportation system within the given conditions. On the other side, companies choose their location under the given conditions and the expected changes and influence the structure of the city and its economy in a continuous way. City and transport planning methods have not considered these effects in their work so far and are therefore influenced by the driving forces of the economy of scale and demand oriented traffic growth. The introduction of principles of logistics into the early stages of land use and city planning would change the "given conditions" and open the path for a more sustainable development, with more pressure for innovation and fairness in the market.

1 INTRODUCTION

To optimise transport between supply and demand, sophisticated systems of logistics have to be applied. Traditionally logistics did not question structures and infrastructures and so far they are a part of the “hardware”, the so-called built infrastructure, houses, factories, roads, railways etc. The result of the traditional approach in logistics can therefore only be sub-optimal, if the underlying structure is not developed in such a way that principles of optimal logistic strategies can be applied easily (Ihde, 1991).

The organisation of the functions of cities, in space and time, has therefore been planned in such a way that, together with the dynamic of the logistic concepts, an optimum can occur.

This optimisation process must not only take into account the traditional methods of short-term logistic strategies but must take care of long-term organisation procedures. Short-term optimisation as well as local optimised systems will not lead to an overall optimum.

2 THE PROBLEM OF DIFFERENT DISCIPLINES

Land use management, city architecture, structural planning and the design of infrastructure for different kinds of land transport modes have their own goals, which are sometimes contradictory and in most cases not co-ordinated in reality (Bauordnung für Wien, 1997). Each discipline uses its own set of indicators to fulfil their duties. Some of the core disciplines (and faculties) in this system have no contact with logistics at all, although they are producing elements which influence logistics of today substantially. Very often these disciplines are separated into different ministries or other administrative bodies. The outcome of this practice or policy is a kind of accumulation of “sectoral optima” with more or less gaps between them. This deficit has then to be compensated with “Logistics”. Normally the result can never reach an overall optimum – because it is not needed.

3 BASIC RELATIONSHIP

Human settlement structures exist in a great variety of shapes. These structures have always been dependent on the energy of the transport system. As long as human bodies energy was the main source of power the distances and the size of settlements where limited to the travel and energy budget of the inhabitants. The density was only bearable if it was compensated with high quality in form of an excellent logistic system, combining store rooms with a variety of workshops, specialisation and a good organised external transport system (Mumford, 1984). The development of aqueducts, post stations, rules and privileges for trade are elements of this historical development of logistics.

Just in time was not the only problem of the transport system, it was the farsighted planning and the forecast of demand and supply, the trade off between store rooms, transportation possibilities and actual needs. The result of this optimisation process high quality cities which resulted from logistic optimisation over a long time in a complex system. This is still reflected in the ratings scale of world capitals, as it was done by Kenworthy and Newman (1989) (Figure 1).

