Removal of Roof-Mounted Emergency Lighting from Police Patrol Vehicles: An Evaluation

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ABSTRACT

In 1982, based on a study of fuel use and vehicle accidents, the Illinois Department of State Police began a test of the effects of removing roof-mounted emergency lights from police patrol vehicles. The test group consisted of 120 vehicles, half of which had their roof-mounted lights removed. The vehicles were randomly issued in pairs to officers who had similar patrols in rural regions. After 6 months, the fuel economy, vehicle accidents, and productivity of the officers were compared. Significant improvements were found for those officers driving vehicles without roof-mounted lights. More vehicles without roof-mounted lights were placed in service in early 1983. This study compares 208 vehicles with and without roof-mounted lights for the April 1982 through January 1984 time period. The officers drove these vehicles more than 5.5 million miles. All officers had similar driving records before the study was conducted. The results show that those officers who drove vehicles without roof-mounted lights improved their fuel mileage by 7 percent, were 25 percent more productive in speed enforcement (but not in overall enforcement), and were involved in 65 percent fewer accidents per million vehicle miles traveled. All results are statistically significant. The findings suggest that removing roof-mounted lights from police vehicles that patrol rural regions reduces fuel and accident costs and improves productivity.

In April 1982, the Illinois Department of State Police (DSP) began testing 60 marked patrol vehicles without roof-mounted emergency lights. Those vehicles were selected at random from 120 marked vehicles that were placed in service that year. Emergency lighting was placed inside the grille and on the back window ledge. The basis for this change was a study conducted by Stoica for the DSP in 1982 that recommended that the light bars be removed to save fuel (1). The study also found that drivers of unmarked police cars (without roof-mounted lights or state police markings) tended to have fewer accidents (1,p.7).

The 120 police vehicles (squads) introduced in 1982 were evenly divided into two groups: those with and those without roof-mounted emergency lights. All vehicles retained traditional state police markings including striping, decals, and the words "State Police." The test cars were randomly distributed to pairs of field officers with similar patrols in each district. In Illinois, the squad is an officer's permanent vehicle. The choice of which officers would receive vehicles was made without referring to the officers' driving records. At the end of the first 6 months, the Bureau of Planning and Analysis evaluated the results of the test (2).

Even with less than 1 million mi of driving, fuel savings were significant. Those vehicles without roof-mounted lights (hereafter termed "semimarked" to distinguish them from "unmarked" vehicles) averaged 6.4 percent better gas mileage than marked vehicles (2,p.3). Officers in all 120 vehicles had been involved in only 15 accidents, a base too small to be statistically analyzed. However, accidents involving vehicles with roof-mounted lights were occurring at a rate twice that of the semimarked vehicles, as was expected (2,p.8).

In this interim period, officer productivity was evaluated. Officers driving semimarked vehicles wrote speeding citations at twice the rate of the officers who drove traditional vehicles. There were no differences in other forms of traffic enforcement (2,p.10). In a survey of officers, those driving semimarked vehicles expressed satisfaction with the new configuration. Some officers believed that the lack of roof lights only presented problems at the scene of an accident. In terms of safety, one officer's statement sums up the attitudes of the test group: "I personally like my semimarked squad. In fact, it has made me even more safety conscious knowing there is a possibility that I may not be seen" (2,p.20).

As a result of the interim evaluation, DSP began issuing semimarked vehicles. In 1984, these vehicles were also placed in service in the Chicago metropolitan region, a six-county region. Their use will be monitored closely, because the review of accidents of unmarked vehicles had shown few differences between unmarked and marked vehicles in urban regions. For instance, there was no difference in fuel economy between marked and unmarked vehicles in urban regions. Finally, the traditional use of roof-mounted lights and the lack of strong evidence of improved safety in urban regions precluded their introduction into those regions. The current success of semimarked vehicles has led to them becoming the standard vehicle statewide.

This report compares the performance of the two types of vehicles from April 1982 through January 1984. Three comparisons are made: fuel consumption, officer productivity, and vehicle accidents. The findings of this evaluation show greater differences than those discovered in the interim report, thereby enhancing the original findings.

