EUROPEAN CONFERENCE OF MINISTERS OF TRANSPORT

SOCIAL ASPECTS OF ROAD TRANSPORT

EUROPEAN CONFERENCE OF MINISTERS OF TRANSPORT

SOCIAL ASPECTS OF ROAD TRANSPORT

ECMT

EUROPEAN CONFERENCE OF MINISTERS OF TRANSPORT (ECMT)

The European Conference of Ministers of Transport (ECMT) is an inter-governmental organisation established by a Protocol signed in Brussels on 17 October 1953. It is a forum in which Ministers responsible for transport, and more specifically the inland transport sector, can co-operate on policy. Within this forum, Ministers can openly discuss current problems and agree upon joint approaches aimed at improving the utilisation and at ensuring the rational development of European transport systems of international importance.

At present, the ECMT's role primarily consists of:

– helping to create an integrated transport system throughout the enlarged Europe that is economically and technically efficient, meets the highest possible safety and environmental standards and takes full account of the social dimension;

– helping also to build a bridge between the European Union and the rest of the continent at a political level.

The Council of the Conference comprises the Ministers of Transport of 39 full Member countries: Albania, Austria, Azerbaijan, Belarus, Belgium, Bosnia-Herzegovina, Bulgaria, Croatia, the Czech Republic, Denmark, Estonia, Finland, France, the Former Yugoslav Republic of Macedonia (F.Y.R.O.M.), Georgia, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Moldova, Netherlands, Norway, Poland, Portugal, Romania, the Russian Federation, the Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Turkey, Ukraine and the United Kingdom. There are five Associate member countries (Australia, Canada, Japan, New Zealand and the United States) and three Observer countries (Armenia, Liechtenstein and Morocco).

A Committee of Deputies, composed of senior civil servants representing Ministers, prepares proposals for consideration by the Council of Ministers. The Committee is assisted by working groups, each of which has a specific mandate.

The issues currently being studied – on which policy decisions by Ministers will be required – include the development and implementation of a pan-European transport policy; the integration of Central and Eastern European Countries into the European transport market; specific issues relating to transport by rail, road and waterway; combined transport; transport and the environment; the social costs of transport; trends in international transport and infrastructure needs; transport for people with mobility handicaps; road safety; traffic management; road traffic information and new communications technologies.

Statistical analyses of trends in traffic and investment are published regularly by the ECMT and provide a clear indication of the situation, on a trimestrial or annual basis, in the transport sector in different European countries.

As part of its research activities, the ECMT holds regular Symposia, Seminars and Round Tables on transport economics issues. Their conclusions are considered by the competent organs of the Conference under the authority of the Committee of Deputies and serve as a basis for formulating proposals for policy decisions to be submitted to Ministers.

The ECMT's Documentation Service has extensive information available concerning the transport sector. This information is accessible on the ECMT Internet site.

For administrative purposes the ECMT's Secretariat is attached to the Organisation for Economic Co-operation and Development (OECD).

Publié en français sous le titre :
ASPECTS SOCIAUX DU TRANSPORT ROUTIER

Further information about the ECMT is available on Internet at the following address:
http://www.oecd.org/cem/

ECMT Publications are distributed by:
OECD Publications Service,
2, rue André Pascal, 75775 PARIS CEDEX 16, France.

FOREWORD

As part of the ECMT's activities, a survey on the social aspects of road transport was launched at the beginning of 1998. It covered national definitions of professional drivers' working hours and rest periods, the correlation between working hours and pay, social provisions and drivers' training.

In view of the diversity of the replies received and their lack of homogeneity, and the work under way in the European Union, the Conference decided to suspend its work on the issue pending the outcome of discussions at the level of the fifteen European Union Member countries.

However, given that the ECMT has for many years been conducting transport economics research for the purpose of informing the policy discussions of its Council of Ministers, it seemed useful to organise, within the framework of its research activities, a seminar on **the social aspects of road transport.**

This seminar, which brought together experts, and members of the ECMT's Group on Road Transport, led to a draft Resolution which is to be discussed at the next meeting of the ECMT Council of Ministers in Warsaw in May 1999.

Failure to respect certain basic rules of human physiology places road users at risk. Among the factors that cause accidents are not only driving time or lack of rest but also the length of the working day, the frequency of night work, etc. A tendency to overstep the regulations in these areas is deeply entrenched in the road haulage sector. This said, the issue is one that cannot be analysed rapidly. All the ins and outs need to be looked at. It is also necessary to address drivers' pay and training, controls and regulations, and the impact of technological progress.

The social aspects of road transport are thus not confined to regulations regarding driving time or rest periods. It is necessary to go beyond these questions -- which, moreover, often prevent progress from being made elsewhere -- and to try to grasp the issue as a whole.

TABLE OF CONTENTS

SUMMARY OF DISCUSSIONS

On 14 and 15 December 1998, the ECMT held an international seminar in Paris on the social aspects of road transport. The seminar opened with papers by Mrs. C. Garo (D) and Messrs. P. Hamelin (F), T. Åkerstedt (S), N. McDonald (IRL), F. Van Ouwerkerk (NL), J. Burnewicz (PL), J. Palfavi (H) and W. Smolders (IRU).

The Seminar took as its starting point the fact that the road transport sector was relatively disparate. There was a wide variety of services and the sector was divided into numerous segments and niche markets. Furthermore, small companies operated alongside much larger enterprises offering different types of service. However, regardless of the type of enterprise, drivers in the road transport sector worked very long hours and the sector ranked high in terms of the number of work-related accidents.

The social aspects of road transport are also an issue frequently in the public eye as a result of strike actions by professional drivers, which in some countries have brought the entire road network to a standstill.

After a day and a half of discussions, chaired by Mr. G. Dobias (F), the Seminar reached a number of conclusions that can be presented under three headings:

1. Working conditions and regulations.

2. Access to the profession and the future of the latter.

3. The role of public authorities and inspections.

1. Working conditions and regulations

Scientific studies and investigations of lorry drivers' working hours confirm that fatigue and stress among professional drivers are linked to irregular shift patterns, night driving, long working hours and not simply to the number of hours actually spent driving. All of these factors have a negative impact not only on road safety but also on safety at work when drivers are not driving, notably when the latter are involved in loading and unloading operations. Fatigue arises from the fact that drivers must perform a number of constraining activities and various surveys, particularly in France, have shown that over the period 1975 to 1996 there has been little change in this respect. The overall length of working hours has remained stable and on average is over 50 per cent higher than in other sectors of the economy. Working hours are also spread widely over the working day. If there is one major factor in accidents that merits attention, it is the risk associated with night driving which runs counter to the normal cycle of human metabolism. After a driver has remained awake at night for a certain period of time, the risk of an accident increases two-fold. Ultimately drivers' know-how and experience can compensate for this higher level of risk, although the risk is simply shifted, for example, onto loading and unloading activities. Every prior action has implications for the following one. Moreover, regulations on driving hours may in some cases allow substantial changes to be made

every day to the time when rest periods are permitted. The irregular pattern of work cycles is harmful to both the health and safety of drivers. It should also be noted that when working hours are organised into regular shifts, the corresponding working times are shorter. In contrast, the high volume of night driving may be explained by the fact that driving conditions are far better at night and by the fact that loading and unloading operators usually take place during the day.

The road transport sector would seem to be cursed by the fact that in many cases only the time spent driving is treated as working time. And yet the time that drivers spend on checking their vehicles and loads, which means that they are still involved in work activities, cannot be considered as free time. Properly defined working hours have been established in other areas of the transport sector (e.g. air, rail and maritime transport) and there is no fundamental reason why a similar outcome could not be achieved in the road transport sector by taking account of the number of hours drivers remain at the disposal of their employers. During these hours drivers are not driving, but are busy loading or unloading their vehicles or waiting for formalities or vehicle maintenance to be completed. The notion of time on duty, during which drivers perform tasks useful to their employers, might perhaps help to resolve any problems that may arise. It would also help to avoid confusion over wage issues, which far too often encroach on and cloud the debate over the definition of working hours. Besides these considerations, salaried and self-employed drivers need to be treated equally in order to avoid distortion between own account and hire and reward services, and size of firm should no longer be used as a criterion. Furthermore, it is unfortunate that the problem of scheduled passenger bus services at the local level has not been adequately taken into account hitherto.

It is proposed that the ECMT, working in collaboration with the IRU and union organisations, draw up a guide to the ways and means of organising work in a manner that would lessen the adverse impacts on road safety mentioned above. This information could be used in initial and continuing training courses for drivers and heads of companies. This training should address the connections between work organisation, fatigue and the implications with regard to safety. Better instruction in regulatory requirements can help to improve the conditions under which road transport services are provided in that a lack of understanding simply exacerbates the perceived complexity and usefulness of regulations. It is essential to draw up a code of good practice with regard to all these issues and to ensure that it is widely disseminated and applied. Capitalising on the expertise available to draft such advice constitutes a feasible objective. What matters here is to put in place, through both regulatory and conventional instruments, rules for training in greater depth at the beginning, during and at the end of drivers' careers.

The diversity of national situations and regulations in Member countries will ultimately require harmonisation through regulatory means of the length of driving and working hours of drivers employed by firms and by self-employed drivers. The road transport sector is attempting to strike a balance between safety, which requires a better distribution of working hours, and the flexibility needed to adjust to the economic cycle.

Observations of working conditions reveal that, on average, the working time spent on loading and unloading operations amounts to at least a third of driving time and are in addition to that time. It is very easy to accumulate 48 hours of working time per week with significantly fewer hours of driving than the amount permitted under European regulations (36 hours to be precise).

Regulations regarding driving times must not be abandoned, instead they should be reviewed and amended to ensure that regulations on driving and working times are mutually consistent. Efforts should also be made to eliminate exemptions. As a general rule, regulations must not be too complex and should remain simple, readily understandable and easy to apply. It must also be possible to check compliance with regulations.