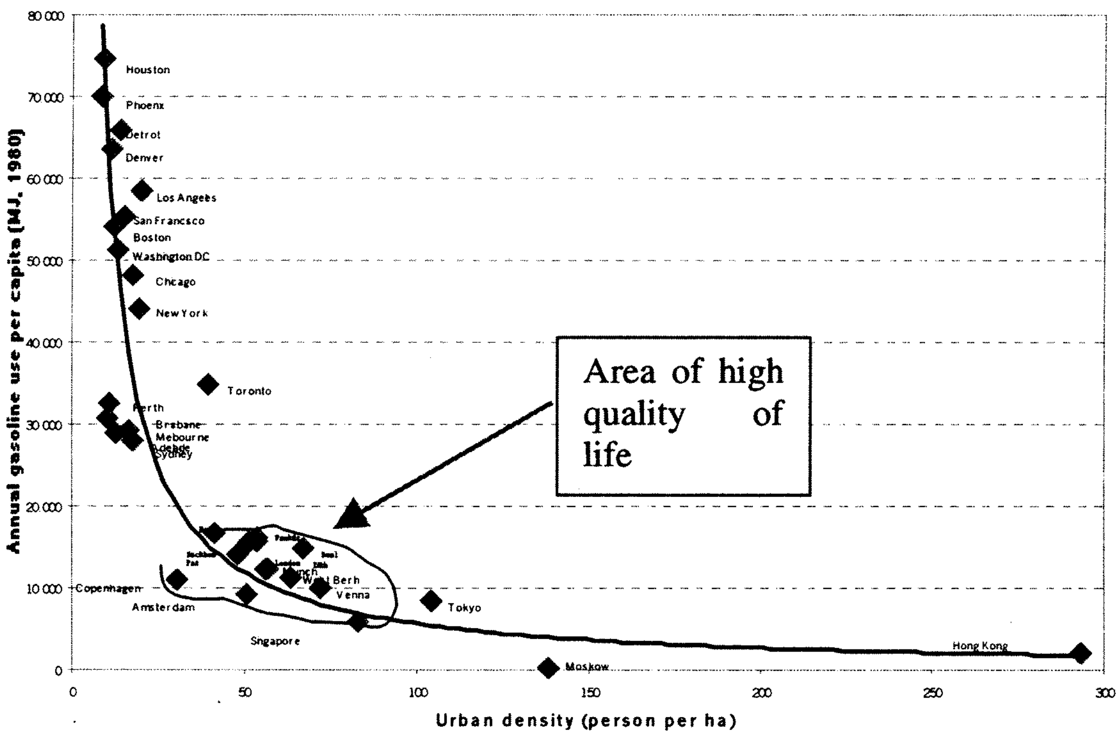


Figure 1 Relationship between urban density and energy demand for transport

It is obvious that the main differences in city structures are caused by differences in the transport system, mainly transport costs and land use regulations.

4 INTER-RELATIONS

There exist close and manifold inter-relationships between city structures, transport system, industry and logistics, that have not been realised so far. The whole history of invention in transport shows traces of this inter-relationship. Rail and the invention of traffic lights before the sophisticated computerised traffic management system, including GIS and GPS, are the result of these efforts, not knowing the underlying driving forces of the system, which have segregated well co-ordinated functions in historical cities during the last 150 years.

Logistics helps to reduce costs in the system. However, the definition of cost depends on the defined system borders, which outside these borders, economists call external costs. Studies in Germany indicate that external costs for good transport on roads are 77 – 89% of the real costs (Teufel *et al*, 1989). If the market does not reflect the reality of the system then, current optimal solutions are far away from the real optimum.

5 STRUCTURES AND ECONOMY OF SCALE

Competitiveness in our economy depends very much upon the advantages relating to economy of scale. The bigger the scale, the cheaper the products (Samuelson, Nordhaus, 1987), although the scale is limited by transport costs. If transport costs can be "externalised" then the bigger one always have the comparative advantage.

Following Knoflacher (1995) it can be shown that the scale of units is directly related to the speed of the transport system. If the speed is not compensated with costs, the bigger ones (not the better) penetrate the market with lower prices on the one side and increasing profit on the other side (Figure 2). Innovation can reduce prices. Enterprises can become more competitive on a smaller scale, with lower prices, but also on a bigger scale with the same price (Figure 3). If transport costs are reduced the scale increases without any effort from the enterprise. Cost advantages come from the transport system (Figure 4).

