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Regulating hours of work in the road haulage industry: The case for social criteria

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1. Introduction

Regulations governing hours of work in the road haulage industry, for example Regulation 543/69 of the European Economic Community (EEC), frequently make reference to the improvement of drivers' social conditions and the prevention of accidents due to fatigue. However, they are also influenced by economic considerations, for example the need to harmonise the conditions under which competition in the industry takes place. While these various factors may coincide in promoting the regulation of hours of work, the precise form the regulations are given may be determined by one set of considerations more than another. Thus regulations aimed at harmonising conditions of competition may not be framed optimally from the point of view of the safety or well-being of drivers. It is pertinent, therefore, to ask, first, to what extent evidence on safety was sought by the legislator; and second, what sort of psycho-social criteria such legislation should meet if it is to protect the safety and well-being of professional drivers and other road users. Such criteria might include: *(a)* safety, based on an objective assessment of the relationship between hours of work and actual risk of accident (or any other objective criterion of driving safety); *(b)* due regard for normal requirements concerning sleep, rest, hygiene and nourishment; and *(c)* a degree of congruence between the norms of work established by the regulations and the norms of social, domestic and occupational activity that are accepted in society at large. A final consideration concerning the impact and effectiveness of legislation is the question how far its provisions are enforced and actually do govern working practices. The table recapitulates the main provisions of a number of international and national conventions, laws, regulations and recommendations on hours of work and rest periods in road transport.

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Summary of the main provisions of selected regulations on hours of work and rest in road transport

Area regulated	United States Code of Federal Regulations Title 49	EEC Regulation 543/69	Amendments to EEC Regulation 543/69 effective from 29/9/86	ILO Convention No. 153	ILO Recommendation No. 161
Maximum daily driving period	10	8	9 (10 hours twice a week)	9 (average)	9 (average)
Maximum driving period without break	.	4	4½ (work time excluding waiting)	4 (5 in some cases)	4 (5 in some cases)
Maximum weekly driving period	.	48	90 per fortnight (weekly rest must be taken after 6 driving periods)	48 (average)	48 (average)
Working day	15 (maximum hours)	.	.	.	8 (average; maximum 10) ("normal hours", subject to exceptions)
Working week	60 (maximum) hours)	.	.	.	40 (average) ("normal hours", subject to exceptions)
Minimum daily rest	8	11 (8 in some cases)	11 (average over 2 weeks) (minimum 9 hours three times a week) (minimum continuous 8 hours; if rest period is broken minimum total is 12 hours)	10 (average) (minimum 8 hours twice a week)	11 (average)
Minimum weekly rest	.	29 plus daily rest	45 (average over 3 weeks) (minimum 36 hours continuous at home, minimum 24 hours continuous away from home)	.	24 plus daily rest (preferably on Sunday and at home)

2. Evidence on safety and the promulgation of legislation

Those who framed some of the earliest legislation, such as the 1933 Road and Rail Traffic Act in the United Kingdom, had little or no firm scientific evidence to guide them on the question of fatigue and safety, with the exception perhaps of various studies carried out during and after the First World War by the Industrial Fatigue Research Board in the munitions and mining industries. They are more likely to have relied on anecdotal evidence, of which much was presented to the Salter Conference on the Transport Industry (1932-33), and on their personal judgement. In the United States, on the other hand, the promulgation in 1939 of the Interstate Commerce Commission (ICC) Hours of Service Regulations (which established the ten-hour driving limit) was preceded by two National Safety Council reports issued in 1935 and 1937. The earlier of these reports concluded that driving excessively long hours was a common practice on American highways, but that total on-duty time (i.e. not just driving time), as well as other factors like alcohol and carbon monoxide, was an important determinant of fatigue. It also concluded that many motor vehicle accidents occur because drivers fall asleep or are so tired that they are unable to drive safely. The later report described the circumstances of accidents due to falling asleep: these could, according to the report, occur after any period of driving, and a large proportion involved inadequate sleep during the previous night or nights, a long period of time since the last sleep period, or long periods at the wheel without a break. Slightly later, Jones et al. (1941) published their field experimental study, which purported to show that various psychological functions related to driving deteriorated after prolonged hours of duty; their findings appear to have played a part in the adoption of the ten-hour limit prescribed by the American regulations.

Little further evidence was available by the time the 1968 Road and Rail Traffic Act was passed in the United Kingdom. Indeed, a leaflet issued in 1969 by the Road Research Laboratory concluded that "there is practically no evidence of any correlation between length of driving time and accidents *per se* or changes in driving behaviour involving increased risk" (Road Research Laboratory, 1969). However, it went on to argue for the ten-hour limit on daily driving periods as a "common sense limitation", invoking arguments primarily concerned with the need for an adequate amount of sleep and adequate rest breaks during the day. As for the Commission of the European Communities, it does not appear to have conducted any evaluation of the evidence or commissioned any research on the problem of fatigue and driving safety before the adoption of Regulation 543/69.

