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SYSTEMATIC IMPLEMENTATION OF LOCAL, STATE AND FEDERAL REGULATIONS  
TO CONTROL TRANSPORTATION AND LAND USE CAN REDUCE ENERGY  
REQUIRED FOR TRANSPORTATION

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Abstract

Petroleum is available in limited amounts and the Transportation industry is currently using a giant share of the petroleum based fuel used in America. Ways are explored in this paper to reduce the amount of fuel needed to maintain mobility. Regulations on Transportation and Land Use are shown to be potential tools for fuel savings.

1. INTRODUCTION

The Transportation industry in America is consuming a giant share (approximately 28 percent) of all energy used each year. This represents 52 percent of the petroleum based energy used by the entire nation. Measured in gallons, transportation in the United States consumed approximately 127 billion gallons of crude oil in 1970 or an average of about 7 million barrels per day. Total known and expected domestic resources of petroleum have been estimated to be approximately 275 billion barrels. At the present rate of consumption this would last about 50 years and if historic trends of growth continue, these reserves could be depleted in 25 years. Enough data is available to show that conservation measures in transportation can reduce the amount of petroleum currently used. (1)

This paper will address the problem of conserving the dwindling fossil fuel reserves by a program of regulations to be applied to land use and transportation. More effective city planning, improved traffic operations, less fuel waste by improved vehicle design and maintenance, and methods to increase the usage of public transportation will be discussed as possible means to

save fuel. Regulations to force (encourage) implementation of these energy saving procedures are also reviewed.

2. VEHICLE REGULATIONS

Fraize, Dyson and Gouse of the MITRE Corporation point out that Federal emission regulations have caused an increase of 7 percent in automobile fuel consumption. (2) These authors also suggest that as much as 7.8 percent of the 1970 transportation energy budget could be saved through the reduction of tire and aerodynamic drags, and that 9.3 percent could be saved if one-half of all standard and intermediate size cars were replaced by small automobiles. Other studies have proved what should be obvious to the casual observer and that is the monumental savings in fuel via use of the small auto when compared to the standard American four door sedan. Economy in fuel may also be possible through the development of new propulsion systems. Regulations to encourage the development and use of a more fuel efficient automobile are suggested in the following paragraphs.

The authors suggest that regulations to control automobile manufacture, research, ownership, and

use have the potential to save many gallons of fuel. A regulation to be administered by the Federal Government through the U.S. Department of Transportation and State Licensing Agencies that would restrict the ownership of automobiles with air conditioning, power steering, electric windows, etc., is proposed. Rules restricting ownership of an air conditioned automobile to areas with certain average annual temperatures and then only for reasons of health could save many gallons of petroleum. Criteria for power steering and other power equipment may be less restrictive since they use far less energy than air conditioning. Another convenience that could be regulated is the automobile with an automatic transmission. It has been reported that a typical 3-speed manual transmission uses about 10 percent less fuel than an automatic. (3)

Federal, state and local agencies should impose a requirement on yearly automobile inspections that would require a engine tune check. As many as half of the cars on the highways have been estimated to be out of time, i.e., incorrectly timed and their carburetor not adjusted properly. This correction could result in an improvement in fuel efficiency of 10 to 15 percent.

Federal regulations are proposed that would require each automobile manufacturer to meet certain fuel efficiency standards for the vehicle they make available to the public. Through strict requirements, the manufacturer would be compelled to implement a research program in an effort to find ways to meet these criteria. Should the financial burden of the research and development be unbearable, government subsidy to the car maker might be a part of the energy program.

The use of radial tires has been reported to improve the gas mileage of highway vehicles and proper tire pressure (or even over inflation) will reduce rolling resistance. Proper alignment of the wheels will also reduce tire wear and improve fuel economy. State vehicle inspection requirements could be upgraded to include checks

of alignment and tire type. Tire pressure regulation would be more difficult to enforce; however, a national campaign to educate the public through spot TV and radio announcements and newspapers could provide the catalyst for an attitude change in the American motorist.