It is equally clear that Regulation 3820, the principle of which is of paramount importance, could benefit from being updated in accordance with the jurisprudence established by the European Court of Justice in its decisions to ensure that rest periods are better spaced with regard to working hours and easier to verify. The work on introducing this urgently needed update must take account of regulations relating to working times. While the principle enshrined in Regulation 3820 is fundamentally sound, the provisions of this Regulation are too complex to allow compliance to be satisfactorily verified by means of tachographs.

The draft European Community directive on working times markedly improves working conditions in the road transport sector by taking account of hours spent driving at night. Ideally, however, a long rest period should precede work at night. It would be worth seeing whether the concept of time on duty discussed earlier, which includes the time during which drivers are available to employers, might not perhaps be the most appropriate one to adopt in view of the way in which road transport is actually organised. In this respect, it is also of paramount importance that daily and weekly rest periods be properly defined.

European regulations would do well to distinguish between drivers whose work is organised into daily shifts and those whose work entails longer periods away from home.

Extending regulations on working times to non EU Member States would be advisable for those countries wishing to apply for EU membership. It is important to send a signal to these countries so that they can start preparing for the introduction of such regulations.

In contrast, it was recognised that relations between all the parties to a transport contract must be based on standardised contracts that can be used to prosecute freight forwarders, when necessary, in cases where a transport plan which fails to comply with regulations is accepted in response to pressure exerted by those awarding contracts. There is an equally urgent need to define the responsibilities of employers, since in far too many cases it is the drivers who find themselves in the firing line. It is a fact that different forms of organisation are starting to emerge (firms with drivers, firms without drivers, firms without vehicles, vehicle rental firms, etc.) and a clear demarcation of responsibilities, according to specific circumstances, is now essential.

It should be noted that growth in just-in-time logistics has brought added pressure to bear on drivers to meet deadlines. At the same time, drivers have lost ground in terms of their freedom to take decisions, now that they are increasingly bound by logistical imperatives. In contrast, the emergence of new information technologies is having the opposite effect and may help to redefine the profession.

2. Access to the profession and the future of the profession

Road transport suffers from the poor perception of the sector by employees, which results in a high rate of employee turnover. During periods of high economic growth, it is difficult to hire drivers and this trend may well be exacerbated by predicted demographic changes and reductions in working hours. Furthermore, unlike the situation in other sectors, temporary work is unsuitable for the transport sector. This means that the labour market is particularly competitive for drivers in the 30 to 35-year old range with five years' experience; indeed, drivers in this category frequently change employer.

Despite all these problems, the road transport sector is a net creator of jobs. These jobs, however, are notable for their difficult working conditions -– particularly with regard to long-distance lorry drivers who must accept long periods away from home –- and the lack of any clear career prospects for

drivers. It is important that all actors in the profession help to forge a new image for the profession, a long-term endeavour that will require high levels of qualification for drivers. It is also worth noting the strong demand from drivers for further training.

Practical guides to methods of work organisation may help to rebuild a positive image of the profession of lorry driver. These practical guides should also provide instruction in contingency management. Often drivers find themselves confronted with an unexpected situation to which they must respond. Practical experience of difficult situations is a basic requirement for drivers, which means that the job of lorry driver is highly demanding in terms of practical skills. Recognising these requirements is the first step towards reburnishing the image of the profession.

To make careers attractive, and to ensure that they do not consist solely of driving, improving initial and continuing training may prove to have an important role to play. The ultimate objective should be to redefine the skill levels of the profession. The sector, which is characterised by very high mobility and a short professional working life, must provide a future for employees outside the profession. But this will not be possible unless the profession itself is redefined. At present, the social status of a professional driver is no longer associated with that of an exciting profession.

There are two major challenges in the provision of professional training for drivers: finding the means to enhance the professional attributes of lorry driving, and ensuring greater safety at work.

With regard to remuneration, it is clear that while the size of firms is not a determining factor in the length of working hours, it is with regard to wage levels. It should also be noted that wage differentials between lorry drivers and workers in other professions are tending to decline. Drivers are encouraged to move to larger firms where from a tax standpoint they benefit from better mileage allowances.

3. The role of the public authorities and inspections

In response to the opening of borders and markets, a number of enterprises decentralised their operational base by setting up subsidiaries in the countries where their clients were located. By way of an illustration, while social legislation is intrinsically national, drivers are transnational actors. This means that enterprises will be likely to take advantage of disparities in social protection and wages to set up branches in countries where wage costs are lowest. The public authorities must be careful not to create a market economy that might function without rules, which would penalise the most vulnerable wage-earners. Despite this consideration, international trade is based on cost disparities and specialisation by countries. Greater freedom of trade is accompanied by gains in economic wealth and the stimulation of innovation. Furthermore, wage differences across countries are steadily declining, which means that comparative advantages are not set in stone. All countries can benefit from international trade provided that stable and clear rules are put in place to govern trade. The existence of competitive disparities between countries is not limited exclusively to the transport sector, which means that there is no reason to exaggerate the importance of this factor. However, such disparities should encourage efforts to harmonise social requirements, in terms of the management of firms and employment of workers, regardless of the country concerned.

Regulations must be drafted in such a way that compliance can be verified. From this standpoint, it is important to specify clearly the aims of inspections. Each State must be aware of the need to verify compliance. Inspections and monitoring must be effective, which means that sanctions must serve as an effective deterrent. For example, the temporary suspension of a enterprise's operating licence may successfully curb repeated infringement of regulations by certain company managers. It is also

important to harmonise sanctions internationally in order to ensure that conditions of competition are non-discriminatory. Sanctions must also be commensurate with the frequency and seriousness of infringements. It might prove effective to draw up a list of offences and provisions should be made to allow firms committing offences abroad to be similarly prosecuted in their home country.

Above all, emphasis should be placed on the enforcement of existing regulations and on how means of ensuring compliance with new regulations. The scale of inspections must also be standardised across countries by setting minimum rates of inspection. The figure mentioned in this respect is inspection of 1 per cent of all transport operations. Inspections must also be applied fairly, that is to say they should target as many domestic as non-resident operators and should be carried out both within enterprises and one the road since these two types of inspection are complementary. It would be well to initiate genuine co-operation between the inspection agencies in different countries and between the latter and the competent legal bodies, since it is important to effectively raise awareness of the impact that working conditions can have on safety.

The use of new technologies is an avenue whose importance should not be neglected. Such technologies can assist drivers with driving operations or warn drivers when driving conditions are no longer safe. They can also help with the inspection of transport operations. What is important is to demonstrate, through full-scale trials, that new technologies can offer added advantages. In order to sway opinion, it is important to make clear what we expect of new technologies. New technologies can not only enhance safety or the organisation of work, they can also improve working conditions, for example, by allowing transport documents to be issued automatically. With regard to these issues, the important thing is to clearly demonstrate the effectiveness of new technologies.

THE WORKING CONDITIONS OF HGV DRIVERS

E. Frieling, P. Kiegeland, and C. Garo
Institut für Arbeitswissenschaft der Universität Gesamthochshule, Kassel, Germany

General context

The context in which heavy goods vehicle (HGV) drivers operate cannot be considered static. Political developments, market requirements, technical progress, new legislation and collective agreements – to name but a few contributing factors – reshape the social conditions under which drivers perform their daily work. The following discussion focuses on changes that have recently affected the vocational profile and the work content of this particular occupation.

Deregulation

In Germany, the deregulation of transport services in the goods haulage industry is regarded as the most significant change that has occurred in transport and logistics over the past few years. In the past, the German haulage industry was largely protected from the usual market forces by a system of licences granted by the State which limited transport supply and capacity, on the one hand, and the so-called *Reichs-Kraftwagen-Tarif*, which guaranteed haulage companies stable prices for the services they provided, on the other.

The deregulation of the road freight market in the context of European integration was to put an end to this privileged situation. Whereas fixed rates had applied in the past, freight prices between shippers, freight forwarders and final consignees became freely negotiable. At the same time, transport supply increased rapidly with the disappearance of compulsory concessions. After cabotage was liberalised, foreign hauliers rushed into the German freight market. Indeed, because their cost structure was more advantageous than that of their German competitors, they easily underbid German haulage companies. These combined to increase competition in the sector dramatically. The fact that the transition from a regulated to a deregulated transport market took place gradually did not help very much to soften the shock.

The changes in market conditions soon triggered a drastic transformation in the structure of the road transport industry. Whereas in the past this sector was characterised by small and medium-sized businesses, a dynamic process of concentration began. Small businesses merged into bigger ones, and large road transport groups gained in influence and tried to consolidate their position on the market by improving the range of services offered (Deecke *et al*., 1991; Plehwe, 1993).

At the same time, the industry made – and is still making – efforts to externalise risks related to the transport of goods. Consequently, a number of larger companies chose to reduce their fleet to a minimum that would presumably still allow them to operate to capacity. Further demand for transport

services is being increasingly dealt with via subcontractors, the so-called owner-operators. These "one-man businesses" are traditionally run by self-employed drivers whose independence is, more often than not, pure illusion. Indeed, they are strongly bound to a particular freight forwarder by contract but still have to shoulder all the risks related to the transport business, such as fluctuating demand for freight services due to seasonal variations, with the result that they often cannot operate to full capacity. They may also have to bear other risks such as contractual penalties for delays in delivery, the usual business risks and –- last but not least -– other consequences in case of infringement of current social regulations. Salaried drivers are often encouraged by their employers to work for their own account and purchase the lorry they have driven at the firm at a "bargain price". Yet, when the first repairs on the vehicle become necessary, the reality of the situation can be harsh for the would-be independent haulier.

On the whole, the economic situation in road transport has become more difficult and more complex than ever before. This has not only brought about far-reaching changes in the structure of the sector but also in the working conditions of HGV drivers.