Thus the empirical support for the provisions of existing and past legislation has been rather thin, and only the ICC regulations in the United States can be said to have resulted from a coherent attempt to produce and evaluate pertinent evidence. As far as more recent efforts are concerned,

perhaps the most impressive programme of studies designed specifically to test the adequacy of a particular set of regulations has been that carried out in the United States by Human Factors Research Inc., for the Bureau of Motor Carrier Safety (Harris et al., 1972, and Mackie and Miller, 1978, in particular). The Bureau is presumably evaluating this evidence with a view to determining whether the United States regulations should be amended. European legislators seem to have shown rather less dynamic concern with the issue of fatigue and driving safety in the haulage industry. An ad hoc subcommittee of the Committee on Medical Research and Public Health of the EC Commission recently conducted a series of expert meetings on driving safety, but produced no really conclusive policy recommendations nor any commitment to commission or undertake further research. What it did produce was a very general set of guide-lines for future research. O'Hanlon (1979) remarks on the reluctance of the secretariat of the European Conference of Ministers of Transport to discuss or evaluate the EEC regulations in relation to safety, despite widely expressed dissatisfaction in the industry concerning their provisions.

If the evidence is rather mixed concerning the diligence with which legislators have sought empirical corroboration for their assumptions concerning the effects of fatigue, what of the other factors relevant to driving safety?

Social considerations concerned with better living and working conditions for drivers will of course overlap with the question of fatigue, which by its very nature is detrimental to the driver's well-being, and, when he is driving, may threaten his safety. However, they also involve broader aspects relating, in particular, to the discrepancy between the social norms that govern the pattern of work, rest and leisure in the haulage industry and those in other industries, a point that will be elaborated below. Here again, it is only fairly recently that a systematic investigation of the subject has been undertaken, and there is no way of knowing how heavily this consideration has weighed with the legislators.

It is clear that the drafting of regulations on drivers' hours of work and rest is a matter with important economic and commercial implications. Such regulations, together with those concerning driving speed and vehicle sizes and weights, set (or should set) limits on the driver's duty period and what can be done within it; thus they are a basic element in costs. This suggests that regulatory bodies have a considerable interest in harmonising those conditions which affect competition within a given market area; indeed, this has been a strong and explicit motive in the promulgation of EEC regulations (Gwilliam and Mackie, 1975). Furthermore, shorter working hours have often been proposed as one way of raising productivity through work intensification and a more efficient use of labour time (National Board for Prices and Incomes, 1967; Price Commission, 1978).

The issue here is not whether economy or safety has been the real reason behind the regulations – for they are not in fact mutually exclusive. Rather, it

is whether, if the regulations were inspired primarily by economic considerations, they also have the effect of enhancing safety and promoting the well-being of drivers. It is not a new issue, for it has been argued (Hart, 1959) that the 1933 Road and Rail Traffic Act in the United Kingdom made no contribution to safety in the haulage industry and was really designed to further the commercial interests of the larger haulage companies, represented by the Road Haulage Association, over those of the smaller, unorganised companies and owner-drivers. The essence of the larger hauliers' case was that excessive competition was making for extreme cost and rate-cutting, leading in turn to widespread bankruptcies as well as to excessive hours of work by drivers and poor maintenance of vehicles. The smaller haulage companies, in particular, were blamed for this allegedly dangerous situation.

One example of a tendency to give greater weight to economic considerations of competition than to the safety and well-being of the driver is afforded by the practice of setting limits on driving hours rather than on working time. As can be seen from the table, there is some divergence between the different legislative provisions not only in the maximum periods specified but in the relative weight given to curtailing driving hours and working hours. From the commercial point of view, it is time spent driving that is the crucial determinant of productivity in road transport. For the driver, on the other hand, it is time spent at work that more decisively affects his psychological and social conditions of existence. The greater weight given to the regulation of driving rather than working hours may well reflect the relative importance of these considerations in the legislator's mind. This question of the relative contribution of working and driving time to fatigue or safety is, of course, open to empirical investigation and will be taken up below.

3. Evidence on hours of work and driving safety

Evidence concerning the relationship between hours of work and risk of accident has only relatively recently become available, and is still by no means comprehensive. Four questions pinpoint the central issues raised by the relationship between working hours and safety. First, what is the link between working hours and accident risk? Second, are hours spent driving more important than total hours at work in determining accident risk? Third, how does the time of day (and in particular the timing and duration of the whole working shift) influence the risk of accident? Fourth, how does the pattern of work and rest over a period of several days or longer affect the risk of accident?