### 3. TRAFFIC OPERATIONS

#### 3.1 SPEED REGULATIONS

The fuel consumption of an internal combustion engine is affected by many factors. In terms of factors relating to the highway, NCHRP Report 122 (4) reports these factors to be roadway surface, speed changes, vehicle speed, vertical curves and horizontal curves.

Vehicle speeds and changes in speed are two factors directly affected by traffic operations. Regulations for speed are perhaps the oldest of the modern traffic regulations with records of enforcement techniques used by New York City policemen dating back to 1903. (5) A recent study by Witheford (5) indicated that most enforcement agencies regard their role in speed enforcement as one that contributes primarily to highway safety. Whereas, the U.S. motorist was convinced that driving at 55 mph was a good idea with the advent of the "energy crisis" in the fall of 1973.

The national 55 mph speed limit was enacted by Congress in late 1974 and a recent study of the 55 mph speed limit and its enforcement by Dart (6) concluded that the fuel savings as a result of the 55 mph speed limit are very modest and probably do not exceed a savings in fuel of more than one to three percent. In early 1974, average speeds on all classes of highways were reduced by as much as 10 mph, but gradual increases have occurred ever since. Today, the percentage of vehicles exceeding 65 mph is less than 10 percent. Police agencies believe that a majority of the public does not now favor the 55 mph speed law and it is becoming increasingly less enforceable particularly on Interstate highways.

Federal legislation is pending on the matter of a 60 mph limit on Interstate highways and perhaps there is justification for a 60 mph speed limit on Interstate highways. The additional fuel consumption is only 0.3 gallon per mile for a speed of 60 mph as compared to 55 mph. To assist officials in the enforcement of the 55 mph speed limit, safety as well as the conservation of energy should be emphasized.

There are also situations existing on secondary roads and local streets where speeds of 35 mph would be desirable since 35 mph is the optimum fuel conserving speed as shown in Figure 1.

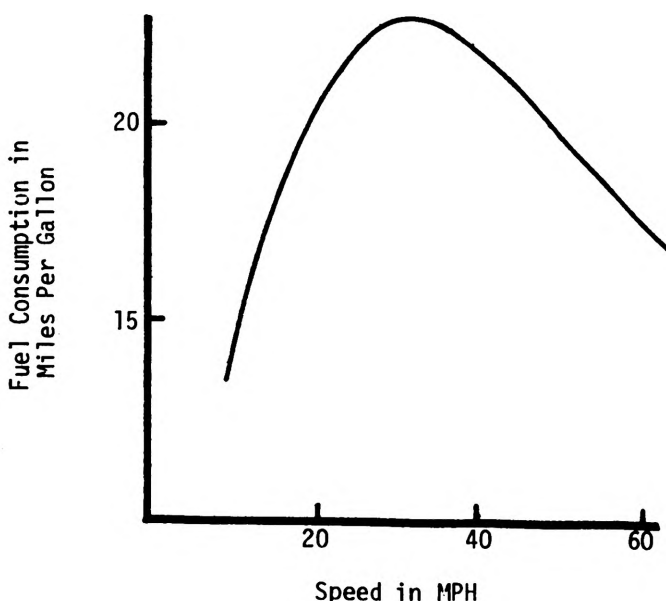


Figure 1. Automobile Fuel Consumption for Composite Vehicle on Level Grade (7)

### 3.2 PROGRESSIVE SIGNALIZATION

Vehicle speed changes and vehicle stops are operational characteristics that consume large amounts of fuel especially in urban areas. The excess fuel used to accelerate above and decelerate back to a uniform speed is more than the fuel used during the uniform speed operation. A reduction of 100 stops per day from a speed of 30 mph will save one gallon of gasoline and 150 less speed changes of 20 mph per day will save another gallon. (7) Moving a platoon of vehicles

through a signal system without stopping reduces fuel consumption. For example, an evaluation of a hybrid traffic control system installed on a 25.99 mile street network in Charleston, S. C., revealed a 55 percent reduction (66,593 stops in the before period and 30,032 in the after period) in daily vehicle stops due solely to the increase in the efficiency of traffic movement resulting from the installation of the modern traffic control system. (8) A reduction in the number of vehicle stops of this magnitude cannot be expected in all instances of improvements to traffic control systems because the characteristics of the systems vary. Improved traffic flow resulting from improved signal systems has been estimated to result in a regional energy reduction of 1 - 4 percent. (2) No new legislation would be required for implementation of traffic signal system improvement and the implementing agency could be either local or state. Standards must be prepared outlining the required performance of traffic signal systems and regulations must be established requiring that a qualified traffic engineer review and evaluate traffic signal timing on a periodic basis to ensure that the traffic signal system is responsive to traffic demands. Public reaction would be positive to a program of regulation for the optimum timing and operation of traffic signals.