Logistics

Considering all the political and market-related changes that have recently occurred, one can reasonably expect that the demand for transport services will continue to grow (Florian, 1993). Among the main reasons for this expansion are the creation of the single European market, which has facilitated goods exchange within the EU, and the opening of eastern European markets. Several surveys forecast an annual growth rate of 2 per cent (Brilon and Schnik, 1990) or 3 per cent (Deutsche Bank, 1990) between 1990 and the year 2000. However, due to political developments at the beginning of the decade (reunification of Germany, emergence of new states in eastern Europe, collapse of the Soviet Union as an entity, adjustment from a state-planned economy to a functioning free-market economic system in those states), the rate is likely to be much higher than earlier predicted (Ernst and Grasslander, 1993).

The volume of freight conveyed by other transport modes (road, rail, air and waterways) will not rise in the same proportions. The biggest increase (+ 21.2 per cent) is expected in long-distance goods haulage, and the smallest (+ 1.2 per cent) should occur in rail transport (Rommerskirchen *et al*., 1989.8; Baum, 1989).

The impact on the transport industry is likely to be qualitative as well as quantitative. Changing demands by charterers and consignees are forcing haulage companies to adapt and extend the range of services they provide. The main requirements are expected to concern the following issues (Florian, 1993; Deecke *et al*., 1991):

- higher quality in terms of punctuality, reliability, and level of damage during transport;
- extra service such as commissioning, collection of outstanding accounts, pick-up service for used packaging;
- more flexibility (express pick-up or delivery service on any route at any time);
- more goods exchanged, higher freight volume and higher rate of deliveries, alongside a reduction in consignment size;
- harmonisation of information and communication systems to meet European standards and norms;
- need for "intercultural" harmonisation owing to cultural and national differences and lack of co-ordination.

In a context of growing traffic congestion, increased strain on the environment and higher financial risks, transport companies must still be able to fulfil customer demand and manage crises whenever transport chains are disrupted (traffic collapse, just-in-jam rather than just-in-time).

Finally, charterers expect to pay the lowest possible rate for goods transport. In the near future, haulage companies will inevitably have to offer a wider and improved range of services in terms of quality at a much lower price. Although the implications of this state of affairs are felt throughout Europe (Gressel, 1993), German transport companies have been affected most because of the general economic context in which they usually operate: high labour costs, a relatively strong currency and a heavier tax burden than in other EU countries. Indeed, they can no longer run their businesses in the usual way: globalisation, increasing freight volume, diversification of services, and tougher competition are terms that spring to mind to describe the situation (Dankwerts, 1993; Dankwerts *et al*., 1992).

The expected implications of this new situation and the ways is which the road transport industry can react to it are issues that may be raised at this stage. In 1991, Deecke *et al*. established a list of possible scenarios:

- courier services and specialised providers will increase their market share;
- firms from other transport-related fields will enter the haulage market (air freight forwarders, shipowners);
- larger forwarding groups will set up tight networks throughout Europe and in the rest of the world;
- transport will become increasingly integrated into industrial just-in-time production cycles.

Obviously, small and medium-sized hauliers do not have the resources necessary to implement such changes. However, certain survival strategies could be envisaged for this category of businesses:

- specialising (market niche strategy according to products, services, or geographical area);
- merging, setting up joint ventures or partnerships;
- franchising;
- joining a freight centre/logistics platform;
- participating in freight exchanges.

The changes described above are accompanied by the introduction of new logistic concepts and further industrialisation and standardisation of the transport process. This means in particular:

- transport services ruled by schedule constraints (*e.g.* around-the-clock deliveries);
- non-stop transport (transport as a constant flow process, transport according to a fixed timetable or on regular fixed routes);
- harmonisation and standardisation of work tools and vehicles (*e.g.* size, quantity and weight of goods, container traffic);
- just-in-time transport which fully reflects the integration of transport processes in industrial production cycles and goods flows.

Working conditions

Understandably, changes that affect an entire sector are bound to have an impact on the jobs of those employed in that industry (Pfaus *et al*., 1993; Möhlmann *et al*., 1993). However, while the impact is universally felt in road transport, the focus here is on the working conditions of HGV drivers.

Night work, shift work

Night work has never been unusual in road transport. It is taken for granted that drivers work at night in "emergencies" or rearrange their timetable in order to compensate for delays in the production or loading of goods. Such expectations are even more common in long-distance haulage. Studies have revealed that long-distance road drivers almost always adjust their daily routine and rhythm (especially breaks and rest periods) to the needs of the transport process (Kiegeland, 1990).

The widespread implementation of new logistics concepts, together with the tendency to consider transport as part of the production process (= industrialisation of the transport process), means that haulage companies will have to meet higher expectations in terms of transport time, compliance with schedules, and reliability of service. Customers from trade and industry are likely to make increasing use of the possibility of having goods transported overnight. Haulage companies operating on regular fixed routes as well as express and courier services clearly publicise this type of service by underlining its "special" character.

For drivers, this means a higher share of night work. Regular shift systems are not the rule in road transport: the amount of night work to be performed tends to vary according to the needs and demands of the transport process. Generally speaking, night work is a major source of stress as well as a considerable risk factor in terms of road safety. According to road accident statistics, single-vehicle accidents – *i.e*. those in which no other road users are involved – tend to occur late at night or in the early morning hours rather than during the day. Indeed, the particularly stressful nature of night work is due to the fact that drivers' physiological functions and mental processes have to be alert at a time when, according to the normal circadian rhythm, drivers would normally want to sleep. The consequence is that the "driver" element in the driver-vehicle-environment system cannot function at its best. The risk of accident is much higher as fatigued drivers are less able to anticipate situations and drive accordingly (Kiegeland, 1997). Moreover, their health will inevitably suffer in the long term (Schäfer and Steininger, 1990).

Drivers' work

If driving seems to take up the lion's share of drivers' total working time, it is by no means the only task they carry out as part of their work. In fact, the length of time spent at the wheel is often overestimated, even by drivers themselves. Indeed, several surveys based on an accurate recording of the "side tasks" performed by drivers show that driving rarely exceeds 50 per cent of their total working time, even in international haulage. A higher percentage is only be found on highly organised regular trucking routes. The rest of drivers' working time is devoted to other tasks, particularly loading and unloading, waiting and on-call time, planning and other administrative tasks, as well as vehicle maintenance.

While progress has certainly been made in the automation of human activities, it has not so far been possible to use machines to drive heavy goods vehicles. Nevertheless, with the installation of automatic, semi-automatic systems and other driving aids in lorries, the demands made on drivers have

clearly changed. Further changes are to be expected when driver support systems currently being developed by leading vehicle manufacturers are ultimately introduced (see reports from the Congress of Traffic Psychologists held in Brunswick, Germany, in 1998; abstracts will be published shortly). Similarly, the know-how and knowledge needed to repair technical defects, which were a significant part of a driver's skills, have lost much of their importance as technology and mechanics in commercial vehicles have become more reliable.

Today, drivers are faced with new kinds of demands which have gained in importance and/or recently arisen. For instance, the planning of trips often means that drivers travel much longer distances per shift than was customary some time ago. In addition, according to modern logistics concepts, drivers are expected to be more cost-conscious in their driving style and more punctual in meeting deadlines. Furthermore, the increasing popularity of information and communication systems as well as data processing in road transport spurs the need to be able to use and handle this kind of technology and is radically changing the way drivers' work is organised. Increasing traffic congestion also affects the demands and constraints that shape drivers' daily routine. At the same time, heavy vehicle manufacturers are striving to automate more vehicle steering functions.

Nevertheless, a basic feature of drivers' work remains very much the same: it is still a task that involves to a large extent the perception, processing and producing of information. According to the area travelled, such (mental) processes place greater or lesser demands on drivers. According to various physiological studies of HGV drivers at the *Institut für Arbeitswissenschaft* of the University of Kassel in Germany, driving in built-up areas is clearly the most stressful and driving on motorways the least fatiguing. In terms of stress, driving on country lanes or on secondary roads falls in the middle. Particularly taxing driving conditions, such as driving at night, on wet roads, or in winter, were found to increase stress significantly. Such situations would fully justify a reduction in the mileage covered by drivers or more frequent breaks. However, given modern logistics concepts, such steps are difficult to put into practice.

Goods handling

Theoretically, loading/unloading is not part of a driver's duties, at least not in third-party long-distance haulage. However, in practice, drivers often have to perform such tasks, either to save time or because, in order to cut labour costs, the charterer/consignee does not have staff available to do or help do the job.

Goods handling is not very popular with HGV drivers. Apart from the physical strain involved, a point to be returned to below, the reason is the low social status of this work. It is widely thought that loading and unloading should not be considered entirely negative since they create variety in the otherwise rather monotonous daily routine of HGV drivers. However, HGV drivers already tend to have to cope with a very heavy workload. Goods handling always is in addition to other jobs besides driving which have to be carried out, but it does not mean that other "side tasks" will be curtailed accordingly. Furthermore, goods handling cannot be compared with healthy exercise or any other fitness training which would surely be beneficial to the drivers' health.

Repeated waiting or extended "on-call time", when drivers remain at the employer's disposal, is seen by most as the opposite of relaxation. Heart-rate measures conducted on HGV drivers have shown a rise in pulse rate during waiting periods. Considering that drivers have to compensate for delays due to waiting by putting in extra effort in order to keep on schedule, this reaction is understandable. As a result, breaks are often curtailed and rest periods are not fully respected. Besides, waiting requires the

driver's full attention; for instance, if a driver does not react fast enough to fill a vacant space in a queue of waiting vehicles, the one following will immediately move into it.

Breaks and rest periods

The distribution of breaks and rest periods over a day's work is of prime importance to drivers' recuperation and thus to road safety. Analyses involving 200 truckers over 1 000 workdays have revealed that, given the impressive length of their working day, drivers take too few breaks and when they do, the breaks are too short (Kiegeland, 1990).

Whereas the working day of city bus drivers has two distinct breaks – breakfast and lunch – long-distance lorry drivers have only one noticeable break at lunch time. The slow but steady increase in their morning hours is due to the fact that many do not reach their destination before early morning and choose to sleep in their truck cab for three to four hours before unloading. Rather than breaks, these should be considered as extremely curtailed rest periods.