One of the main difficulties in constructing an index of safety lies in controlling for exposure – how many drivers are exposed to the risk of accident at a particular time of day or after a particular number of hours of driving. Various techniques have been applied: Harris et al. (1972), using

company records, constructed an index of exposure from the duration of the previous day's driving of each accident-involved driver; Mackie and Miller (1978) compared the actual trip duration prior to the accident with the total estimated duration of each trip had an accident not occurred; this information was provided by official accident report forms. Linklater (1980) also relied on estimates, in this case drivers' own estimates of their average weekly driving hours and their accident record over the previous two years. Others have resorted to independent samples to estimate exposure: Hamelin (1981) used a prior time-budget survey and a sample of driver records, while Mackie and Miller obtained their time-of-day exposure from a survey of driver log books. Pokorny et al. (1981) generated perhaps the most reliable exposure data, using the total number of scheduled hours for one bus company in which each driver rotated through all shifts and all routes. This is the only study of those mentioned here in which the authors corrected for distance travelled. To a large extent the quality of results obtained in these various studies reflects the strengths and weaknesses of the methods used.

Working or driving hours and accident risk

Three studies provide evidence of a relationship between hours of work or driving and the risk of accident (Harris et al., 1972; Mackie and Miller, 1978; and Hamelin, 1981). The first of these showed that, for one large trucking company, following a slight decline in the accident rate (per hour of driving) between the third and the sixth hour of driving, the risk increased at an accelerating pace up to the tenth (maximum) hour of driving, to a value nearly three times higher than expected on the basis of exposure. Unfortunately, the values for the longest trips were based on relatively small numbers of trips and accidents, and so were the least reliable; though the overall result showed a highly significant effect of hours spent driving, it is not clear what proportion of the chi-square value was contributed by the last few hours, where the differences were greatest. The data from two other smaller firms (one trucking, the other a bus operator) did not show as clear-cut a relationship, though for the latter accident risks significantly increased after driving longer hours in the case of older drivers and of night driving. The study by Mackie and Miller was conducted as a larger follow-up to that by Harris et al., using accident data compiled by the Bureau of Motor Carrier Safety. Separate analyses were made for accidents of different types – single-vehicle accidents, accidents involving other vehicles and those in which the driver was reported to have dozed at the wheel. All three analyses showed a significant effect of time spent driving, with the actual proportion of accidents (per hour of driving) exceeding the expected proportion after the fifth or sixth hour but tending to return to expected levels during the ninth and tenth hours of driving (and earlier in the case of other-vehicle accidents). The question arises whether this rather unusual pattern of accident risk could be due partly to a systematic bias in the reporting agency's estimation of the

likely duration of the trip had the accident not occurred. There are other possible explanations for the anomaly; for example, the data include both day and night driving and it is conceivable that night shifts may involve both fewer instances of very long driving hours (McDonald, 1980) and a higher accident rate. However, the clearest summary statistic emerging from the study is that twice as many accidents tend to occur during the second half of driving trips as during the first.

Hamelin (1981) gives figures that indicate a pronounced increase in accident risk when hours of work are long: the index of risk (derived from the frequency of accidents per hour worked) rises from a level of 0.75-0.92 (depending on the reference sample and on whether long- or short-distance hauls are involved) for work periods shorter than ten hours, to 1.1-1.36 for those between ten and 14 hours and to 2.07-2.65 for those exceeding 14 hours. Thus, when working hours exceed 14 the accident rate is 2.5 to three times that for work periods of fewer than ten hours. On the other hand, there was generally not a great difference between short- and long-distance driving operations.

While it is clear that there is a significant correlation between working or driving time and accident risk, the precise parameters of this relationship are not clear. The accident rate has been found to exceed expected levels after five, six or seven hours of driving, while in the case of working hours the threshold has been found to lie somewhere between ten and 14 hours. These conclusions are in general quite congruent with the experimental evidence on driving performance, physiological response and fatigue, though studies have run up against many methodological and interpretative problems (McDonald, 1984). Suffice it to say that the evidence of deteriorating performance associated with prolonged driving has implications for speed perception, steering control, vigilance, risk-taking and ability to interact with other vehicles. Admittedly, such effects have been most commonly (though not exclusively) found to occur when prolonged driving is associated with sleep deprivation or driving at night, or when it follows several days of prolonged driving.

Which to regulate: Working or driving time?