### 3.3 TIMING OF ISOLATED TRAFFIC SIGNALS

In terms of energy management, the best policy for timing of isolated traffic signals is to use control measures and regulations adopted to keep moving vehicles moving. Avoid the use of control measures and regulations which require acceleration and deceleration maneuvers in the traffic stream.

If the assumption is made that a typical motor vehicle consumes 0.0333 gallons of fuel in a starting operating and has an idling fuel consumption of 0.500 gallons per hour, then a vehicle stop is equivalent to 0.066 hours or 4 minutes of delay in its energy use. (9) Using energy consumption as a system effectiveness measure, longer cycle lengths than those

presently used and accepted by the motorist will be required. Total vehicle delay will increase in order to reduce the total fuel consumption of vehicles passing through an intersection since the average passenger car can idle for 4 minutes using the same amount of fuel that would be required to accelerate a single vehicle from a stop condition.

### 3.4 INTERSECTION CONTROL

Over half of the stops, delays and speed changes for vehicles occurs at intersections. Traffic signals have been previously discussed so the operation of stop and yield controlled intersections will be discussed. Often, it is not necessary to require all traffic to stop on one street for traffic approaching on the other street. For intersections with a low approach speed on one street (10-20 mph) and adequate visibility of approaching traffic on the other street, a yield control is all that is needed to provide safe intersection control. This type of control would rate very positively with the motorist since many drivers treat stop conditions as yield situations anyway. In a recent study of driver observance of stop signs, Dyar (10) determined that only about 11 percent of the drivers made a complete stop at two-way stop-sign controlled intersections. The estimated regional energy savings would be up to 2 percent (2) for this measure of replacing unnecessary stop signs so no new legislation would be required unless the development of a new traffic control sign was required.

### 3.5 RIGHT TURN ON RED

Right turn on red (RTOR) means permitting a right turn on a steady red traffic signal after stopping and yielding the right-of-way to pedestrians. RTOR is a practice which has become popular in recent years and is an example of an energy conservation practice enacted by state legislation. Two states, Vermont and Rhode Island, along with the District of Columbia, totally prohibit RTOR. Preliminary studies in a portion of the CBD network in Washington, D. C., indicate RTOR could

reduce fuel consumption 4 to 8.9 percent for all vehicles (11) operating in the network. Police officials do not perceive RTOR as a major enforcement problem and RTOR is popular with the motorist because it reduces right turn delays, consequently reducing auto emissions and increasing fuel savings.

### 3.6 PARKING REGULATIONS

The responsibility for providing street space for moving vehicles has long been a government burden but the responsibility for parking has been shared by government and private interests. Regulations have been used to establish types of parking and to establish parking turnover rates. The cost of parking can have a bearing on turnover. In short, the pricing mechanism can be used for regulatory purposes. Restrictive parking policies combined with relatively high parking fees provide a means of encouraging an increase in occupancy rates for commuter vehicles and/or the use of park-and-ride facilities. With express bus lanes and high-quality transit service extended, the transit market area and the number of transit riders have increased within the Shirley Highway corridor. (12) Zoning ordinances for CBD parking should be restricted to stipulate maximum as well as minimum amounts of parking. Regulations should set costs to users such that fringe parking and express transit would be less than the costs to drive and park downtown. (23)

## 4. LAND USE REGULATIONS

Many studies in recent years have shown that land use and traffic demand are directly related. New transportation facilities result in better access to lands, often opens new land areas, and land use is changed as a result. New land use generates new traffic and often congestion, and this congestion suggests a deficiency in the transportation system. New or improved facilities are often believed the answer to the congestion, and the cycle is complete. (13) It is hypothesized that if the land use portion of this cycle is regulated, that transportation demands can be reduced and energy conserved. Owen in his book, The