Further analysis of their working time reveals clear differences in the rhythm of work between long-distance and short-distance road drivers. Whereas short-distance drivers enjoy a fairly "normal" daily routine, starting work in the morning, having breaks for breakfast and lunch and finishing their day's work in the evening, this not the case for their counterparts in long-distance haulage where the traditional working time breakdown has largely disappeared. Drivers have to adjust the distribution of their working time to meet the demands of the transport business. To carry out their workload, they have to set aside their own needs, as their pattern of breaks and rest demonstrates.

On the whole, long-distance haulage drivers are expected to show more flexibility in the way they organise their working time than their counterparts in short-distance haulage. However, it is difficult to assess how frequent and widespread such expectations are, as drivers themselves have divergent views on the subject (Meifort *et al*., 1983).

Finally, only those who withstand the selection process and can cope with such an organisation of their working time are likely to remain long-distance road drivers. It is nevertheless certain that, in addition to the overall high demands of a driver's job, irregular working hours generally mean additional stress and therefore have repercussions on road safety.

Occupational health

In long-distance haulage, drivers' work is characterised by a great number of objective strains and stresses. Excessive working hours, irregular working rhythms, strenuous physical labour during loading and unloading, prolonged phases of constant posture without exercise can cause health disorders. Still, professional drivers tend to view their health as highly satisfactory, feel physically fit on the whole and/or are little affected, if at all, by health troubles. This seems rather surprising considering how demanding a driver's job is (Frieling *et al*., 1990). However, there are three major reasons for such a positive assessment:

- The work of professional road drivers, while highly demanding, is on the whole relatively varied, even in terms of physical activity, as shown by the rather high amount of goods handling involved. Even if this particular task tends to be unpopular among drivers, it appears to be rather beneficial to their health as long as extreme efforts are avoided. According to this, categories of drivers performing one-sided tasks, like those in

long-distance haulage, should have a higher incidence of health disorders, as has been seen.

- The second reason, certainly the more decisive one, is the "self-selection" within the driving profession. In the first place, this demanding work can only be chosen by those who are physically fit and feel able and energetic enough to cope with the numerous demands – mostly self-imposed – which are inherent in this particular occupation. If health disorders arise, drivers soon have no choice but to quit their jobs, both because of its demanding character and because it is difficult to get medical assistance during longer trips. Only those who are – at least subjectively – fit will remain in the driving profession. This may explain why there is a lower incidence of health disorders for this category of worker than one would reasonably expect. This hypothesis is supported by the findings of Meifort *et al*. (1983). Their survey established that respondents who dropped their driving job altogether suffered more frequently from health disorders than those who were still active drivers, both groups working or having worked in short-distance public transport.
- The third possible explanation is that some drivers tend to ignore or not to mention health problems (truckers' mentality) out of false pride. However, it was not possible to test the validity of this assumption, since medical examinations were not performed.

Indeed, drivers' health appears in a different light when based on a medical examination rather than on drivers' subjective assessment. According to investigations by Haas and Dziambor (1988), workers in the transport sector underwent more frequent medical treatment than industrial workers, who made up the largest proportion of the reference group (13.8 per cent against 10.7 per cent). In the transport occupations, there is a higher incidence of disorders affecting the following functions and/or organs: eating habits/metabolism, digestive organs, eyes, blood circulation, and musculo-skeletal system. The least affected organs were the skin and the hearing system.

Another fact indicates that transport occupations are more exposed to health hazards than others: in Germany, for example, a vast majority of bus drivers in short-distance public transport take early retirement for health reasons. It is exceptional to reach normal retirement age in this sector (Bailer and Tränkle, 1993). However, lorry drivers often covet driving assignments in public transport because of the "lower level of stress" involved.

It therefore appears that there is a noticeable contradiction between subjective and objective well-being among professional road drivers in general and those in long-distance haulage in particular (van der Beek, 1994). It could well be that drivers simply set aside their health-related needs as well as many other needs, such as those connected with their social life and physiology.

If this is verified in further investigations, it would be highly advisable to encourage road drivers to develop a greater awareness of their own health and well-being as a first step towards successful health management.

Road safety

Occupational risks

Long-distance truck driving undoubtedly ranks among the most dangerous professions. As a matter of example, any steering mistake can have fatal consequences: there is no "emergency button" to stop a lorry which has started skidding on the road. Apart from driving, drivers frequently have to perform a

fair share of loading and unloading. The fact that drivers are very exposed to risks of accident during the completion or supervision of this kind of task is often neglected (McDonald, 1984).

According to specialists, however, the major danger in terms of road safety stems from a combination of unsatisfactory working condition, driver fatigue, drowsiness and other fatigue-related states. The word "fatigue" is commonly used in several senses and describes a set of different feelings. For scientific purposes, it is therefore necessary to try and narrow the definition.

Fatigue and fatigue-related states can be seen as expressions of a particular state of activation/arousal. There is a distinction to be drawn between fatigue and other states which are very similar to fatigue in their expression but have a different origin and therefore require different countermeasures, if they are to be averted or suppressed. Monotony, boredom, decline in working motivation, decreased alertness and certain forms of stress fall into that category.

Monotony: Monotony is a state of reduced activity which is accompanied by the experience of tiredness and sleepiness (dozing). Contrary to mental fatigue, it is possible quickly to overcome or avert monotony by varying tasks or changing activity.

Listlessness/decreased willingness to continue activity: Plath and Richter (1984) define this particular state as follows: "'A decrease in willingness to continue activity' can arise during the performance of tasks which are highly repetitive and/or (subjectively) deemed as purposeless". In this state of mental irritation, listlessness, reluctant tension and growing aversion to continuing a specific activity, emotion can trigger increased alertness. As for monotony, "mental listlessness can be quickly averted by giving the task performed a purpose, *i.e.* by integrating it into the overall duties of the driver concerned". The content and relevance of a task are decisive. In road transport, such symptoms are more common and more strongly felt in sectors where temporary drivers are employed, such as courier services, or on regular fixed transport routes that offer virtually no variety. Especially critical in the driving profession is a tendency to sudden outbursts of emotion which can easily bring about dangerous situations in traffic.

Decreased alertness: It is questionable whether this symptom can be found at all among road drivers travelling throughout Europe, since high-density traffic has become almost a permanent feature on European roads. Under such conditions, situations conducive to really low levels of alertness are unlikely to occur. Lowered vigilance implies for instance that a driver receives no arousal signals over a period of 20 to 30 minutes, which seems almost impossible considering today's road traffic.

Stress: Greif *et al*. (1991) give the following definition of stress and stressor: "Stress is a subjective state of tension characterised by intensity and unpleasantness. It arises out of the fear that one is not or probably will not be able fully to manage a situation which, according to the subject, ought to be averted in any case. It applies in particular to highly unpleasant situations (*e.g.* conflict situations), subjectively "close" situations, whether they are to arise in the near future or have already taken place, and prolonged situations." Professional road drivers mention in particular the following stressors: time pressure, sleep deficit, loading/unloading, very long hours of work. Such stress factors can largely be suppressed by reorganising drivers' work and schedules.

The risk that fatigue-related symptoms, signs of boredom, or possibly a decrease in vigilance may occur in lorry drivers is particularly high at constant driving speed, during prolonged periods of driving, long hours of work, and/or exposure to monotonous noise and to heat. However, there appears to be little risk of a decrease in vigilance occurring.

All the states mentioned involve the risk of a serious impairment of a driver's ability to react and process information. Whenever a driver feels reluctance to continue activity, his emotional state can create potentially dangerous situations. Drivers in such a state are prone to react improperly and/or overreact in road traffic.

Table 1. Critical states while driving and respective countermeasures

	Fatigue	Monotony/ boredom	Decreased willingness to continue activity	Decline in alertness	Stress
Causes	Prolonged work demand	Repetitive task, mostly recurring at short intervals	Lack of purpose in task felt by the operator	Constant attention in a context of low or irregular frequency of arousing signals	Subjectively unmanageable, temporally close or adverse situation
Effects	Overall decline in performance, limited ability to react and process information, risk of falling asleep at the wheel	Mainly the same effects as in the state of fatigue	Increased tension, restlessness, emotional outbursts	Decline in attention, tendency to oversee signals	Physiological, mental and psychosomatic effects
Counter-measures	Only method: sufficient sleep	Temporarily effective: change or vary tasks	Temporarily effective: show the operator the purpose of the task performed and how it fits in his work	Temporarily effective: change the frequency of the arousing signals	Change the situation altogether, introduce various possibilities of action
Practical solutions for truck drivers	Allow for sufficient breaks and resting periods, work organisation	Introduce a holistic organisation of workload and task distribution, a 2-man driving crew, long rides to be performed by rail or by other means of transport.	Make corporate strategies and planning transparent, involve drivers in decision making	Avoid driving conditions with low activation, arrange and make a range of information available to drivers, include a choice of routes while planning trips	Improve work organisation, train the drivers, and interface staff accordingly

Ultimately, the effects of stress can be varied and affect the whole range of mental and physical functions. They present a serious health hazard for the driver. However, in the driver's daily work, there are many ways of tackling such problems: in the present situation, countermeasures involving a "restructuring" of the drivers' work ought to take priority. Besides, the impact of legislation alone is to be rated as critical since laws and regulations are, on the one hand, not very flexible, and have not proven very effective in the past, on the other.

The sense and nonsense of social legislation

Considering the size of their vehicles (and their momentum) as well as the specific hazards related to goods handling, lorry drivers are expected to perform their duty with great care. Although their job ranks among the most "accident-prone" occupations, their working conditions leave a lot to be desired.

Excessively long shifts, prolonged driving, and arduous physical labour during loading and unloading place high demands on drivers. The likelihood that they will fall asleep at the wheel or experience bouts of reduced ability to react when driving on monotonous stretches is clearly increased by such working conditions. The need for relevant policy and legislation was identified a long time ago. To protect HGV drivers and other road users, detailed regulations setting maximum driving time and length of shifts, breaks and rest periods have been established. Today, a set of regulations applicable in the EU also govern international haulage. However, the problem of the extremely long working hours in road haulage has not yet been satisfactorily solved.