The evidence discussed above is inconclusive as to the respective contributions of driving time and working time to the risk of accident. There are logical reasons for supposing that hours of work must in themselves play an important part in determining the driver's state of well-being and fitness to drive. Any time spent at work is time that cannot be used for rest and relaxation. This applies even to comparatively idle periods on the job, e.g. when waiting (at a depot, or at customs), where the waiting time is unpredictable but the driver's presence is none the less required. Secondly, as will be argued below, what matters where hours of work are concerned is not just their duration, but the point in the daily (circadian) or weekly

(circaseptan) biorhythmic cycles at which they occur – this is important because it determines the physiological and social value of rest periods. One straw in the wind, so far as the relative importance of working and driving time as an accident risk factor is concerned, is the finding by McDonald (1980) that the readiness or otherwise of truck drivers to continue driving at the end of their shift was related rather more strongly to hours worked than to hours driven (r^2 of 21.5 and 15.6 respectively). Whatever weight one gives to this finding, the clear implication is that in the prevention of fatigue it is more important to control working than driving time.

Time of day and driving safety

The clearest evidence that time of day has a marked effect on accident risk comes from Hamelin's 1981 study, which showed that the accident risk for truck drivers at night is around twice as high as in daytime. Mackie and Miller (1978) found that, while accidents involving other vehicles tended to follow the diurnal distribution of truck traffic, there was a marked divergence in the case of single-vehicle accidents and more particularly accidents in which the driver had dozed at the wheel. In the former case, between midnight and 8 a.m. accidents were two and a half times more frequent than expected on the basis of the traffic distribution; in the latter, they were three-and-a-half times more frequent. This pattern has been confirmed by other studies. Thus McDonald (1984, p. 80) found that, among truck accidents (excluding those in which alcohol played a part), single-vehicle accidents and rear-end collisions were disproportionately common at night, both of these being types of accident with which fatigue has been associated. The classic study of car drivers' reports of falling asleep at the wheel is that by O. and L. Prokop (1955), which found that the majority of such cases occurred between 11 p.m. and 6 a.m., with a smaller peak (about a quarter of the accidents) in the early afternoon (between midday and 4 p.m.), no more than one-sixth having occurred in the remaining 13 hours. Thus, it is clear that driving at night involves a greater accident risk, especially as regards those accidents in which fatigue and falling asleep are implicated.

However, effects due to hours of work and time of day never occur in isolation. At any time in a work shift there will be a particular combination of factors – hours worked, time of day, time at which the shift started and timing and duration of the previous sleep period – all of which must be expected to affect the driver's susceptibility to fatigue and falling asleep. This is demonstrated by an interesting analysis of accidents involving buses by Pokorny et al. (1981).

This study found that *(a)* the early shift (starting between 5.30 a.m. and 10 a.m.) contributed a much higher proportion of the accidents (corrected for mileage covered) than the late shift (starting between 1 p.m. and 5 p.m.); *(b)* within each shift, earlier starting times were associated with higher accident rates; and *(c)* the two shifts differed quite markedly in the relationship

between hours of driving and accident rate. Higher accident rates in the late shift were confined to the early hours of driving duty, while in the early shift the peak rates were observed in the third and fourth hours and, to a lesser extent, in the eighth and final hour of the shift. The authors conclude that the hour of the day as such does not have a substantial impact on accident risk; more important were the hours of driving duty on particular shifts.

The drivers in this sample did not work for more than eight hours, nor between 1 a.m. and 5.30 a.m. Therefore the study cannot provide an accurate idea of the role of "fatigue" in the rather more rigorous conditions under which truck drivers normally work. However, the findings do suggest that the peculiar results of the analyses by Harris and Mackie and by Mackie and Miller might be due to the interaction of two or more distinct shift-related patterns, and they also suggest that if account was taken of the time of day during which the whole of the driver's shift was worked, rather than just the time of day of the accident, a much fuller picture of the contribution of shift work to accident frequency might emerge. Clearly, if the comprehensive statistics of the United States Bureau of Motor Carrier Safety (used by Mackie and Miller) could be adapted to this kind of analysis, it might begin to be possible to make a realistic assessment of the part played by shifts and by hours of work and driving in causing accidents. Meanwhile, the Pokorny study suggests at least that early morning starting times, with the disruption of sleep they usually entail, are a further risk factor deserving attention in relation to truck safety.

Fatigue and the working week

There is also the possibility that factors influencing the driver's well-being, and therefore his safety, may operate over a time span exceeding the 24-hour cycle – for example, the effects of prolonged work and inadequate sleep may accumulate over several days. Linklater (1980) found that, among a number of variables, average weekly driving hours, as reported by the driver, was the best predictor of probable crash involvement. The best discrimination between those who had no crashes over the previous two years and those who had at least one came at 55 hours per week. When exposure to risk (in terms of number of *working* hours) was taken into account the accident peak came in working weeks of over 55 and up to 74 hours, falling to a surprisingly low level thereafter. There is no obvious reason why the crash rate, per million driving hours, should fall off with very long working weeks, but several explanations can be suggested. First, there may be some statistical distortion due to the comparatively small number of drivers on very long working weeks. It is possible, too, that the sample may not have been drawn from a truly representative population, either because only the fittest drivers are likely to work very long hours, or because variations in working hours may be associated with major differences in the type of trucking operation. Finally, it is conceivable that a minority of drivers exaggerated

their typical weekly working hours. While there is no solid evidence to support these assumptions, there *are* indications suggesting that a driver's fitness may progressively deteriorate over several days of work and improve following several days of rest.