SOURCES OF DATA AND HYPOTHESES TESTED

Data and Tests Used

The data used for this evaluation were derived from three sources maintained by DSP: first, a vehicle cost file that contained information about monthly expenditures for fuel and maintenance, fuel used, and miles driven; second, an on-line data base known as the Traffic Information Planning System (TIPS) that showed officer activity; and finally, accident reports. The latter are not contained in a data processing file; analysis of information was therefore limited because of the difficulty of obtaining data rapidly. All data cover the January 1976 through January 1984 period.

Three statistical tests were employed. Because miles per gallon is a skewed function and because of the method of recording fuel used and miles driven, parametric analysis of variance was impractical. A Wilcoxon or Kruskal-Wallis test of analysis variance (automatically chosen by the Statistical Analysis System or SAS) was therefore employed (3). Chi-square was used for the contingency tables and a t-test was occasionally applied. This test supported the non-parametric tests. The following three null hypotheses were tested:

1. Marked vehicles have the same fuel economy as semimarked vehicles,
2. Officer productivity in each type of vehicle does not differ, and
3. There are no differences in the number of accidents between the two types of vehicles.

Description of Vehicles and Drivers

Since the first marked and semimarked vehicles were placed in service in 1982, DSP has operated 208 squads marked as Division of State Troopers in line patrol. This group excludes vehicles that were issued to officers in Districts 3, 4, and 15 (Chicago and Cook County) and those used by officers other than the rank of Trooper or for other types of patrol such as truck law enforcement. Of the 208 vehicles, 128 or 61.5 percent were semimarked. During this same period, 235 State Troopers drove the vehicles on patrol. There were more officers than vehicles because transfers, promotions, and changes in assignment resulted in some officers changing vehicles. The 208 vehicles were driven 5.7 million mi, used 484,900 gal of fuel, and were involved in 49 accidents. All 208 vehicles were white with Illinois State Police markings. These data are summarized in Table 1.

TABLE 1 Summary of Data Bases Used for Evaluation (vehicles in service since 1982)

	Vehicle Type		
	Marked	Semimarked	Total
Number of vehicles	80	128	208
Percent	38.5	61.5	
Number of officers	102	133	235
Percent	43.4	56.6	
Miles driven (000,000s)	2.94	2.73	5.67
Gallons of fuel used	260,900	224,000	484,900
Accidents	37	12	49

Drivers of the first 60 pairs of vehicles issued in 1982 were chosen randomly. Each district that was scheduled to receive a vehicle submitted pairs of names of officers on similar patrols (all officers rotate through three shifts and the only consideration was the geography of the patrol). The Bureau of Planning and Analysis selected one officer of each pair to receive the semimarked vehicle. If the officer refused the vehicle, both officers were eliminated from the test.

All of the statistical tests described in the remainder of this paper divide the officers into two categories: those driving vehicles with roof-mounted lights (marked vehicles) and those driving vehicles without roof-mounted lights (semimarked vehicles). For the three measures of fuel consumption, productivity, and accidents, a separate comparison was made between the new vehicles and the older marked vehicles driven before the test. (All marked vehicles driven prior to 1982 had roof-mounted lights.) Fewer officers comprised the base for historical comparison because some drove unmarked (plain-color) vehicles.

FUEL ECONOMY, PRODUCTIVITY, AND ACCIDENTS

Fuel Consumption

The first null hypothesis tested was that the fuel usage of those officers driving semimarked vehicles was no different from that of officers driving marked vehicles. As shown in Table 2, marked vehicles traveled slightly more miles and used more gasoline. Officers in semimarked squads averaged 12.4 mpg, which is 6.9 percent better than the 11.6 mpg obtained by officers in marked vehicles. The difference is significant at the .001 level. The total cost of operation, of which fuel was the largest component, was 14.3 cents per mile for marked vehicles and 13.0 cents per mile for semimarked vehicles. This difference of 10 percent also was significant at the .001 level. The hypothesis that fuel usage was the same for semimarked and marked vehicles was rejected.

TABLE 2 Costs, Mileage, and Fuel Economy of the Tested Vehicles (1982 vehicles)

	Vehicle Type		
	Marked	Semimarked	Total
Number of vehicles	80	128	208
Miles driven (000,000s)	2.94	2.73	5.67
Average mileage	36,720	21,310	27,240
Gasoline used (gallons)	260,900	224,000	484,900
Average mpg[a]	11.6	12.4	12.1 (avg)[b]
Average cost per mile (cents)[a]	14.3	13.0	13.5 (avg)[c]

[a]Average of (a) miles per gallon and (b) cents per mile per vehicle.
[b]Wilcoxon z equals -3.628; significance equals $p < .001$.
[c]Wilcoxon z equals +4.955; significance equals $p < .001$.