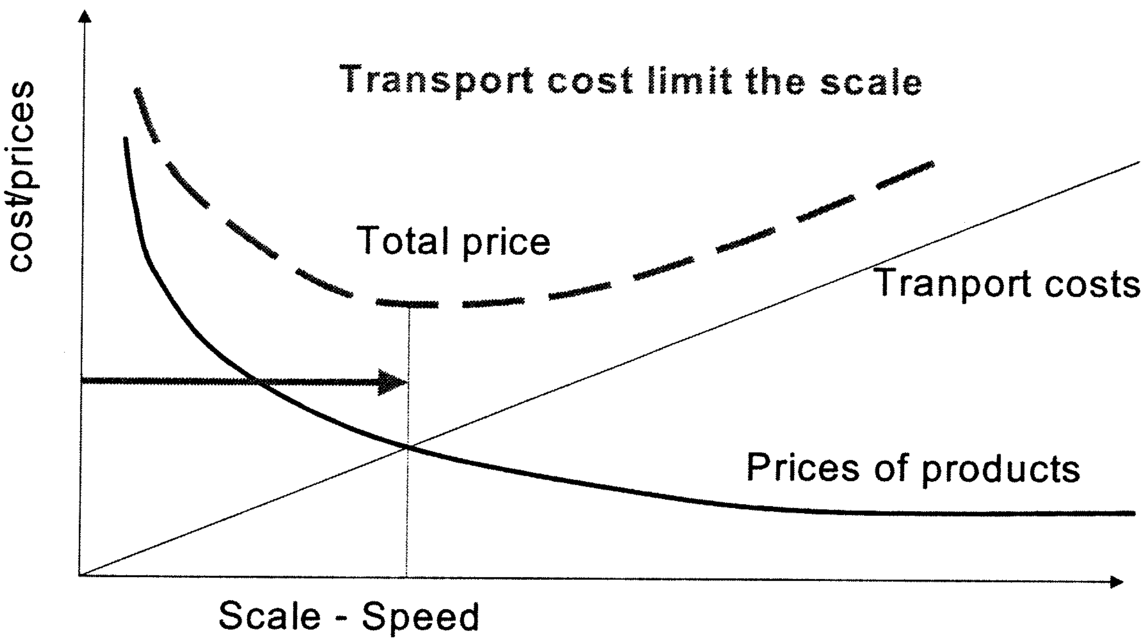


Figure 2 Simplified sketch showing the effect of transport costs on scale

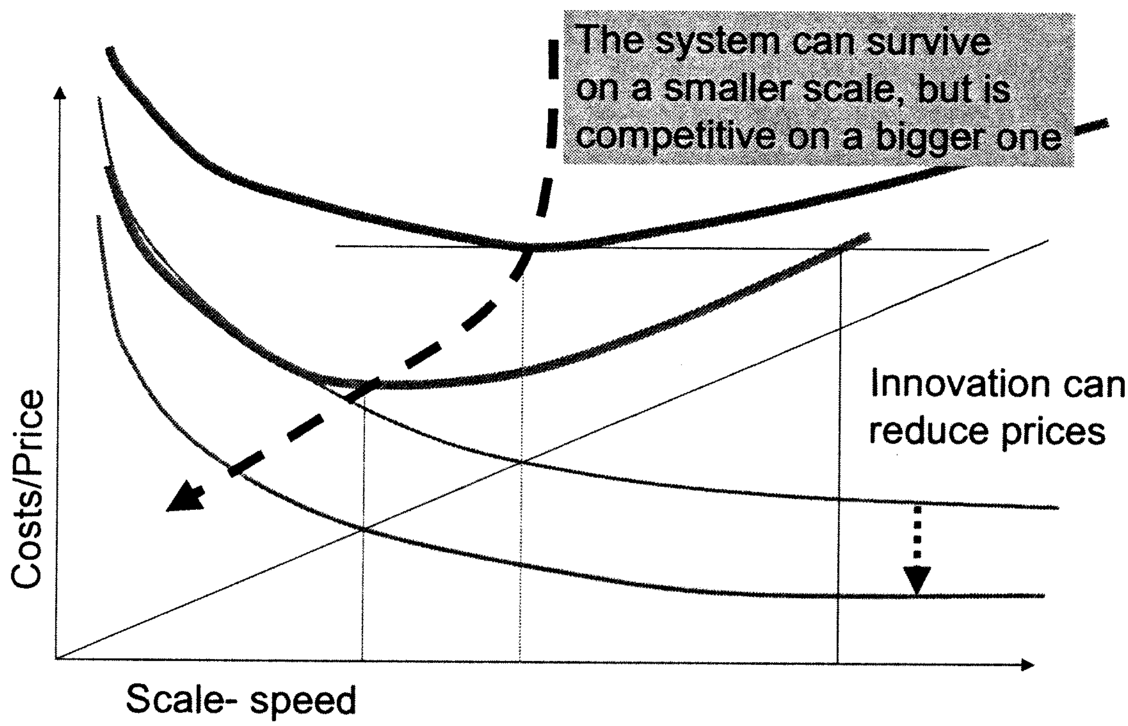


Figure 3 Innovation can reduce the price, but open the space for competition, the optimum is on a smaller scale