Mackie and Miller (1978) found evidence of more pronounced fatigue at the end of a week of "sleeper operations" (two drivers alternately driving and sleeping in the cab bunk during a long trip) than earlier in the week. This was inferred from the patterns of subjective ratings, catecholamine response, and heart rate and electroencephalographic changes. There is also evidence, from studies of locomotive drivers, that errors and near-accidents are due in part to influences extending over several days. Thus Kogi and Ohta (1975) found that drowsiness incidents, which were much more common during the night hours than during the day, occurred much earlier during the second night of duty (after two to three hours) than during the first night (after eight to 14 hours of duty). Furthermore, the duration of the previous rest period was found to have a bearing on errors by locomotive drivers (Hildebrandt et al., 1975). Less serious errors (leading to the sounding of a warning hooter) were rather frequent following rest periods of ten to 16 hours, falling to a low after 20 to 24 hours of rest, subsequently increasing to a further peak during the third day after the previous work shift, and thereafter declining again. Perhaps more significantly, more serious errors (leading to automatic braking of the locomotive) declined markedly with longer rest periods (exceeding 24 hours), though once more with a slight hiccup for shifts starting again on the third day following the previous shift. Thus long periods of weekly rest do appear to have a beneficial effect but, it seems, not an identical one on serious and on less serious errors.

4. Provision for rest, sleep, hygiene and nourishment

Shift work and night work are common in road transport; in many countries the amount of shiftworking in the transport and communications industries has been increasing (see, for example, European Foundation for the Improvement of Living and Working Conditions, 1978), yet the question of the arrangement of working shifts is not addressed in any of the instruments listed in the table. Thus, many shift arrangements exist which bear no relation to any ergonomic criteria for the protection of the health and well-being of the driver. An example is the following description by a driver of his shift system, as reported to the author:

> The shifts change every week, but not on a regular basis – I could come on one week at one minute past midnight, next week I could be on at 1 a.m., the week after that I could come back to 10 p.m. and then at midday, and then the week after it could be back to midnight. You are given a rota for the next three months but this is only a very rough guide to the time you could be starting. You know which route you will be on but not which time you will be starting (this could vary between 3 a.m. and midday) and within that week the time can vary a lot – you can start around 3 a.m. and end up starting around 8 a.m.

It is well established that periods of sleep taken during the day tend to be shorter and less beneficial than normal night sleep (see, for example, the study of train drivers on irregular schedules by Forêt and Lantin (1972) and that by Mackie and Miller (1978) on truck and bus drivers). Truck drivers, no less than other occupational groups, are susceptible to problems of adaptation to shift work (Adum, 1975).

An additional problem for many drivers in getting sufficient sleep is that in long-distance and international journeys they are often away from home and sleep in the cab bunk. This is not conducive to sound sleep. Insufficient ventilation means that it can be too hot in summer and too cold in winter; it is noisy if the engine has to be kept running (which is necessary in refrigerated trucks); and, if the truck has to be parked near moving traffic, there is additional noise, disturbance from lights, and maybe vibration from air displacement (Carré and Hamelin, 1978). Both Hamelin (1975) and Mackie and Miller (1978) found the period of sleep of drivers in cabs to be shorter than a normal night's sleep in bed: in the latter study a median duration of about six hours' sleep in cab berths compared with over nine hours at home during off-duty periods; "sleeper drivers" averaged between three and four-and-a-half hours of sleep, depending on the starting time of their driving period.

Carré and Hamelin (1978) also draw attention to the generally poor standards of hygiene and feeding facilities available to the driver, either en route, at the customer's depot, or at other places where time must be spent. The possible impact of diet and shiftworking on the health of drivers has been briefly reviewed by McDonald (1984).

It is thus clear, first, that the suitability of different times of day or night for purposes of rest, sleep or work varies in accordance with physiological factors associated with the circadian cycle and, second, that the physical conditions in which sleep takes place also affect its physiological value. Yet this major aspect of drivers' working conditions has not been taken into account in the relevant regulations.