Did the officers drive differently before they received the new vehicles? Table 3 shows the average gas mileages and average total costs per mile for squads driven by these officers prior to receiving the new vehicles. Since 1976, each officer has driven more than one vehicle. Because officers originally drove both marked and unmarked cars, the data are divided accordingly. Although officers currently driving semimarked vehicles had historically obtained slightly better gas mileage and had lower operating costs, the differences between them and the other group of officers were insignificant.

Other factors, such as location of patrol or distance driven, that could have influenced the current findings had no effect. Vehicles with and without light bars were distributed evenly throughout state districts. The first 120 test vehicles were assigned randomly within those districts. Patrols in the urban regions surrounding Chicago were not included in the analysis. State Police patrols outside Cook County are primarily rural. While the total miles

TABLE 3 Fuel Consumption by Vehicles Before 1982 (1976 to 1982)

Type of Vehicle Driven Before 1982	Type of Vehicle Currently Driven: Marked	Semimarked
Marked		
Number driven	105	19
Average mpg	10.25[a]	10.51[b]
Average cost per mile (cents)	18.28[c]	17.17[d]
Unmarked		
Number driven	118	10
Average mpg	10.66[a]	11.08[b]
Average cost per mile (cents)	18.08[c]	16.73[d]

[a]Wilcoxon z equals -1.254; no significance.
[b]Wilcoxon z equals -0.425; no significance.
[c]Wilcoxon z equals 0.120; no significance.
[d]Wilcoxon z equals 0.232; no significance.

driven differed slightly, the differences were insignificant.

Vehicles in this study were limited to Fords and Dodges manufactured in 1982 and 1983. As a result of the initial findings, semimarked squads became the standard issue starting in 1984 and their use has now been extended to all regions, including the urban regions of Cook County.

Based on the differences in fuel mileage found on the test (12.4 mpg for semimarked squads versus 11.6 mpg for marked squads), semimarked vehicles require less fuel. If squads average 21,310 mi of travel per year (based on data for semimarked vehicles from Table 2), the removal of roof-mounted lights will save 118.5 gal of gasoline per vehicle. At $1.30 per gallon, this equals a savings of $154 per vehicle per year. The emergency lighting installed in the grille and on the rear deck is also less costly than any roof-mounted lighting, especially the aerodynamic type.

Officer Productivity

Officer productivity was not expected to depend on the type of vehicle driven. However, it was found that officers driving semimarked vehicles wrote more speeding citations (2,pp.9-10). Moreover, a study by the International Association of Chiefs of Police also indicated that police in unmarked vehicles were more effective at enforcing the 55-mph speed limit than those in marked vehicles (4).

Shown in Table 4 are data for traffic enforcement for the April 1982 through January 1984 time period. The only category in which officers driving semimarked vehicles were more productive was in the issuance of speeding citations. The rate of 21.9 speeding citations per 100 hr of patrol in semimarked vehicles is significantly higher than the 17.7 citations per 100 hr for officers in marked vehicles. However, these same officers issued fewer citations for other violations. Therefore, with the exception of citations for speeding, the null hypothesis of no difference in productivity held.

An examination of police activity before the introduction of new vehicles, from 1979 to 1982, also showed no statistical differences between the two groups, even for speeding citations. While all the vehicles in this study had traditional State Police markings, semimarked vehicles did not readily appear to be police vehicles, particularly to approaching motorists. Because most officers use moving radar to enforce the speed limit, speeding motorists that are approaching police vehicles might be easier to detect from semimarked squads.

TABLE 4 Average Productivity of Officers in 1982 and 1983 Police Vehicles

	Vehicle Type: Marked	Semimarked	Average
Number of officers	91	99	190 (total)
Hours of patrol	2,509	2,162	2,328
Speeding citations			
Total number	444.0	474.4	459.8
Rate per 100 hr	17.7	21.9	19.8[a]
All citations			
Total number	667.9	641.3	654.0
Rate per 100 hr	26.6	29.7	28.1[b]
Including warnings			
Total number	1,894.6	1,615.4	1,749.1
Rate per 100 hr	75.5	74.7	75.1[c]
DUI citations	15.8	14.9	15.3

[a]t-test equals -2.42; significance equals $p < .02$ (deviations are not shown, but have been used for all t-tests).
[b]t-test equals -0.41; no significance
[c]t-test equals +0.45; no significance.

