

## REDUCING FUEL CONSUMPTION WITH LAND MOBILE RADIO

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### ABSTRACT

In a variety of situations the substitution of communication for transportation could be made, resulting in a reduction of fuel consumption. This paper examines the fuel savings that can be achieved when mobile radio communication is used to decrease the amount of driving by automobiles and trucks. Although this benefit is as varied as the operations which use radio, the general magnitude of the fuel savings is discussed. An indication of the way one might estimate the savings for a particular operation is provided. Reducing fuel consumption in this manner has a negative aspect which is briefly mentioned. Land mobile radio communication has become highly congested in recent years. Relief of the fuel consumption problem will increase radio congestion.

### Introduction

In recent years we have had to contend with both shortages and higher prices of fuel for automobiles and other vehicles. These problems have become the subject of much attention and research aimed at lowering fuel consumption without altering our lifestyle in ways that would be considered highly objectionable.

Direct attacks on the problem have involved research intended to improve the efficiency of the automobile [1, 2]. The automobile manufacturers now include fuel economy as an attribute with which to compete for sales. Recognition that the equipment which reduces undesirable engine exhaust emissions also decreases the efficiency of the engine leads to the conclusion that making the

emission standards less stringent is one definite way to use less fuel for a given amount of driving. A second way of using less fuel is to drive less. The relationship among mileage driven, exhaust emissions, and air quality was explored by Cesario [3]. A given level of air quality can be achieved by different combinations of miles driven and exhaust emission standards. These same factors are related to total fuel consumption.

Another way in which the systems approach is used to examine the potential reduction in fuel consumption is to study what may be called the transportation-communication trade-off. While Cesario takes mileage reduction as a parameter to determine the effect on air quality, this approach seeks to measure the mileage reduction and consequent fuel savings that result from substituting communication for transportation. Along this line Orski has pointed to improving communications and reducing travel needs as a means to reduce fuel consumption. Typical examples of this approach include analyses of the fuel saved when conferences are held via telephone or some television arrangement instead of having all personnel travel to one location and analyses which suggest that in the future many workers could perform their tasks at home instead of traveling to an office, communicating with the office and/or computer by means of telecommunications. In this paper we address our attention to yet another area in which the transportation-communication trade-off is used to reduce fuel consumption. In many business, government, and educational operations today communication by land mobile radio is decreasing the number of miles driven by automobiles and trucks and in this manner is providing a fuel savings. The potential for additional savings remains. As discussed by Brinkley with respect to Western Europe but whose comments apply elsewhere as well, "clearly no stone should be left unturned to find cheaper and less oil-hungry methods of communication" [4]. This paper explores the reduction in fuel consumption that can be achieved by communication with land mobile radio.

### **The Nature of the Benefit**

Land mobile radio communication is the sending of information by radio either between a fixed point and a vehicle which moves throughout some region or between one vehicle and another. With the development of handheld radios, the term "vehicle" now includes "human being." Land mobile radio was used little in the years before World War II, mainly by police departments and

taxicab companies. After the war, technical developments and awareness of radio benefits led to a tremendous rise in this type of communication. Today almost every type of business and industry, public safety agency, and government has come to rely on land mobile radio; they say it would be difficult to operate without radio.

There are many benefits of mobile radio; some are economic and some non-economic. Some are straight-forward to evaluate; others are difficult to measure. The subject of this paper—the fuel savings obtained through the implementation of mobile radio—is a benefit for both profit and non-profit operations. It is recognized that the fuel savings may be only a secondary benefit in some operations. For example, lowered manpower requirements or increased patient survival rates may at times be the prime benefit. Yet in recent years we have seen limited fuel availability as a reality which has elevated the importance of any fuel-saving technique.

There are two basic ways in which the economic benefit of mobile radio can be measured. When a fleet of vehicles can serve additional customers by using mobile radio, the benefit can be measured in terms of the additional profit yielded by the customers. On the other hand, if a given level of business operation can be maintained at a lower operating cost when radio is used, then this savings is the economic benefit of mobile radio. We are concerned here with the latter type of benefit analysis.