5. Social norms of work and leisure

In many countries there has been a recent trend towards the reduction of working hours in road transport. There are, however, many exceptions and the norms of working time still frequently exceed by far those obtaining in other industries (ILO, 1984). The problem is exacerbated for many drivers who have to spend several days away from home. Surveys of the working hours of professional truck drivers in various countries have been carried out by Harris et al. (1972), Hamelin (1975), Böcher (1975) and McDonald (1978). Carré and Hamelin (1978) describe the working life of many long-distance drivers as consisting almost exclusively of working time and time devoted to the regeneration – through rest, sleep, food and hygiene – of the drivers' work capacity. There is no leisure except during the weekend, which

is the focus of all social and domestic activities (and may be ended prematurely by the resumption of work on Sunday night). Drivers therefore attach considerable importance to spending their weekends at home rather than having to guard their vehicle in some socially dead industrial zone.

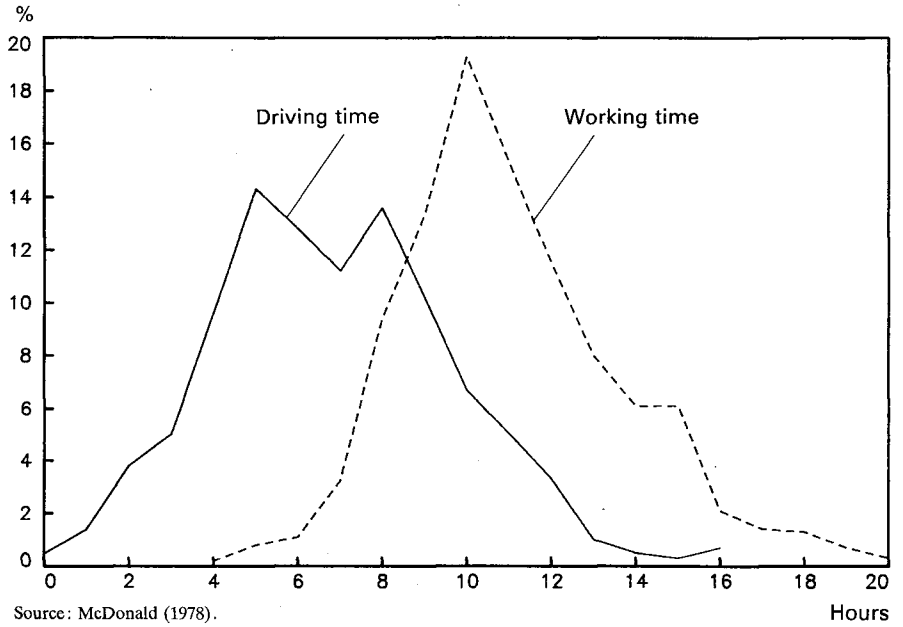
Drivers working shifts may have problems comparable to those of other shiftworkers in being required to work during evenings and at weekends, which for many shiftworkers means social isolation and domestic disruption (Carpentier and Cazamian, 1977).

Thus time also has a social value which varies during the day and throughout the week: this is another factor of which regulations governing drivers' hours should as far as possible take account.

6. Enforcement of the regulations

Regulations are obviously ineffective if they are not enforced or adhered to. The figure shows the distribution of daily hours worked and driven by a group of Irish drivers in 1976 (McDonald, 1978). The regulations at that time stipulated a maximum of 11 hours per day for driving and related work (loading, attendance, etc.): this does not appear to have affected the distribution of hours at all. The pattern of hours worked and driven is very comparable to that found by a survey carried out in France, where the EEC

Percentage distribution of days worked (n=875) by a sample of Irish truck drivers: Driving and working time



Source: McDonald (1978).

regulations applied (Hamelin, 1975). Carré and Hamelin (1978) point out that, where regulations ignore practical work requirements and come to be disregarded as a matter of routine, they become an additional source of stress for the driver rather than a protection. In such cases drivers see the authorities as hypocritical in that they seem to accept and recognise that the regulations are unrealistic and tend, by and large, to let things go – until they carry out a spot check that invariably results in penalising the driver.

In such a situation the driver feels himself to be the victim of circumstances beyond his control, paradoxically so because – where fatigue and fitness to continue driving are concerned – he is the best, and indeed the only judge. The onset of fatigue and drowsiness is a gradual process with easily recognisable symptoms (O. and L. Prokop, 1955) and people are sensitive to their state of fitness to drive (Nelson, 1981). The problem arises not because fatigue is a sudden or imperceptible phenomenon but because of pressure to carry on driving despite experiencing fatigue. Any set of regulations should emphasise the responsibility of drivers to stop driving under such circumstances, irrespective of the number of hours driven, thus asserting unequivocally the priority of safety over other goals.

7. Implications for the design of regulations

The drafting of appropriate regulations is hindered by the lack of evidence on a number of crucial issues. This is particularly true of the question of the effect of shift systems on driving safety, perhaps most importantly in relation to the interaction of hours of work and time of day, but also with regard to influences operating over a longer time scale. The most that can be deduced from the present evidence is that a relationship does exist between hours and accidents but there is no accurate method for estimating its quantitative parameters as a basis for a reasoned policy judgement. (And it has to be admitted that even when such information does become available it is unlikely to provide precise criteria for determining the optimal number of hours of work or rest.) There are, on the other hand, some issues on which general guide-lines can already be derived from the evidence available. These are briefly discussed below.