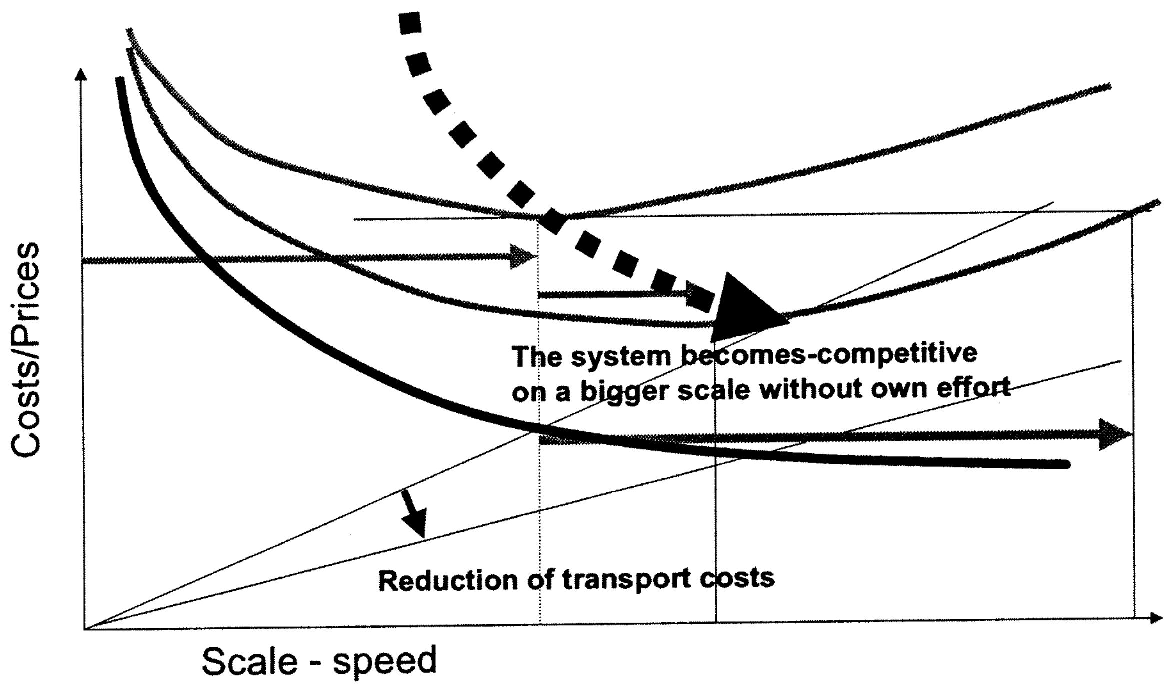


Figure 4 Reduced transport costs have advantages for the bigger enterprise, it can penetrate into the market of smaller ones

On the other side, low transport costs in a system with high speed increase the opportunities for choice of housing for the individuals. They react in the same way as corporations, but for other reasons, for example, low prices for apartments, green environment, etc. The result in the system is known as city sprawl. This however is only one side of the coin. The other side is the concentration of economic activities. The effect is the production of transport demand, which is developed exponentially. (There is no growth in mobility in terms of the number of trips in the system. This "growth" is the effect of modal split change and the increasing speed of the transport system) (Knoflacher, 1993).

It is easy to recognise that such a system can only occur if fundamental principles of logistics are not applied in land use and city planning. Costs are postponed or transferred to society, the future and to other regions of the world since the system is too complex and long lasting that the effects on economy, ecology and society are not direct visible.

Or is the goal of logistics the maximisation of transport? But transport logistics does not care about city planning systems and city planning principles are in general free of the principles of logistics, which are mainly formal principles.

If we apply better logistics in the usual way, we can mitigate against the problems, but we have to consider that negative side effects might occur. The more attention paid to logistics in the early stages of city planning, the less effort is needed to compensate the deficit between land use, city and transport planning. This can be proved by analysing the development of settlement structures, industries and transport indicators during the time period of technical transport systems. On the other hand, highly developed systems in cities and other logistics can be found in structures preceding this period of time (Figure 1).

6 KEY FACTORS

An optimum in logistics can only be achieved, if hardware (built structures) elements and software (information system and modes) are taken into account in an early stage. This is the city-planning stage and in this the early part is land use planning and development planning.

This however, is not the key element. This is the knowledge of human behaviour. There is a lack of understanding of this non-linear law for behaviour in all related disciplines which creates an exponential growth of problems of different kinds (congestion, time losses and a decrease of efficiency of the whole system).