Police Vehicle Accidents

According to the analysis of police vehicle accidents in 1980, officers who drove marked vehicles were involved in a rate of accidents twice that of those who drove unmarked vehicles (1,p.8) (see Table 5). For every 100 marked vehicles, 26.9 were involved in accidents. The rate for unmarked vehicles was 11.7, or one accident for every 2.3 involving marked vehicles. Each of these vehicles had been driven on patrol for approximately the same number of miles.

TABLE 5 Involvement of Police Vehicles in Accidents During 1980

Vehicle Type	Accidents: Number	Accidents: Percent	Vehicles: Number	Vehicles: Percent	Rate of Accidents per 100 Vehicles
Marked	199	87.7	741	75.6	26.9
Unmarked	28	12.3	239	24.4	11.7[a]
Total	227		980		

[a]Chi-square equals 15.54; d.f. equals 1; $p < .001$.

The null hypothesis states that there should be no difference in the number of accidents for marked vehicles versus semimarked vehicles. A comparison similar to that of Table 5 is made in Table 6. Of the 49 accidents involving all vehicles issued since 1982 (1982 Fords and 1983 Dodges), 37 or 75.5 percent involved marked vehicles and 12 involved semimarked vehicles. On the other hand, more vehicles were semimarked. As a result, the rate of accidents for

TABLE 6 Involvement of Police Vehicles in Accidents During 1982 and 1983 (21 months)

Vehicle Type	Accidents: Number	Accidents: Percent	Vehicles: Number	Vehicles: Percent	Rate of Accidents per 100 Vehicles
Marked	37	75.5	80	38.5	46.3
Semimarked	12	24.5	128	61.5	9.4[a]
Total	49		208		

[a]Chi-square equals 12.14; d.f. equals 1; $p < .001$.

marked vehicles was 46.3 per 100 vehicles compared to 9.4 per 100 for semimarked vehicles. These data cover the 21-month period from April 1982 through January 1984. Therefore, the yearly rate of accidents per 100 marked vehicles was 26.5, which was similar to the accident rate for marked vehicles in 1980. On the other hand, the yearly rate of 5.4 accidents per 100 semimarked vehicles is lower than that of unmarked vehicles in 1980. The difference in rates is statistically significant at the .001 level.

In 1980, the ratio of accidents between marked vehicles and semimarked vehicles was 2.3 to 1. This ratio increased to 4.7 to 1 in the 1982 to 1983 period. The null hypothesis that there would be no difference in the rate of accidents was therefore rejected.

The number of accidents per million vehicle miles is shown in Table 7. The rate of accidents per million vehicle miles was 12.6 for marked vehicles and 4.4 for semimarked vehicles. Accidents involving marked vehicles resulted in higher repair costs and more personal injuries, although the differences were not statistically significant. No attempt was made to assign a cost to the injuries, but a comparison would not have been meaningful because there were no injuries to officers involved in accidents while driving semimarked vehicles.

TABLE 7 Other Characteristics of Police Vehicle Accidents

	Vehicle Type		
	Marked	Semimarked	Total
Accidents			
Total	37	12	49
Police service excluding patrol	10	3	13
Miles driven (000,000s)	2.94	2.73	5.67
Accidents per 1 million vehicle miles			
Total	12.6	4.4	8.7 (avg)
Police service	3.4	1.1	2.3 (avg)
Average accident costs	\$1,020	\$730	\$950 (avg)[a]
Injury to officer			
None	31	12	43[b]
Injury	6	0	6[b]
Average number of vehicles involved	1.7	1.7	1.7 (avg)[c]

[a]No significance.
[b]Not computed.
[c]No significance.

A detailed tabulation of accidents by type is shown in Table 8. The exclusion of accidents involving vehicles on patrol, vehicles used for miscellaneous business, and vehicles left unattended leaves a base of 13 accidents for both types of vehicles. Of these accidents, 10 or 77 percent involved marked vehicles, which is a base too small to be statistically analyzed.