Accessible City, states that the laissez-faire city is likely to result in a disaster (16) and suggests that cities be made accessible by design. Home to work trips account for the largest portion of home based trips and if these trips can be reduced in number or the mode of travel changed energy can be conserved. Carpooling and mass transit commuting are discussed in other portions of this paper; therefore, the emphasis here is to suggest ways to reduce the length of home to work trips. A study by Jones (15) suggests that decentralized work places, rather than one central work place, would save in the total commuting cost to the workers. Decentralized work places may be encouraged through zoning regulations that specify a certain parcel of land in each subsection of a metropolitan area be reserved for industry. Approximately 150 acres of industrial, commercial, and public use area is required for each 100 acres used for residential development. (16) If it is assumed that thirty percent of all intracity travel is work related, and the average home to work distance can be reduced twenty percent, a savings of approximately  $275 \times 10^{12}$  BTU's of energy could have been saved in 1970. This represents a savings of about 6 percent of the energy consumed in urban passenger traffic in 1970 or two billion gallons of crude oil. (2) No change other than to shorten the average length of trip has been suggested in the above example, and this trip length reduction was hypothesized as being made possible through a decentralization of work places. This concept of decentralization would be more difficult to achieve in an old town; however, in new or developing cities the program warrants serious consideration.

Another concept that may be used to reduce the volume of urban travel is implementation of the Planned Unit Development (PUD) concept for all urban expansion. PUD is an outgrowth of the planned community concept. (17,18) Basically, the idea of PUD is for each development to be as self-contained as possible. Each PUD would contain a variety of housing types, open spaces, retail or commercial areas, schools, medical

offices, and work places. In each of these PUD units, there should be employment, school, and shopping within walking distance of residential areas, and driving when required would be for short distances.

An estimate of the savings in travel would be hard to obtain for a PUD; however, city planners have given less traffic demands as one of several advantages of the PUD concept. Implementation of this plan would require a strong zoning ordinance and would obviously be easier to accomplish in a new town than in an old established metropolitan area.

"Foot Streets" are now popular in many European towns. (19) In order to provide a portion of the CBD for shopping and business that could be completed while walking from store to store, Limbecker Strasse in Essen was closed to vehicular traffic in 1927. with parking provided in circumference locations, many stop and start operations of the private auto could be eliminated if such CBD's for pedestrians were used with shuttle buses to move people within a reasonable walk of the businesses. Reports from the West German cities that have converted their CBD's to foot traffic only indicate that the plan is well received by the public.

## 5. PUBLIC TRANSPORTATION

### 5.1 REGULATIONS TO INCREASE TRANSIT PATRONAGE

Transit patronage in the U.S. has been declining since the end of World War II while the total of urban passenger miles of travel has been increasing (Figure 2).

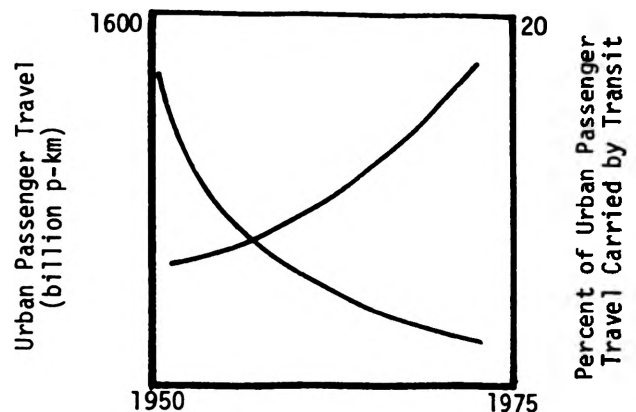


Figure 2. Urban Passenger Travel from 1950 to 1973 (20)

Even though public transit accounts for such a small percentage (less than 3 percent) of the total urban passenger travel that its short term potential for energy conservation is very small the long term potential should be examined. Significant quantities of petroleum can be saved if a substantial number of transit riders can be attracted in the long term.