If the drivers' working time is stretched to the maximum set under current regulations, it is likely that the total amount of stress they experience will be extremely high. Given a conjunction of the worst possible circumstances, the expectations may surpass drivers capabilities.

The risk that drivers face with excessive demands is likely to rise whenever working arrangements are less restrictive, as is explicitly allowed in collective agreements. According to EU legislation, under a collective agreement, a maximum working time of 84 hours per week is possible and even legal. Furthermore, in everyday practice, breaks and rest periods in road transport are repeatedly disregarded and drivers often exceed the maximum driving time. Therefore, especially in long-distance haulage, serious accidents are caused by drivers who, after a long day's work and stress, are unable to react adequately or simply fall asleep at the wheel.

Studies by Luczak (1982) and Fuller (1983, 1984) revealed that the frequency of single-vehicle accidents, *i.e.* those that involve no other road users, is particularly high late at night and early in the morning. It was also established that accident frequency increases with drivers' working time, especially towards the end of the shift (Hamelin, 1987; Insurance Institute for Highway Safety, 1987; Wedeburn, 1987). McDonald (1984) found that the risk of accident is twice as high in the second half of a driver's trip as in the first half.

However, it is difficult to identify precisely when the risk starts increasing. This reveals another shortcoming of the current legislation on labour and rest periods: existing provisions take into consideration the number of hours worked but not the quality or rather the circumstances under which the work is performed. Whether the driver travels during the day or at night, whether on the motorway, which can be comparatively relaxing, or in city traffic, which requires great alertness, concentration and the ability to react promptly, whether in summer on dry roads or in winter when roads are wet or icy make a great deal of difference.

At this stage, the following conclusions may be drawn:

- It is difficult to lay down rigorous legal provisions which take into account the demands of road transport, the requirements of road safety and drivers' needs.
- It is necessary to develop means and methods of assessing and continuously monitoring drivers' fitness to drive and take part in road traffic. This should be a continuous process so that they have immediate feed-back when critical states arise while they are driving (fatigue, boredom, decreased willingness to continue activity).

Accidents and causes of accidents

Commercial vehicle technology has become highly reliable, and road accident statistics seldom show technical defects as the cause of accident. Several experts (*e.g.* Beierle, 1993) even assume that nearly all HGV accidents are more or less directly caused by human error.

When comparing the working situation of HGV drivers who have been involved in at least one road accident with drivers who have never had an accident, Beierle identified relationships with the following characteristics:

- Those without accident involvement had completed their training as drivers in the German army, whereas drivers who had been involved in at least one road accident had learned to drive a lorry in a traditional driving school.
- Drivers who had had an accident suffered more frequently from health disorders, such as backache, headaches, digestive trouble.
- Drivers involved in an accident judged their work routine more demanding than those without any accident involvement.
- Drivers with accident experience were less positive about the atmosphere and the level of satisfaction at work. Similarly, very few could imagine being HGV drivers for the rest of their lives. Their counterparts with no accident experience were more positive about remaining in this occupation.

According to the latest survey by Frieling *et al*. (1997) of 200 professional road drivers in four EU countries, there are significant relationships between fatigue at the wheel, the rate of near accidents, actual accident records, and the drivers' breaks and rest periods. The risk of falling asleep at the wheel, the number of near accidents, and the effective accident rate were clearly higher when drivers had not complied with the compulsory breaks and rest periods.

Beierle (199e) and Frieling *et al*. (1997) suggested a series of measures for reducing the number of HGV accidents. Among other things, they stressed the need to improve drivers' training, to upgrade their driving skills (*e.g.* through special safe-driving training for lorry drivers) while underlining the extremely high demands made upon this category of staff.

Under present circumstances, a more humane organisation of drivers' working time that leaves enough time for restoring their mental and physical ability to perform must be a priority so as to reduce drivers' exposure to accident risk.

Career pattern of long-distance road drivers

Motivations and profile

Professional road drivers choose their occupation for different reasons. Among those who choose to work in long-distance haulage, the vast majority of drivers mentioned earnings as the first incentive. As road drivers, they expect to earn more than in their previous jobs. Other reasons frequently mentioned were "the desire to be one's own boss" , the advantage of "not always having a boss on one's back", "of going places and seeing the world", and the opportunity to "escape from a traditional lifestyle and work routine", although some reportedly had not been able to cope with their previous occupation.

Certainly, earnings in long-distance haulage are generally higher than in the drivers' previous occupation, but the difference often bears little relation to the amount of extra work involved. Another reservation to be made is the fact that, at least in Germany, a considerable share of drivers' income consists of bonuses and travel expenses for which social security coverage is not required.

Depending on the area travelled, drivers' other expectations are more or less met by their occupational choice. However, the work of a long-distance road driver does not only have positive aspects.

Career start and qualifications

In Germany, one can officially train to become a professional long-distance road driver. However, this is still not the usual way of entering the profession: more often than not, the license to drive heavy goods vehicles is the only formal qualification required, and many lorry drivers acquire this qualification during their military service. In most cases, initiation and further training take place "on the job", with the assistance of well-disposed fellow-drivers, if one is lucky.

The demand for qualified drivers is currently very high and hard to meet. On the one hand, there is a growing awareness among haulage companies that drivers who are properly trained not only contribute to cutting costs but also to reducing accidents by behaving and reacting adequately in road traffic (BDF, 1996). On the other hand, there is an increasing shortage of qualified newcomers in trucking: young people throughout Europe are "deserting" the driving profession, an indication of the lack of appeal of the working conditions in this sector.

Prospects and possibilities

The desire to earn a better living is an indication that potential long-distance drivers have needs which they expect to fulfil by means of a higher income. At the beginning of their driving career, most long-distance truckers are still involved in community life. At this early stage, few drivers can imagine remaining in this occupation for the rest of their lives. The motivation to earn good money for a couple of years often comes first.

At the beginning, novelty and variety tend to make their job interesting: new demands, new challenges, a new work environment, different impressions and experiences resulting from changing tasks. However, after two or three years, a fair number give up their jobs because they are no longer prepared to provide the requested level of performance and accept the disruption of their social lives (and in particular their family lives) for a little extra money.

As for the others, once the newcomers to the profession are more or less used to the specific working conditions of long-distance haulage, they enter a phase of "socialisation as long-distance truckers" without necessarily being aware of it. As their workload becomes heavier, they begin to curtail or even drop certain personal interests (*e.g.* leisure activities) and to forget or neglect their roles as fathers, husbands or partners. Things that once were important to them become less relevant. Psychologically, this can be explained as a stress reduction strategy: if one wants to work in long-distance haulage and live the lifestyle it implies, there is no choice but to give less importance to other needs and interests that develop in the course of one's personal life. Otherwise, in the long run, long-distance drivers will not be able to stand the tensions that arise between these needs and the limited possibilities they have of fulfilling them.

At the same time, other aspects take on importance. Everything closely related to their jobs and lifestyles as long-distance truckers gains more and more weight. Not only does their driving job dominate their daily lives in terms of time, it also leads to a concentration of their overall experience on work and family (if they are lucky enough to have one). This process is mainly accompanied by a growing estrangement from most of the people they knew outside their work.

As a result, a person who once had a variety of needs and interests unconsciously ends up being exclusively a long-distance trucker. Such a transformation is bound to have serious effects on the overall situation of the person concerned. Indeed, after a few years "on the road", it is very difficult for long-distance drivers to change jobs or return to their previous occupation since their knowledge of that field is very likely to have become obsolete. Openings available are likely to be unskilled jobs such as manual labour which, in the long term, cannot satisfy long-distance drivers who have grown used to autonomy and variety in their jobs. In the meantime, the drivers may have reached an age when they are less "employable" in light of today's particularly difficult labour market.

More decisive is the fact that after many years of long-distance trucking, drivers are no longer integrated in a functioning social network: they have no circle of friends to rely upon for help and support when problems occur. Many families, where one still exists after those long years, cannot cope with the new situation when the husband/father suddenly gives up his driver's job.

Furthermore, the chances of improving one's job prospects by "climbing up the ladder" are fairly limited. Few positions are suitable and there are not enough for all drivers in such situations. At best, there may be openings as fleet managers, in warehousing, or in the administrative departments of their employers.

Similarly, older long-distance truck drivers cannot reasonably expect to find employment driving buses or taxis. In any case, the working conditions in passenger transport also leave a lot to be desired.

Finally, it must be said that, for the vast majority of long-distance road drivers, giving up their driving occupation equals losing a major part of their identity. It almost certainly and ultimately means coming down to a level where they have to accept unskilled and often badly paid jobs that leave little room for personal initiative and/or only require a minimal part of their skills.

Beside all the psychological problems related to such a drastic change in their careers, giving up long-distance trucking involves a financial loss. In many cases, their disposable income is in fact cut by half.

Further education and training

As mentioned above, drivers in general, among them those in long-distance haulage, have little chance of "climbing up the career ladder". Only large companies are likely to offer such prospects within their organisation. Therefore, further training of professional road drivers is mostly limited to broadening or improving existing skills and qualifications. Typical areas of training focus on energy-saving, safe driving, handling dangerous goods or accident avoidance. Some HGV drivers also choose to qualify as bus, coach or taxi drivers in order to enhance their job prospects.

Environmental consciousness vs. economics in road haulage

The expansion of road traffic is having various effects on society, human habits and behaviour. The positive side of such a development, *e.g.* increased mobility, independence and the trouble-free provision of goods of all sorts and origins, are indeed appreciated by most. Yet, road traffic has reached such proportions that its negative effects are becoming more and more noticeable. As a result, a wide range of organisations are calling for effective action to reduce traffic in order to protect the environment and people's health.

To clarify, the purpose here is not, at this stage, to discuss the many aspects of such a complex issue but to offer insight into the problems posed by HGV transport while presenting the main opinions on this highly controversial topic.