Night work

None of the regulatory texts summarised in the table takes into account the timing of work shifts within the circadian cycle; yet the evidence is clear that this is a major variable which affects driving safety. There are three main issues that need to be addressed: provision of adequate rest, problems of driving at night, and the possibility of selecting drivers who are less susceptible to the adverse effects of shift work.

Rutenfranz et al. (1976) have suggested that at least 24 hours of free time should be allowed after each night shift to permit proper sleep and

recovery. When this formula is applied to rapidly rotating shift systems it is not quite so disruptive of the sequence of work shifts as it would be in systems with a slower rotation. Moreover, it does underline the importance of providing the possibility for sleep to be taken at night and in proper accommodation with a high degree of frequency and regularity, as opposed to fitful sleep in a truck cab, for example, which cannot be considered an adequate substitute.

Two comparable approaches have been suggested in relation to working at night. Rutenfranz et al. suggest curtailing shift lengths to eight hours for most types of work. Gardell et al. (1982), in a study of local bus drivers, have proposed counting hours worked during the normal night-time hours (10 p.m to 6 a.m) as double daytime hours. Although driving at night, when there is less traffic congestion, is easier for many drivers, this alone cannot compensate for the extra strains imposed by night work, notably with respect to maintaining alertness and concentration at an inappropriate point in the circadian cycle. Indeed, for many drivers the relative absence of stimulation from road and traffic conditions at night may even prove an additional source of difficulty. Some adjustment in the calculation of working hours at night would therefore be of benefit. In the present state of evidence any particular computational mechanism would be arbitrary; but, to be comprehensive, it should take into account not only the length of shifts worked at night, but also the number of successive shifts and the need for adequate rest and sleep at appropriate times between shifts. Concerning selection, Rutenfranz et al. have identified various categories of workers for whom shift and night work is contra-indicated (the young, the old, those with certain diseases, or poor home accommodation). This might exclude some but not all who are susceptible to the adverse effects of shift work. Unfortunately, a more positive predictive criterion of fitness for shift work does not exist; so it is necessary to reinforce the possibility for transferring out of a job that requires working at night, and for taking early retirement, as appropriate.

Working and driving hours

Despite the absence of firm evidence concerning the parameters of the relationship between safety and hours worked or driven, it seems fair to say that moves to curtail working time (effectively done by increasing minimum rest periods) and to reduce the discrepancy between permitted driving times and working times are appropriate means of promoting safety. It is worth mentioning that in the United Kingdom the 1968 Transport Act cut working hours to 11 per day, which is less than those implicitly permitted by the EEC regulations in their minimum daily rest provisions.

Social and domestic life

Regulations governing hours of work should recognise the importance of social and domestic life and acknowledge that time has a social value, which rates highly on evenings and at weekends (Wedderburn, 1981). Among the various standard-setting texts, the ILO's Hours of Work and Rest Periods (Road Transport) Recommendation, 1979 (No. 161), seems to be alone in incorporating this notion when it stipulates that the weekly rest period should as far as possible coincide with a Sunday or with traditional and customary days of rest, and should preferably be spent at home. Here we see a clear expression of the social goal of bringing the working and living rhythms of professional drivers more closely into line with those of the rest of the community.

* * *

In conclusion, if there are any issues that stand out more starkly than others, they can be summed up by reference to the threefold need: for better monitoring and investigation of professional drivers' safety problems (this is important from the point of view of other road users as well); for more effective commissioning of research on policy issues relevant to the regulatory process; and for regulations framed with a clearer relationship to objective criteria of driving safety.

References

Adum, O. 1975. "Shiftwork of professional drivers", in W. P. Colquhoun et al. (eds.): *Experimental studies of shiftwork*. Opladen, Westdeutscher Verlag.

Böcher, W. 1975. *Untersuchungen über das Berufsbild des Lastkraftwagenfahrers*. Cologne, Technischer Überwachungs-Verein Rheinland e.V. Medizinisch-Psychologisches Institut.

Carpentier, J.; and Cazamian, P. 1977. *Night work: Its effects on the health and welfare of the worker*. Geneva, ILO.

Carré, J. R.; and Hamelin, P. 1978. *Rapports sociaux de production, mode de régulation et conditions de travail des conducteurs routiers*. Montlhéry, Organisme national de sécurité routière.

European Foundation for the Improvement of Living and Working Conditions. 1978. *The spread of shift work in the European Community: Ireland*. Dublin.