Regulations to increase transit patronage include those to improve service and to improve traffic-related operations. Service regulations include those regulations dealing with frequency of service, travel time, and service features such as park-and-ride services. Traffic related operations include special requirements for punctual and speedy operation, passenger comfort and safety.

## 5.2 REGULATIONS AND TRAFFIC RELATED OPERATIONS

One type of traffic regulations related to high-occupancy vehicles is restrictions on busway and bus and carpool preferential lanes. Types of operations have included express lanes, shoulder bus lanes, bus lanes, contraflow bus lanes and carpool priority lanes, exclusive bus and carpool lanes and center-reversible exclusive bus lanes. A study (21) of the issues and problems associated with the legal, regulatory, judicial and enforcement environments related to busway and bus and carpool lanes indicates the following questions are prerequisite to the design of an effective preferential lane project:

- (1) Do the existing laws or ordinances provide adequate authority to local or state agencies to restrict the use of lanes to certain types of vehicles? What procedures must be followed to implement such restrictive measures?
- (2) Do the enforcement jurisdictions have the authority to apprehend and cite violators of such lane restrictions? Does the apprehending officer have to be a witnessing officer in order to cite the violator?

- (3) Does the judicial system have sufficient authority to impose fines and penalties for violations of lane restrictions? (21)

The enforcement program should be an integral part of the planning and design process for busway and carpool lanes and bus lanes. Some busway and bus and carpool lanes are self-enforceable but other lanes such as a curb bus priority lane are very difficult to enforce and may require a special enforcement technique.

Other traffic related measures requiring regulations are bus stops and turn prohibitions. The establishment of bus stops of adequate length and the enactment and enforcement regulations of parking prohibitions will provide a smooth flow of transit vehicle traffic. Prohibitions against making a left or right turn are often used by traffic engineers at critical intersections. These prohibitions might require rerouting of a transit vehicle with additional mileage, travel time and fuel consumption resulting. Regulations can be enacted to exempt transit vehicles from such turn prohibitions thus reducing travel time and delay to bus passengers.

## 5.3 REGULATIONS AND IMPROVEMENT OF SERVICE

A demonstration by the Shirley Highway Express-Bus-on-Freeway Project revealed that well-planned park-and-ride operations can lead to sizable increases in bus patronage. Bus commuter surveys have shown that park-and-ride use increased from about 25 percent of the corridor bus ridership in 1971 to about 30 percent in 1974. (12) The enactment of regulations requiring items such as bus shelters, minimal walking distances, car security, and parking convenience at park-and-ride locations would satisfy a large percentage of the park-and-ride transit patrons. A regional energy reduction of 0.5-2.5 percent might be expected as a result of increased transit patronage park-and-ride with express bus service. (2)

## 6. IMPLEMENTATION

Implementation of many of the regulations

suggested in this paper will be difficult because they require sacrifices of a way of life. Other restrictions would be less difficult to start since they would impose few hardships on the American public. A wide and thorough educational program is suggested as a primer to impress on the public that steps must be taken (and now) to ensure that there is energy tomorrow. Congressman Mike McCormack expressed the idea when speaking at an energy conference in Atlanta as follows (3):

"this nation can develop policies and programs which will provide for adequate energy to maintain our economic stability and standard of living, while protecting or even improving our environment and the health and physical well being of our citizens.

I believe we can do it if we establish energy policies that do make sense and if we implement them at every level right away."

Other support to the basic philosophy that the public will cooperate can be shown through the 28,000 written answers to the Public Notice that appeared in the March 2, 1977, edition of The Federal Register. (22) Seventy-eight percent of the general public agree that conservation of all forms of energy throughout the U.S. is now required, and 88 percent say all levels of government must have certain areas to regulate. At ten regional town meetings held in preparation of the National Energy Plan, there was ample support for direct and indirect government promotion of fuel efficient autos, taxes on large cars, and continuation of emission standards. Substantial support was also expressed for regulations and standards. Americans when faced with a common problem will unite and fight in a cooperative fashion.