Although heavy goods vehicles (over 1 000 kg unladen weight) only represent 2 to 3 per cent of all motor vehicles, their presence in road traffic has drastically increased owing to the fact that they are being used more intensively than private cars. While the annual mileage of an "average" motor car in Germany is between 10 000 to 20 000 km, heavy goods vehicles used in long-distance haulage can travel up to 200 000 km a year, producing a corresponding volume in exhaust emissions. According to various forecasts, road traffic will continue to expand, although its detrimental effects are already being felt: growing air pollution hazardous to people's health, dying forests, photo-smog, greenhouse effect, to mention a few partly caused by vehicle exhaust fumes. To be added to the list are other types of nuisance, such as noise or the ugly scenery resulting from the construction of new roads or the widening of existing ones. Another major repercussion is the number of fatalities and injuries in road accidents.

If one focuses on the negative impacts of air pollution, it is high time to devise measures and strategies to curb and even reduce the release of exhausts over the long term. In this respect, the International Panel for Climate Change (IPCC) formulated targets concerning CO_2 emissions (quoted by Hey *et al.*, 1992): 30 per cent reduction by the year 2005 and 80 per cent reduction by 2050. These percentages apply to the total volume of exhaust gases released into the atmosphere, not just those produced by motor vehicles. However, if the overall target is to be met, similar figures should be envisaged for vehicle emissions.

Various possibilities for reaching the targets formulated by IPCC are examined in detail below. Supposedly, a reduction in CO_2 exhaust will largely be concomitant with that of other harmful emissions and greenhouse gases released in road traffic. In principle, three strategies might be envisaged:

- improve vehicle technology to lower energy consumption in motor vehicles and trains;
- transfer road freight to other means of transport, especially to rail;
- avoid goods transport by road, which implies disentangling economic growth from the expansion of goods traffic.

Of the three, ***enhanced vehicle technology*** seems to be the most appealing strategy. Technical improvements and possibly new drive systems for motor vehicles would contribute to drastically reducing energy consumption and thus CO_2 emission, the advantage being that no further measures would be necessary. Economic growth would not imply further restrictions on road transport. Higher transport charges resulting from comprehensive research as well as more sophisticated vehicle equipment and technology would almost certainly be accepted by most.

Should there be no improvements in this area, CO_2 emissions are bound to rise by 60 per cent throughout Europe by the year 2010. Under these assumptions, the entire potential of such measures would be just about sufficient to hold the increase in CO_2 exhaust to 13 per cent, should the expansion in road freight traffic remain unchanged (EURES survey quoted by Hey *et al*., 1992; for similar views, see Rommerskirchen *et al*., 1991, 1992).

In contrast, the ***switch from road haulage to other modes of goods transportation*** is likely to meet with various degrees of resistance by the parties concerned. Apart from the road transport industry, many other sectors of the economy are bound to reject such a solution. In fact, switching from road haulage to other modes of transport is easier said than done. Indeed, transport requirements vary from one type of goods to another, which explains how a "special relationship" can develop between a particular mode of transport and a certain type of freight. Finally, such a transfer only makes sense if it contributes to saving primary energy.

In this respect, it should be noted that air transport and – further down the list – road haulage have the worst ratio between the volume of freight transported and the amount of energy used for that purpose. Considering its large contribution to the total volume of emissions, it would appear sensible to try to curb road haulage even if air transport is no model of environmental friendliness. For that matter, the growth of air freight should not be encouraged. If one considers existing adequacies between type of freight and mode of transport, switching from road to rail transport or rather transferring road freight to trains should be the preferred solution. Yet, because of their limited transport capacity, the German railways are hardly in a position to take a significant volume of freight off the roads at present. Even if the railways doubled their capacity, they would only cover approximately 10 per cent of the total volume of road freight. If the total growth of road freight was to be taken over and covered by the railways, their transport capacity would have to be raised up to 325 per cent.

If the transfer from road to rail is implemented with the necessary toughness (together with other steps not detailed in the present contribution), CO_2 emission will drop by approximately 3.5 per cent (Hey *et al*., 1992). Considering how drastic this measure is, or would have to be, the results may prove disappointing. It can only be rated a success if one bears in mind how much exhaust emissions would grow should no changes be made in the transport system. The above-mentioned target of 40 per cent reduction cannot be reached simply by switching from road to rail. Only a combination of technical enhancement and specific steps to avoid unnecessary transport can solve the problem.

To achieve a further reduction in CO_2 emission, it is imperative to ***avoid unnecessary trips***, examples of which abound. Yet, from the point of view of business administration, there is no such thing as long as a cost economy or a cost advantage of any sort can be obtained on a particular transport assignment**.** This leads to "transport inflation", which is exacerbated by the fact that the share of transport costs borne by the community rather than by those who generate transport is still very high.

To define what "unnecessary transport" is, one could try to assess how "demand-oriented" and/or "customer-oriented" a specific transport assignment is. On this criterion, all trips and rides performed to satisfy customers' needs could be tolerated, although it may be difficult to assess how real a particular need is.

To reach the IPCC targets, it is not only imperative to avoid unnecessary transport but also to limit the trips and rides that are still regarded today as useful or absolutely necessary by most and to set up structures which make such transport redundant. Again, only a combination of adequate policies and interventions can help. Planning transport facilities which are geographically close to customer locations, setting up regional production facilities, creating restrictive conditions that indirectly

promote the idea of avoiding transport among companies, encouraging relevant corporate policies and facilities planning are ideas that spring to mind.

According to simulation forecasts, it should be possible to curb the expansion of road transport to 10 per cent if the various measures to save transport (with prices reflecting the shortage of transport as a resource) are consistently put into practice. By implementing simultaneously the three strategies described above, a 42 per cent reduction in CO_2 emissions could be achieved. This means that the IPCC target could and would be met. Certainly, the necessary measures would not be politically popular: resistance is to be expected from various sides. Moreover, world-wide co-ordination would be required.

On the other hand, according to present scientific knowledge, the level of energy consumption and the corresponding emissions today are leading to a world-wide disaster. In industrialised nations, road transport is obviously not the only cause of air pollution, but it contributes significantly: when fossil fuel is used, CO_2 emissions that result from combustion are unavoidable, no catalytic converter can make such a gas harmless or dissipate it altogether, at least not as long as there is enough energy left to be used. The only way to reduce CO_2 emissions is to give up using such fuels. From an ecological point of view, there are no acceptable substitutes at present. Using nuclear energy entails other serious disadvantages which, to put it mildly, would not appear to make this solution very desirable, either.

According to the state of knowledge today, drastic and decisive measures (not only in road transport) are a must if a threatening climatic disaster is to be averted.

REFERENCES

Bailer, H. and U. Tränkle (1993), "Fahrerarbeit als Lebensperspektive", in Bundesanstalt für Arbeitsschutz (ed.), *Europäische Forschungsansätze zur Gestaltung der Fahrerarbeit im ÖPNV*, Wirtschaftsverlag NW, Bremerhaven.

Baum (1989),"Verkehrsprognose und Anpassungsstrategien", *Zeitschrift fuer Verkehrswissenschaft*, Vol. 1, p. 38 ff.

Beek, A. v.d. (1994), "Assessment of Workload in Lorry Drivers", Universiteit van Amsterdam, Amsterdam.

Beierle, B. (1993), "Psychologische Analyse von Lkw-Verkehrsunfällen", in G. Kroj, H. Utzelmann and W. Winkler (eds.), *Psychologische Innovationen für die Verkehrssicherheit*, Deutscher Psychologen Verlag, Bonn.

Brilon, W. and M. Schnik (1990), "Aktualisierte pauschale Prognose der Fahrleistungen auf deutschen Strassen", *Internationales Verkehrswesen*, 42, pp. 69 ff.

Bundesverband des Deutschen Güterfernverkehrs (1996), *Mehr Sicherheit - Weniger Kosten*, Ein BdF-DVR Programm fuer Transportunternehmen und Kraftwagenspeditionen, Frankfurt.

Dankwerts, D. (1993), "Arbeit im internationalen Transport", *Logistik und Arbeit*, 4, pp. 6-9.

Dankwerts, D., H.O. Char and J. Lausch (1992), "Branche im Wandel", *Logistik und Arbeit*, 2, pp. 70-73.

Deecke, H., J. Glaser, H.-W. Hetzler, C. Holst and H. Werner (1991), "Die neue Rolle der Transportwirtschaft (Marktanforderungen und moderne Arbeitskonzepte für den Güterverkehr)", Rationalisierungskuratorium der deutschen Wirtschaft, Eschborn.

Deutsche Bank (1990), *Verkehr 2000. Europa vor dem Verkehrsinfarkt*, Frankfurt.

Ernst, G. and J. E. Grasslander (1993), "Arbeit und Technik in Internationalen Speditionen", *Logistik und Arbeit*, 4, pp. 4-5.

Florian, M. (1993), "Spiel ohne Grenzen (Soziale, organisatorische und kulturelle Hemmnisse informationstechnischer Innovationen im grenzüberschreitenden Güterverkehr)", *Logistik und Arbeit*, 4 (Soziale, organisatorische und kulturelle Hemmnisse informationstechnischer Innovationen im grenzüberschreitenden Güterverkehr), pp. 60-68.

Frieling, E., U. Bogedale and P. Kiegeland (1990), "Tätigkeitsbezogene Anforderungen und Belastungen bei Berufskraftfahrern und ihre Beziehungen zur Risikobereitschaft und Strassenverkehrssicherheit" (Endbericht zum Forschungsprojekt 8304/2 der BASt), Bergisch, Gladbach.

Frieling, E., P. Kiegeland and C. Garo (1997), "Le lien entre la durée du travail des conducteurs routiers et la sécurité routière au sein de l'Union européenne" (Rapport final du Contrat d'étude n° B95-B2 7020-SIN 3973), Universität – Gesamthochschule Kassel, Institut für Arbeitswissenschaft, Kassel.

Fuller, R. G. C. (1983), "Prolonged Heavy Vehicle Driving Performance: Effects of Unpredictable Shift Onset and Duration in Convoy vs. Independent Driving Conditions", US Army, London.