To understand the way that mobile radio can save fuel in any operation we have to understand the way mobile radio is used. This varies among the different businesses, organizations, or government agencies. Consider, for example, a service company such as a plumbing or air conditioning company. At the beginning of the day the serviceman leaves for the first customer. After performing the service the serviceman must find out where to go next. Without radio this must be done by telephone. Although sometimes the customer's telephone can be used, this is not always possible. In addition, company policy may discourage or prohibit this. Consequently some driving may be required to locate a public telephone. In fact, it may be that this driving is opposite to the direction for the next customer. Now it may be that while the serviceman is enroute to the next customer a call comes in from another customer in the area the serviceman left or somewhere along his route to the next customer. The dispatcher could redirect the serviceman immediately if they are using mobile radio. If not, he must wait until their next telephone contact. Without the radio additional driving will be required to serve all the customers.

Perhaps the serviceman forgot to load all his equipment back into the truck. The customer could call the company and the company could radio the serviceman before he travelled very far. Without radio he might not realize his mistake until he reached his next destination. With radio a package that did not get loaded onto a truck would cause little difficulty as the driver could be notified quickly. Without radio an additional trip would be required to retrieve it. Considering the great variety of operations in which motor vehicles have a function, it takes little imagination or familiarity to recognize circumstances under which driving would be reduced by communication with radio.

The reduction in driving mileage achieved with mobile radio as illustrated above depends on the way the company operated. For example, we described a company for which the mobile unit must telephone the company dispatcher after servicing each customer. In other companies, a driver is given a list of customers at the beginning of the day. Perhaps only one or two telephone calls are required during the day. While this decreases the driving to find a telephone, the less contact that is maintained the greater the additional driving needed to serve the new customers calling in during the day. Companies operating over a larger area will find this a greater problem than those operating over a smaller area. However, it is not just the area that affects the savings that can be obtained with radio; it is the area covered by each mobile unit. A company with only one serviceman operating throughout a large area would be especially sensitive to the savings that mobile radio could bring. When the area per mobile unit is large, a good portion of the work day could be spent traveling between customers. Here there would be a great opportunity for improvement in operational efficiency in general and a reduction of fuel consumption in particular.

### Measurement of Fuel Savings

When the use of mobile radio reduces mileage, how much fuel is saved? As we have seen, it depends on how the radio is used, so there is no single answer to the question. A figure mentioned by Stover and widely accepted is based on studies showing that four radio-equipped vehicles can do the work of five non-equipped vehicles, with a consequent 20 per cent reduction in fuel consumption [5]. A study conducted by the National Association of Business and Educational Radio, Inc., and reported by the Federal Communications Commission indicated "that three radio-equipped vehicles can do the work of four vehicles not so equipped, in most

situations" [6]. This would indicate a 25 per cent fuel reduction. Taff reports the American Trucking Association has indicated productivity increases of 15 to 25 per cent in pickup and delivery operations with mobile radio [7]. A different figure has been given for police patrol cars, where the Federal Communications Commission reported "that it would be necessary to double the number of cars in use if mobile radio were not available."

A concrete and construction firm is reported by Maxwell to have kept records of truck travel to and from construction sites and realized a 25 per cent savings in fuel [8]. Considering that such a company often is operating in areas without readily available telephone communication it is not surprising to see a savings above the general 20 per cent figure.

Since there are a number of factors causing the variation in fuel savings brought by mobile radio, to determine in advance the savings that could be expected for a particular company would require a detailed analysis. This would have to consider such factors as the distance between customers, the number of stops per day for each mobile unit, the need to redirect the mobile units, and the availability of telephone communication. This type of detailed analysis was illustrated by Plotkin, although the purpose there was to study the overall economic impact of delays in radio communication, only part of which concerned the mileage aspect [9].

- Let  $p$  = per cent mileage reduction with radio
- $m$  = miles per day per vehicle without radio
- $n$  = number of operating days per year
- $e$  = fuel consumption, miles per gallon
- $S$  = savings per day per vehicle, gallons

The daily fuel savings brought by mobile radio can be expressed in terms of the above. For each vehicle,

$$S = (p/100)mn/c = pmn/100c$$

This has been done and plotted in Figure 1 on the basis of 300 operating days per year. The values are given for mileage reductions of 15 per cent and 25 per cent. They form a range which includes the most frequently reported values. Also shown in Figure 1 is the effect of vehicle efficiency, with fuel savings determined for 10 miles/gallon and 15 miles/gallon. It should be pointed out that the savings shown in Figure 1 are for one vehicle. A company operating with more than one vehicle would obtain an annual fuel savings of  $S$  times the number of vehicles.