With the understanding that implementation of any regulations should be preceded by a nationwide educational program, the restraints or regulations proposed in this paper will be discussed to

suggest how they may be made effective.

Land use regulations may be imposed at state and local levels of government; however, many local governments could be pressured to be inconsistent in their administration of the best of plans. Political favoritism and conflict of interest situations where the city leaders are businessmen would be common in many cities. Federal regulations with state level agencies to supervise compliance would be required to assure effective enforcement of land use regulations. Tax breaks and revenue sharing might be used as incentives to reward those who comply. Results of this program would be long range, and it would probably require several years for the plan to become effective in the fuel saving it promises.

The planned city concept or new town has been tried in recent years on a limited basis as demonstration projects in various locations. To initiate a national movement to PUD type community developments would require similar laws as those for general land use regulations discussed in the prior paragraph. However, additional changes, that cannot be legislated, would be necessary to prompt the adoption of PUD developments. Implementation of this program would require an estimated five years or more. Fuel savings thus generated would not be immediate; however, savings would be continuous.

It is felt that foot streets could be started with little legislation other than local or perhaps state laws required to authorize such zoning. Time to implement the program would vary with city size and area to be closed to vehicular traffic. Savings in fuel would be hard to estimate and would actually only begin after the savings via reduced vehicular traffic equaled the fuel needed to build the parking facilities, etc., needed to make foot streets work.

Regulation of the vehicle in regard to horsepower, weight, emission control, etc., will require additional federal legislation in the opinion of the authors. The restriction of who may own the automobile with air conditioning, power steering,



automatic transmissions, etc., should be controlled by state level agencies. More stringent controls on tire pressure, proper engine tuning, and wheel alignment might be enforced by the state licensing and law enforcement agencies, and these improvements would yield immediate fuel savings.

Traffic operations can and should be improved to save lives, reduce travel time, and conserve fuel. Speed regulations, progressive signalization, timing of isolated traffic signals, intersection control, parking regulations, and right turn on red have all been listed as areas where improvements would save fuel. Changes in speed limits on highways constructed with Federal monies would be subject to legislation at the national level but speed restrictions on city streets and some secondary routes may be imposed by state and local authorities. Implementation of state and local changes could be very rapid and fuel savings begin immediately. Enforcement would be the major problem in achieving the benefits of speed regulations. Most of the other improvements, i.e., right turn on red, progressive signalization, etc., would be accepted by the public, and local laws would permit their implementation.

Programs to increase public transit patronage were suggested to deal with the improvement of transit service to a point that it becomes more attractive to the potential user. Many of these regulations if implemented would be unpopular to the transit company because of the financial outlay required to add more vehicles to increase frequency, to add comfort and safety features, and to implement park-and-ride programs. Federal subsidies to these transit companies might be required to encourage the companies, and the subsidy revenue might come in part from a tax imposed on large automobiles. Legislation at the Federal and State level would be required to bring into existence the transit ridership needed to reduce energy consumption by an appreciable amount.

## 7. CONCLUSIONS

Although transportation is but one of the many

energy users, it has been suggested in this paper that much energy can be conserved through its regulation. Vehicle regulations to reduce emission control standards could save as much as 7 percent of auto fuel, removal of power accessories from automobiles might save as much as 4 percent of automobile fuel, and the use of smaller, lighter vehicles could save even a larger percentage. (2)

Traffic control regulations in the form of progressive traffic signals, right turn on red, and speed regulations were shown to be devices by which many gallons of petroleum may be saved (possibly 1-5 percent of transportation energy). These regulations should be easy to implement because local authority is normally adequate to put these into affect.

Land use regulations were also suggested as a means to reduce the demand for intracity driving through more efficient planning. The results of such planning would be manifest after a longer time frame since it would be an evolutionary process; however, these results would be continuous. Legislation and zoning regulations would be required, but the reduction in urban travel and energy used could be dramatic.

Regulations and more particularly those that place restrictions on the mobile society of America may be unpopular, but in times of need the people have shown their willingness to sacrifice. By carefully and thoroughly explaining to the public what the problem really is and its seriousness, it is felt that a majority will agree to restrictions imposed by government. America can and will survive the energy crisis.

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