7 WHERE DOES THE MISTAKE HAPPEN?

Today the system is not driven by system principles but much more by the sum of principles from its elements which try to optimise their position without taking into account the whole system. The basic relationship between system users, speed and the amount of transport is described by the basic formula:

$$Q = D \cdot V \tag{1}$$

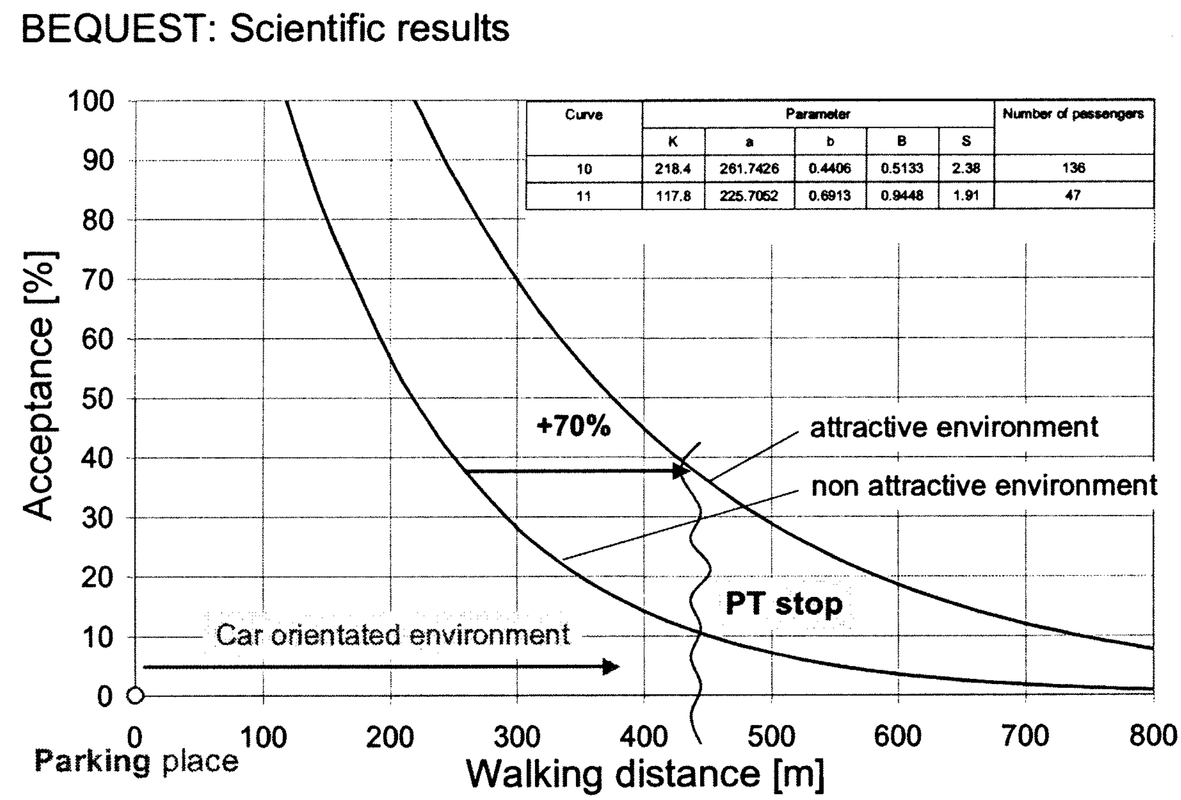
where,

Q: amount of transport (Km per time)
D: number of system users (car-units)
V: speed of system users

If we want to reduce the amount of traffic we have two possibilities: we can reduce D and or V (On the level of a company the goal is opposite, since Q is the indicator for its turnover, its success in the system.). However, where is the most effective leverage point?

If we take into account real human behaviour, the organisation of the local structures is the key factor. How parking is organised in relation to the places of human activities is shown in Figure 5.

Today companies as well as individual people try to optimise their logistics within the given conditions. If the conditions are biased, which is the case for transport costs, the whole system will not be able to achieve the best overall performance. The decision for the best mode is crucial in this context. Modal split is strongly influenced by the organisation of parking places, railway stations or public transport stops and the location of human and other economic activities. The influence of this "micro-level" on speed and modal split decisions is much more important than it was in the past.



Curve	Parameter					Number of passengers
	K	a	b	B	S	
10	218.4	261.7426	0.4406	0.5133	2.38	136
11	117.8	225.7052	0.6913	0.9448	1.91	47

Figure 5 Acceptance function for different environments, based on empirical data. This function is based on human body energy consumption and its perception (Knoflacher, 1987)

The function in Figure 5 is the reciprocal of the "cost function" for an individual. It is based on the fundamental law from Weber and Fechner (1871) which is a useful tool to describe human behaviour in this artificial environment (The Encyclopedia Americana, 1975).