TABLE 8 Types of Police Vehicle Accidents

	Vehicle Type	
	Marked	Semimarked
Number of vehicles	37	12
Police functions		
Accidents and violators	5	1
Emergency	3	1
Pursuit	2	1
Other functions		
Patrol	13	3
Unattended	8	1
Other	6	5

One concern expressed in the previous survey of officers was that the semimarked vehicles might be more vulnerable to accidents when parked at the scene of an accident. However, only one accident involved a semimarked vehicle and none involved a semimarked vehicle stopped behind a violator. Two accidents occurred in marked vehicles while an officer was handling another accident, and three occurred in traffic stops. Therefore, most of the accidents involved a marked vehicle from which an officer was conducting police business and that had the emergency lights turned on.

Were those officers who drove marked vehicles during the time of the study also involved in more accidents before the study? As is shown in Table 9, records showed that 207 of these 235 officers were involved in 106 accidents, all in marked vehicles, from January 1976 to April 1982. Even though the rate of accidents per 100 officers in marked vehicles during this study is higher than the accident rate for the other officers, the difference is not statistically significant. An analysis of the variance of repair costs also showed no statistical difference.

TABLE 9 Officer Involvement in Police Vehicle Accidents Before Study

Current Vehicle Type	Officers in Base	Accidents in Marked Vehicles		Rate of Accidents per 100 Officers
		Number	Percent	
Marked	102	57	53.8	55.9
Semimarked	105	49	46.2	46.7[a]
Total	207	106		

[a]Chi-square equals 1.29; d.f. equals 1; no significance.

As was shown previously, those officers currently driving semimarked vehicles were less likely to be involved in accidents during policing functions. The same patterns are not as evident when examining accidents prior to the study. It is shown in Table 10 that those officers currently driving semimarked vehicles also had a slightly better driving record.

TABLE 10 Types of Police Vehicle Accidents Before Study

	Current Vehicle Type	
	Marked	Semimarked
Number of vehicles	57	49
Police functions		
Accidents and violators	7	9
Emergency	11	4
Pursuit	10	7
Other functions		
Patrol	13	13
Unattended	7	4
Other	9	12

TABLE 11 Potential Savings if Marked Vehicles were Converted to Semimarked Vehicles (21-month period beginning April 1982)

Vehicle Type	Number of Vehicles	Miles Driven (000,000s)	Gallons Used	Operating Costs: Fuel	Operating Costs: Accident	Operating Costs: Total
Marked	80	2.94	236,900	$307,960	$ 5,590	$313,550
Semimarked	128	2.73	224,000	291,200	8,760	299,960
Actual cost	208	5.67	484,900	630,370	46,500	676,870
Potential cost	–	–	460,900	599,160	14,350	613,510
Potential savings	–	–	24,000	$ 31,210	$32,150	$ 63,360

[a]If converted to semimarked vehicles, based on actual costs incurred by semimarked vehicles.

However, the mileage driven relative to the number of accidents is unknown.

CONCLUSIONS

Accidents appear to be more likely to occur to officers driving marked vehicles; marked vehicles have poorer gas mileage; and there is no difference in productivity between the two test groups other than that officers who drive marked vehicles are less productive at enforcing the speed limit. The examination of fuel usage, productivity, and vehicle accidents involving these officers prior to receiving the new vehicles does not indicate a bias. Officers in each test group had similar driving records. Any differences found between the two groups in this study appear to be causally related to the use or lack of use of roof-mounted lighting equipment.

The findings in terms of operating costs and accident rates are important. Given an average reduction in fuel use of 118.5 gal for a fleet of 1,100 patrol vehicles, at a cost of $1.30 per gallon, a savings will result of approximately $169,400 per year, which is enough to purchase at least 16 new vehicles at the current market price. In addition, the cost of installing grille-mounted and rear window lights is less than $100 per vehicle. Aerodynamic lighting systems can cost more than $300 per vehicle.

The findings in terms of reduced accidents are even more critical. One of the strongest original arguments against the removal of light bars was officer safety. Roof-mounted emergency lights were supposed to help protect the officer. Yet, accidents involving semimarked vehicles resulted in substantially fewer injuries to officers driving those vehicles (as was shown in Table 7) than to officers driving marked vehicles. No cost was attached to injury in this study, because too few injuries occurred for an adequate analysis. However, any reduction in the injury rate increases the availability of manpower, reduces out-of-pocket costs, and reduces insurance costs.