The fuel savings obtained by using land mobile radio

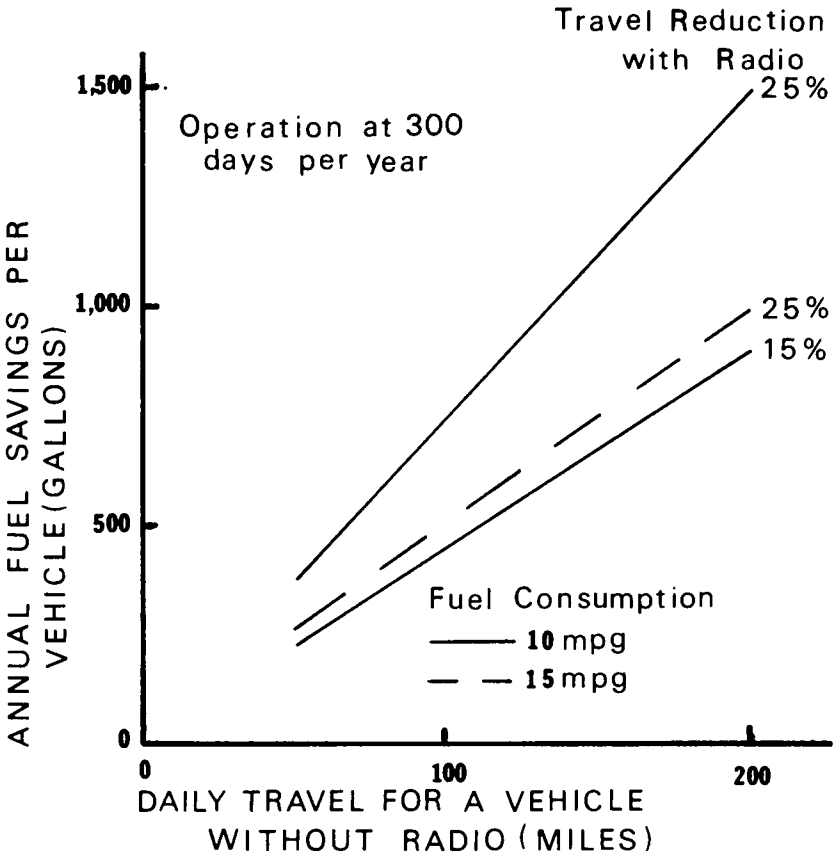


Figure 1. Fuel savings with radio as a function of daily travel.

communication has been measured in gallons of fuel. This benefit is of interest as an analysis of resource conservation. This view of the benefit would have immediate impact if there were imposed limits on fuel consumption, as with rationing. Without limits a more important view of the benefit to any particular company or organization is the fuel savings as measured in dollars. While the purpose of this paper has been to consider the fuel savings yielded by increased radio communication, the economic benefit of the savings would be the figure the businessman would want to see. Once we can measure the gallons of fuel that could be saved, the economic value depends on our knowledge of the price of fuel.

### The Other Side of the Trade-Off

While discussing the fuel savings made possible by mobile radio communication we must also examine the effect on the communication situation. Radio communication is made by using a part of the electromagnetic spectrum. Since the spectrum is finite it has come to be viewed as a limited natural resource [10, 11]. The tremendous growth of all kinds of uses of the radio spectrum has led us to the point of "electronic pollution" [12-14]. Recognition of its benefits, such as the one addressed in this paper, has caused so many people to adopt land mobile radio that its allocated portion of the spectrum has become extremely congested in some areas. Yet even after the government has reallocated some UHF television spectrum to land mobile radio, according to the president of the National Association of Business and Educational Radio, Inc.,

We are rapidly approaching another saturation crisis similar to our problems prior to the sharing of UHF-TV space . . . [15].

While we have discussed the transportation-communication trade-off in the direction of increasing communication in order to save fuel, others have suggested decreasing the amount of such communication in order to relieve radio congestion [16]. Without becoming involved in the problems of the radio spectrum, we are at least aware that using radio to save fuel is not a completely positive suggestion. A burden is shifted elsewhere.

### Conclusion

One way to reduce the amount of fuel used by automobiles and trucks is to drive less. In many circumstances this can be accomplished at no loss of operational performance by incorporating land mobile radio communication in the operation. Although the actual mileage reduction and fuel savings will depend on the particular operational characteristics, most commonly reported and generally accepted savings are in the 15-25 per cent range. Recognition of this and other benefits has increased radio communication to the extent that the mobile radio portion of the radio spectrum—a limited natural resource—now has the problem of congestion. This paper has discussed one segment of the trade-off of benefits and problems that exists between transportation and communication.

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