This law is behind many well known relations in transport formulas and formulas of transport economy. If the whole system is analysed by using these inter-relationships, city logistics must be applied in a much wider context, taking into account settlement structures and parking organisation (accessibility of activities in great details).

This new approach is extremely helpful in analysing existing systems and in developing optimal strategies for solutions, as it was done partly in the research projects of the European Union OPTIMA, FATIMA, EMRECU and PROSPECTS (2000). There are also data from several empirical analyses available such as from the city of Vienna (WIZK, Vienna international Conference for the Future, Knoflacher, 1995).

8 RECOMMENDATIONS

If the inter-relationships between logistics, city structures, industry and transport are known, it becomes obvious, that city planning must include in each step of its work at least the principles of logistics. Since the key element of the system are humans, these principles must take care on their inherent behavioural structure in a rational and not an emotional way.

If these principles are applied, different patterns of city structures will result, although different industrial structures will follow which are much more sustainable than the structures of today. In principle this is the application of logistic strategies in a long-term context of the dynamic evolution of city structures. The empirical results show effects on a much greater magnitude, compared to the traditional field of applied logistics. The theoretical background of this approach will greatly assist practitioners to develop systems which are not only useful for the application of city logistics for city planning purposes, but also to move the whole development into a more sustainable direction.

Since existing strategies in city logistic tend to reduce the resistance function, to optimise the economic efficiency of the companies there is less (or nearly no) need to optimise the performance of the whole. This will reduce the efficiency of the whole, or could even lead to more instability in the future. City logistics, as it is applied today is influencing the core factors of the transport system – the resistance function. This must be taken into account to prevent this important instrument from producing adverse effects in the long term, while it produces strong positive effects in the short-term cycle.

REFERENCES

Bauordnung für Wien (Landuse Regulation exampel) (1997) Textausgabe nach dem Stand 1.1.1997. Linde Verlag, Wien.

EMRECU, EU - DG XVII Project (1998).

Ihde, G.B. (1991) *Transport, Verkehr, Logistik: gesamtwirtschaftliche Aspekte und einzelwirtschaftliche Handhabung.* 2., völlig überarbeitete und erweiterte Auflage. Vahlen Verlag, München.

Knoflacher, H. (1987) *Verkehrsplanung für den Menschen. Band 1: Grundstrukturen.* Verlag Orac, Wien.

Knoflacher, H. (1993) Does the Development of Mobility in Traffic Follow a Pattern? *History of Technology*, **15**, 125-140.

Knoflacher, H. (1995) Economy of Scale – Die Transportkosten und das Ökosystem. *GAIA* **4(2)**, 100-108.

Knoflacher, H. (1995) *Sustainable Development – Öko-City.* Projektgruppe 1: „Mobilität in der Stadt" (Stadt und Verkehr). Durchgeführt im Auftrag der Wiener Internationalen Zukunftskonferenz (WIZK).

Mumford, L. (1984) *Die Stadt.* DTV Wissenschaft Nr. 4326.

Newman, P.W.G. and Kenworthy, J.R. (1989) *Cities and Automobile Dependence: A Sourcebook.* Gower Publishing Company Limited, Essex.

OPTIMA; FATIMA; PROSPECTS; EU - DG VII Projects (1995-2001)

Samuelson, P.A., Nordhaus, W.D. (1987) *Volkswirtschaftslehre. Grundlagen der Makro- und Mikroökonomie.* Achte, grundlegend überarbeitete deutsche Neuauflage. Bund-Verlag, Köln.

Teufel, D., Bauer, P, Beker, G. and Wagner, Th. (1989) *Gesellschaftliche Kosten des Straßengüterverkehrs. Kosten-Deckungsgrad im Jahr 1987 und Vorschläge zur Realisierung des Verursacherprinzips.* UPI Umwelt- und Prognose-Institut Heidelberg, UPI-Bericht Nr. 14.

Weber-Fechner Law (1975) *The Encyclopedia Americana.* International Edition. Complete in Thirty Volumes. **28** (Venice to Wilmote, John) Americana Corporation, New York.