Even if injuries are not considered, there is a difference in accident repair costs between the two sets of vehicles. Given the cost per accident for marked vehicles, repairs to the 12 semimarked vehicles could have cost more than $12,000. However, it actually cost $9,000 to repair these 12 vehicles, resulting in a savings of $3,000. Therefore, given the rate of accidents for semimarked vehicles, had all 80 marked vehicles been converted to semimarked vehicles, the savings in accident-related repair costs would have exceeded $32,150. A summary of total potential savings from the use of semimarked vehicles is shown in Table 11. The $63,360 savings for the 21-month period represents an average savings of $450 per vehicle per year based on the conversion of 80 marked vehicles to semimarked vehicles.

Why are semimarked vehicles safer? The officer quoted earlier in this paper implied that officers assume that roof-mounted emergency lights project unchallenged authority. However, the number of incidents in which police vehicles with roof-mounted lights apparently collided with other vehicles challenges this assumption. When the light bars are removed, an officer has to become a more cautious driver.

The use of light bars in urban regions was not discussed in this study because semimarked vehicles were placed only on rural patrol; no vehicles were sent to a metropolitan region. As was noted earlier, the review of fuel economy and accidents during 1980 did not show significant differences between marked versus unmarked vehicles in urban regions. The traditionalists' argument for roof-mounted lights apparently could not be overcome in urban regions. However, the success of semimarked vehicles has led to the issuance of semimarked vehicles in urban regions in 1984. Initial feedback from officers using these vehicles suggests that they accept them. Differences in operating costs, productivity, and accidents in urban regions will be the subject of a future report. Unfortunately, the vehicles were introduced in urban regions without establishing the same type of paired comparison used for the study of vehicles in rural regions.

The DSP now issues new semimarked vehicles as the standard State Police squad. Some officers, however, still prefer vehicles with roof-mounted lights. Because light bars are still on traded vehicles, these officers can be accommodated. However, if all vehicles in the patrol fleet (approximately 1,100) were semimarked, DSP could save more than $495,000 per year in fuel purchases and accident repair costs (based on a savings of $380 per vehicle per year). The increased availability of manpower because of the reduced number of injuries resulting from accidents is also significant, although difficult to quantify.

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The Applicability of a Motorcycle Headlamp Modulator as a Device for Enhancing Daytime Conspicuity

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ABSTRACT

Considerable research is needed before any positive steps are taken to further the general use of modulated high-beam headlamps as motorcycle conspicuity aids. Such research cannot proceed satisfactorily without rigorous measurements of the visual characteristics of a modulating device, which have so far been lacking. The purpose of this paper is to provide an example of such measurements and, in particular, to report on the measurements of the relevant photometric characteristics of the Q-Switch modulating device. The results of these measurements demonstrate that the device falls within the specifications recommended by the authors for an extended flashing-signal code to be used by motorcyclists and moped riders, and clearly show that measurements in field conditions will form an essential part of any future conspicuity program based on lights.

Flashing light signals are used extensively in the road environment. On vehicles they are used as turning indicators, hazard warning lights, and emergency vehicle identifiers. On the highway they are used to indicate roadside hazards, temporary construction work, railway crossings, and so forth. These diverse applications have the common purpose of alerting a road user immediately and certainly to an uncommon situation that is potentially hazardous or requires distinctive identification.

The use of flashing signals in the road environment has been reviewed by the authors (1). They proposed a coherent code of flashing signals for the traffic environment that encompasses and extends their applications to allow for the use of a modulated light device to enhance the conspicuity of motorcyclists, bicyclists, and moped riders. The problem of motorcycle conspicuity is widespread and important in many different countries (2-4), resulting in several investigations of the efficacy of headlamps, daytime running lights, and motorcyclist's clothing as aids to frontal conspicuity. The potential contribution of modulated lights is substantial. There have been some reports of promising conspicuity response effects from the use of modulated headlamps on motorcycles from Olson et al. (5).

Olson et al. compared many different types of conspicuity aids for day and night conditions, including low-beam, modulated high-beam, and reduced-intensity (10 percent) low-beam headlamps and various garments for conspicuity enhancement. They found that the modulated high-beam headlamp was the most effective daytime conspicuity aid evaluated. However, no details of the characteristics of the device were given.

Considerable research is needed before any positive steps are taken to further the general use of these devices as conspicuity aids. Such research cannot proceed satisfactorily without rigorous measurements of the visual characteristics of the modulating devices, which have so far been lacking. The purpose of this paper is to provide an example of such measurements and, in particular, to report on the measurements of the relevant photometric