Fuller, R. G. C. (1984), "Prolonged Driving in Convoy: The Truck Driver's Experience", *Accident Analysis and Prevention*, 16(5/6), pp. 371-382.

Greif, S., E. Bamberg and N. Semmer (1991), *Psychischer Stress am Arbeitsplatz*, Hogrefe, Göttingen.

Gressel, R. (1993), "Probleme internationaler Speditionen aus französischer Sicht", contribution to the Workshop "Arbeit und Technik in internationalen Speditionen", Stralsund, 8-9 September.

Haas, J. and G. Dziambor (1988), "Analyse betriebsärztlicher Daten für die Verkehrsberufe", *Amtliche Mitteilungen der Bundesanstalt für Arbeitsschutz*, 3, pp. 6-9.

Hamelin, P. (1987), "Lorry driver's time habits in work and their involvement in traffic accidents", *Ergonomics*, 30, pp. 1323-1333.

Hey, C., G. Hickmann, S. Geisendorf and R. Schleicher-Tappeser (1992), "Dead End Road" (Klimaschutz im europäischen Güterverkehr), Hamburg.

Insurance Institute for Highway Safety (1987), "More Than 8 Hours Behind the Wheel? – Twice the Crash Risk", *Status Report*, 22, 1-2.

Kiegeland, P. (1990), *Anforderungen, Beanspruchung und verkehrsrelevante Einstellungen von Berufskraftfahrern* (Eine arbeitswissenschaftlich-verkehrspsychologische Untersuchung), Verlag TÜV Rheinland, Cologne.

Kiegeland, P. (1997), *Arbeitsplatz Lkw: Ermüdung und Lenkverhalten, ökologische Aspekte, Perspektiven*, Deutscher Psychologen Verlag, Bonn.

Luczak, H. (1982), *Belastung, Beanspruchung und Erholungszeit bei informatorisch-mentaler Arbeit*, Wirtschaftsverlag NW, Bremerhaven.

McDonald, N. (1984), *Fatigue, Safety and the Truck Driver*, Taylor and Francis, London and Philadelphia.

Meifort, J., H. Reiner and J. Schuh (1983), *Arbeitsbedingungen von Linienbus- und Strassenbahnfahrern*, Wirtschaftsverlag NW, Bremerhaven.

Möhlmann, D., F. Nachreiner, P. Nickel and H. Schlechter (1993), "Manuelle versus EDV-gestützte Disposition", *Logistik und Arbeit*, 4, pp. 41-45.

Pfaus, H. (1993), "Neue Logistikkonzepte und ihre Wirkungen auf die Lkw-Fahrer", *Logistik und Arbeit*, 4, pp. 50-57.

Plath, H.-E. and P. Richter (1984), *Ermüdung – Monotonie – Sättigung – Stress* (BMS-Handanweisung), Psychodiagnostisches Zentrum, Berlin.

Plehwe, D. (1993), "Schluesselkonzerne im Transportsektor", *Logistik und Arbeit*, Vol. 3, pp. 56-63.

Rommerskirchen, P. (1989), "Szenarien zur Entwicklung der Umweltbelastungen durch den Verkehr", in H. S. Seidenfus (ed.), *Der Verkehr in der Phase der Anpassung an den vollendeten*, Binnenmarkt, Göttingen.

Rommerskirchen, S., U. Becker and M. Eland (1992), "Unbefriedigende Perspektiven. Entwicklung der Luftschadstoffemissionen des Verkehrs in Deutschland bis 2010", *Internationales Verkehrswesen*, 44 (3), pp. 59-66.

Rommerskirchen, S. *et al*. (1991), "Wirksamkeit verschiedener Massnahmen zur Reduktion der verkehrlichen CO2-Emissionen bis zum Jahr 2005" (Untersuchung im Auftrag des Bundesminister für Verkehr), (Schlussbericht FE-Nr. 90 303/90), Prognos AG, Basel.

Schäfer, S. and Th. Steininger (1990), *Health hazards and occupational turnover among professional truck drivers*, Wirtschaftsverlag NW, Bremerhaven.

Wedderburn, A. A. I. (1987), "Sleeping on the job: the use of anecdotes for recording rare but serious events", *Ergonomics*, 30, pp. 1229-1233.

SOCIAL ASPECTS OF ROAD TRANSPORT: INTRODUCTION TO THE ANALYSIS OF ISSUES

Jan Burnewicz
University of Gdansk, Poland

Introduction

The road transport system is not simply a technical construct based on physical or mathematical laws but a living organism. The personnel engaged in transport operations, along with the relevant social issues, are an integral part of this system which therefore cannot be managed simply by applying the relevant legal instruments and technical standards. The sector's social regulations and policy are essential, in that they can help to resolve or attenuate problems that may result in conflicts or strikes. Aspects of transport workers' family life that depend on the general state of the national economy and those that are closely connected with working conditions in this sector must, of course, be kept separate.

A market economy does not provide full economic freedom as it gives road transport workers only quite limited possibilities of a stable family life. Inter-carrier competition and social demands are opposing factors. Transport firms cannot be competitive without cutting costs, but stringent management substantially reduces the room for manoeuvre in the social field. There are no examples of national policies or of a European social policy which could provide a balance between an acceptable level of road transport costs and a satisfactory standard of living for the workers concerned.

The road transport sector should have an effective social policy. Satisfactory social conditions which would be proof of this effectiveness cannot, however, be measured and standardized. In an economically less developed country, a lorry driver will work 12 to 16 hours a day at an hourly rate of ECU 1 without demanding decent working conditions, while in a rich country a driver expects a contract for only 8 to 10 hours a day paid at ECU 10 per hour, a pension at age 55, paid non-driving times, long holidays, etc. The opening up of transport markets means that drivers from these two types of countries are operating in the same competitive field and that employers and the authorities need to find ways of resolving social problems. Specialists in transport economics and policy should take part in the search for solutions but have had little to say on the subject. The European Conference of Ministers of Transport can therefore encourage the search for a balance between market requirements and the enforcement of decent working conditions in the road transport sector.

Scale of social problems in road transport

Social problems exist in all transport modes. There has been no lack of conflicts and strikes involving railwaymen, airline pilots, bargees, etc. The seriousness of these problems depends on a number of factors: the sector's and the operators' financial situation, government social policy and aid, the

strictness of regulations, the unemployment rate, the sector's structure (the concentration or dispersion of firms), intensity of competition and working conditions. It is quite difficult to say whether social conditions are more difficult in road transport than in other transport modes, but the size of the road transport labour force would seem to suggest that, from the viewpoint of social policy in the transport field, the scale of problems is the greatest challenge.

The nature of social problems in road transport depends indirectly on the situation in this sector and its role in the economy, and directly on the specific characteristics of this mode's organisation and working conditions. After the Second World War road transport became the main mode for both passenger and freight transport. It would be difficult to imagine a market economy in which there was no possibility of using the road in production and distribution operations. Small and medium-sized enterprises (SMEs) could not take their place in the current economy if, for example, there were only rail or inland waterway transport. Owing to the strengths of road transport (flexibility, access to any destination, low prices), demand for road transport services is very high. There are therefore more and more road transport firms, resulting in fragmentation of the sector and fierce competition.

Road transport is not only a transport mode which could not be easily replaced by other more efficient and more environmentally friendly modes, but is also a sector that stimulates the national economy by creating jobs, facilitating the distribution of goods, developing tourism, etc. Objective measurement of the current role of road transport in economic and social life cannot be limited to external costs: the losses due to the lack of a good road transport system would also have to be evaluated (Burnewicz, 1996*a*).

The road transport sector's specific type of organisation can be seen in its fragmentation, the existence of a great many small operators, and door-to-door services. While a railwayman carries out specialised operations on the basis of rules defined by company management, a lorry driver is often required to carry out a number of different operations (driving, documentation, border formalities, etc.) and take direct responsibility for the results of these activities. But the greater responsibilities of lorry drivers do not guarantee a higher remuneration of labour based on market mechanisms.

The sector's contribution to employment

From a macroeconomic viewpoint a highly automated activity results in a decrease in jobs, higher unemployment and social problems. Intensive automation, which is desirable for purely economic reasons, is opposed by those responsible for social policy as they have few effective solutions for fighting unemployment. There are many industrial sectors in which, as a result of technical discoveries, it is possible to make great technological progress (robotisation, computerisation, etc.), substantially reduce labour and cut costs. The transport sector is not homogeneous and technical progress differs from one mode to another. Pipeline transport is highly automated and requires a very small labour force, while in road transport even a very small quantity of goods cannot be delivered without at least one person being involved.

When pipelines were introduced in the United States, there were clear negative social effects for the road transport firms that had lost an important market (Gantier, 1964, p. 7). Road transport today provides many jobs, despite the rising trend in the number of tonne-kilometres produced per employee. By absorbing labour quite easily, road transport plays a very positive part in the macroeconomic system despite social problems within the sector.

Taking as a basis 1 million tonne-kilometres performed by transport modes in 15 EU member countries in 1994, it has been calculated that road transport requires 2.63 employees, rail

4.56 employees and inland waterway transport 1.74 employees[1]. These indicators are quite surprising (even when adjusted to take account of passenger transport). As road transport is less dependent than rail on technical facilities, it also needs fewer people to carry a particular volume of freight. It can therefore be concluded that road hauliers are more responsive to market pressure than railways.

Job creation in road transport firms follows a simple precept: production is a function of labour. This precept is less strictly applied in rail transport where attempts to restructure employment and adjust it to the volume of traffic are resisted by the trade unions which take no notice of rail's very poor financial situation. It is easier for road transport firms to maintain the level of employment justified by the scale of their activity as they are in most cases privately owned, small in size and subject to keen competition. It would be inconceivable for a road transport company (even a large one) to have as many administrative staff as a railway. This surplus labour is possible in the rail sector when the operator provides both freight and passenger services and receives subsidies (it is difficult to break down infrastructure costs between passenger and freight traffic). In the road transport sector, an extreme but frequent case is the one-man firm, where the owner is also the driver (Poingt, 1997, p. 6). The statistics show that two-thirds of road transport firms in Europe have fewer than five employees. In these firms the employees carry out operations strictly linked to the provision of transport services under working conditions that have nothing in common with those in the offices of large firms.