Forêt, J.; and Lantin, G. 1972. "The sleep of train drivers: An example of the effects of irregular work schedules on sleep", in W. P. Colquhoun (ed.): *Aspects of human efficiency*. London, English Universities Press.

Gardell, B.; Aronsson, G.; and Barkloff, K. 1982. *The working environment for local public transport personnel*. Stockholm, Swedish Work Environment Fund.

Gwilliam, K. M.; and Mackie, P. J. 1975. *Economics and transport policy*. London, George Allen and Unwin.

Hamelin, P. 1975. *Conditions de travail des conducteurs professionnels et sécurité routière*. Montlhéry, Organisme national de sécurité routière.

–. 1981. "Les conditions temporelles de travail des conducteurs routiers et la sécurité routière", in *Le travail humain* (Paris), Vol. 44, No. 1, pp. 5-21.

Harris, W., et al. 1972. *A study of the relationships among fatigue, hours of service, and safety of operations of truck and bus drivers.* Report 1727-2, prepared for the Bureau of Motor Carrier Safety, US Department of Transportation. Goleta, California, Human Factors Research Inc.

Hart, P. E. 1959. "The restriction of road haulage", in *Scottish Journal of Political Economy* (Edinburgh), June 1959, pp. 116-138.

Hildebrandt, G.; Rohmert, W.; and Rutenfranz, J. 1975. "The influence of fatigue and rest period on the circadian variation of error frequency in shift workers (engine drivers)", in Colquhoun et al., op. cit.

ILO. 1984. *General report*, Report I, Inland Transport Committee, 11th Session, Geneva, 1985. See also *Occupational safety and health in road transport*, Report III.

Jones, B. F.; Flynn, R. H; and Hammond, G. C. 1941. "Fatigue and hours of service of interstate truck drivers", in *Public Health Bulletin* (Washington, DC), No. 265.

Kogi, K.; and Ohta, T. 1975. "Incidence of near accidental drowsing in locomotive driving during a period of rotation", in *Journal of Human Ergology* (Tokyo), Sep. 1975, pp. 65-76.

Linklater, D. R. 1980. "Fatigue and long distance truck drivers", in *Australian Road Research Board Proceedings* (Nunawading, Victoria), Vol. 10, No. 4, pp. 193-201.

Mackie, R. R.; and Miller, J. C. 1978. *Effects of hours of service, regularity of schedules and cargo loading on truck and bus driver fatigue.* Technical report 1765-F. Goleta, California, Human Factors Research Inc.

McDonald, N. J. 1978. *Fatigue, safety and the working conditions of heavy goods vehicle drivers.* Ph.D. thesis. Dublin, Trinity College.

–. 1980. "Fatigue, safety and the industrialisation of heavy goods vehicle driving", in D. J. Oborne and J. A. Levis (eds.): *Human factors in transport research*, Vol. I, pp. 130-132. London, Academic Press.

–. 1984. *Fatigue, safety and the truck driver.* London, Taylor and Francis.

National Board for Prices and Incomes. 1967. *Charges, costs and wages in the road haulage industry.* Report No. 48. London.

National Safety Council. 1935. *Too long at the wheel.* Chicago.

–. 1937. *How long on the highway?* Chicago.

Nelson, T. M. 1981. "Personal perceptions of fatigue", in H. C. Foot, A. J. Chapman and F. M. Wade (eds.): *Road safety: Research and practice*, pp. 181-188. Eastbourne, Praeger.

O'Hanlon, J. F. 1979. *The failure of EEC Regulation 543/69 to prevent serious consequences of fatigue in European commercial vehicle operations: An American's opinion.* Groningen, Rijksuniversiteit.

Pokorny, M. L. I.; Blom, D. H. J.; and Van Leeuwen, P. 1981. "Analysis of traffic accident data (from bus drivers) – An alternative approach", I and II, in A. Reinberg, N. Vieux and P. Andlauer (eds.): *Night and shift work: Biological and social aspects*, pp. 271-286. Oxford, Pergamon.

Price Commission. 1978. *The road haulage industry.* London, HMSO.

Prokop, 0.; and Prokop, L. 1955. "Ermüdung and Einschlafen am Steuer", in *Deutsche Zeitschrift für gerichtliche Medizin*, Vol. 44, pp. 343-355.

Road Research Laboratory. 1969. *Fatigue and the drivers of heavy commercial vehicles.* Report LF 138. Crowthorne, Berkshire.

Rutenfranz, J.; Knauth, P.; and Colquhoun, W. P. 1976. "Hours of work and shiftwork", in *Ergonomics* (London), May, pp. 331-340.

Wedderburn, A. 1981. "Is there a pattern in the value of time off work?", in Reinberg et al., op. cit., pp. 495-504.