Owing to the volume of traffic carried by road, which is several times that of rail, transport for hire or reward accounts for over 40 per cent of jobs in the entire transport sector. In the EU (15 countries) in 1994, the labour force in the transport sector amounted to 6 162 600, including 2 860 200 (45 per cent) in the road transport and pipeline fields (European Commission, 1997, p. 16). These figures do not include own-account transport which represents some 40 to 50 per cent more jobs. It could be expected that social problems in road transport would be greatest in countries where this mode accounts for the highest percentage of jobs in the entire transport sector. This is the case in Spain (69 per cent), the Netherlands (57.2 per cent), Italy (57.1 per cent) and Sweden (54.7 per cent). However, the most serious unrest in road transport in the 1990s has been in France, where the road sector accounts for 49.3 per cent of all jobs in the transport field. In Germany, which has the lowest proportion of road transport employees among the EU member countries at 29.1 per cent, the financial and social situation in this mode is no better.

The countries in transition have seen marked changes in the road transport sector. With the advent of a market economy:

- the share of the road in transport activity is rising sharply;
- state ownership is being replaced by private ownership;
- many new small firms have been created;
- the labour force in road transport has declined substantially (by 30 to 50 per cent).

The most surprising development is that employment in road transport has fallen much more than the volume of traffic owing to competition and privatisation. While road transport firms in Poland had a labour force in 1980 of 404 400, the figure dropped to 277 100 in 1988 and to 189 000 in 1995 (a fall of 53.2 per cent) (Burnewicz, 1996*b*). In Hungary, the road transport labour force declined from 119 600 in 1985 to 46 000 in 1992 (OECD/ECMT, 1997, p. 50). This trend is due to the marginalisation of state-owned firms on the transport market.

The transition is causing additional social problems that are not encountered in countries which have been operating as market economies for decades. The problems are most pronounced in declining sectors (steel, mining, etc.). Despite a fall in employment in road transport, Poland, the

Czech Republic and Hungary have not seen the kind of demonstrations by drivers that occurred those in France in 1991 and 1996.

Attractiveness of working in road transport

From the outside the road transport sector seems quite attractive in economic and social terms. It is seen as a sector where being one's own boss and opening a business has great appeal and a good chance of success. The belief in the possibility of a higher social standing and a better standard of living as a self-employed person withstands all evidence to the contrary. Despite the many failures, the examples of firms which go under are not seen as significant and are interpreted as accidents that do not undermine the basic principle (Bernadet and Lasserre, 1985, p. 148).

The road transport sector is subdivided into major operators (few in number but playing the main role on the market) and small-scale operators (large numbers with a secondary role on the market). The pressure to entry in the field concerns the latter, yet their business results and financial situation are not and cannot be good. Many of those who aspire to be their own boss are more interested in freedom of activity than the actual prospects of success. The pressure to enter the field and set up a small family business is not affected by the high cost of a lorry, the need to obtain a certificate of professional competence, the difficulties of obtaining access to freight or the high number of business failures.

The competitive position of large and small transport firms is not comparable: the former conclude long-term contracts with shippers, thereby ensuring a stable volume of activity; the latter are often reduced to the role of subcontractors for less profitable freight. Owing to overcapacity on the road transport market, shippers can oblige large and small operators to compete. Large operators and their groupings have a commercial department (marketing, consolidation, auxiliary services, etc.) which ensures their access to freight. Small operators have to make do with carrying out the transport operation for a fee that is reduced by various commissions charged by intermediaries between them and the shippers. Subject to terms providing very little in the way of security or rewards, the small sub-contracting firm takes on the work which the large firm does not want. He is subjected to working conditions he would not have accepted as an employee, but he is his own boss (Bernadet and Lasserre, 1985, pp. 150-151).

The attractiveness of the market for small road transport firms is therefore an illusion. For those who are keen to provide transport services, freedom of activity is a major asset. It would not be sensible to deter those who wish to enter the field and encourage them to work instead for a large and well-organised road transport firm. The problem is rather to adjust the competitive position of small and large operators. It is not possible to have small firms carry out all the activities of major operators, and it would not be reasonable to reduce the efficiency of the leading firms. Better organisation of the road transport market, however, could reduce the disadvantages of small operators, teach them to calculate costs and encourage the creation of associations. But it would be excessive to implement in the road transport sector a policy similar to the EU's agricultural policy by paying subsidies for withholding road transport services.

Social provisions (Community and national)

There is no single social insurance scheme for Europe. The European Union started from the principle that working conditions would improve as a result of the common market and the harmonization of national economic policies. National social insurance systems differ greatly in terms of the type of

benefits, the level of insurance and the methods of financing insurance schemes. EU member countries have extensive autonomy with regard to their social policies, although the harmonization of labour legislation is an exception. The Union's social policy is not based on a wide range of regulations and directives. It is underpinned by recommendations and action programmes, especially as regards the elimination of poverty and the integration of the disabled.

European labour legislation addresses the issues of equality of treatment for men and women, the duration of the working week (40 hours), the minimum holiday period (four weeks a year), requirements for the employment of minors, the activity of workers' committees, health and safety at work, etc. These provisions are general in nature, but in some cases (education, medicine, etc.) there are specific obligations.

In terms of road transport, European social provisions concern only driving hours and rest periods or breaks. Community legislation, which is mainly justified by safety reasons, does not so far include any provisions for the length of working hours. Regulation 3820/85/EEC defines daily and weekly driving times and rest periods (or those applicable for a fortnight), and breaks from driving. [2] This regulation is broad in scope since it applies to all road transport, including public transport and own-account operations, freight and passengers, and drivers, whether employees or not. This text also spells out the requirements to be met by drivers and sets the minimum age for a driver at 18 or 21 years depending on the vehicle's permissible maximum weight (21 years for passenger transport) (Bernadet, 1990, pp. 84-89).

Member states may apply higher minima or lower maximum values than those defined in the regulation. National provisions often include a long list of standards which are not limited to driving but specify times for work other than driving and standby time. In no case are the working time regulations the same for the two modes competing on the market: road and rail.

Regulation 3820/85/EEC is not aimed at preventing drivers from exploitation by their employers but at harmonising the conditions of competition between methods of inland transport, especially with regard to the road sector and the improvement of working conditions and road safety. Neither the employees of large road transport firms nor the owners of small-scale firms find this regulation satisfactory. All want to earn more, even if it means driving ten hours a day, but the Regulation is restrictive in this respect. As a result of this regulation, the number of accidents caused by lorry drivers was substantially reduced (by over 30 per cent) in the period 1970-95. It is more difficult to say whether the regulation has had any influence on the harmonisation of the conditions of competition: the decrease in road transport prices seems to suggest that firms have offset the impossibility of reducing costs by lengthening working times by other irregularities. The improvement in road safety due to the lower number of accidents caused by lorry drivers has been accompanied by improvements in drivers' working conditions. However, the certainty of having quite long daily and weekly rest periods but no possibility of earning more does not make for a relaxed social climate in the sector.

According to a Committee of Enquiry (European Commission, 1994), current legislation and the way in which it is enforced do not allow for achieving the desired goals for a number of reasons. First, the regulations are sometimes too complicated, as recently confirmed by the Court of Justice of the European Communities; second, they are not applied and respected in the same way by different countries; third, they are frequently breached or circumvented. As labour accounts for a high proportion of total operating costs, non-compliance or non-implementation threaten the safety of drivers and the public but also distort competition. Such distortions exist not only between operators located in different member states but also between different types of operators, since the difficulties for inspection vary with the size of the enterprises concerned.

Although the provisions of Regulation 3820/85/EEC on driving periods[3] are clear and simple, those concerning breaks and rest periods are very complicated[4].

The complexity of Community social regulations means that their enforcement requires quite a large number of inspectors (at least one per 100 road hauliers, or an army of over 6 000 for the fifteen countries). The intensity and effectiveness of inspection differ greatly among countries, especially between western and eastern Europe. In the countries in transition, the road transport inspection system has been abolished as a relic of the old regime, and for the time being the only inspections are at the frontiers with the EU. Attempts to restore inspection bodies are often strongly opposed as they are regarded as a threat to the new market economy[5].

Sources and types of conflicts

The illusion that the operation of road services will provide economic freedom and ensure the well-being of workers is the general cause of discontent in the sector. Despite high demand and the existence of regular customers, road transport is not among the most lucrative of economic activities. The profit margin in EU countries ranges from 0 to 5 per cent on average, and about a third of firms are in the red. In this situation, the employers do not earn sufficient profits and employees are underpaid. Both sides are dissatisfied, but while the employees consider that the employers are mainly responsible, the latter blame the government, the European Community and foreign competitors for their troubles. In reality, the reasons for the unsatisfactory social situation in road transport are more numerous and interconnected.

There are differences in the economic and social interests of employers and employees in major enterprises, large and small enterprises, the owners of large or small enterprises and government, and government and employees. Tensions are least strong between family enterprises and employees in major enterprises (which have different positions with regard to relations with the social partners). Conflicts of interest are mainly connected with the remuneration of labour, but factors such as working time, overtime, holidays, pensionable age, admission to the occupation, subcontracting, etc., can cause crises.

Because they are subject to keen competition on the road transport market, employers have to offer their services at low prices. Those who benefit are the shippers, whose logistical costs are declining, while their revenues are rising. Employees are therefore the victims, as they cannot benefit from technical and economic progress in the road sector. What is lacking is a mechanism that will make shippers who treat carriers unfairly behave responsibly.

The low revenues earned by those who provide road transport is due to lorry overcapacity on the market. This overcapacity is quite easy to calculate. In the Union, 1 100 billion freight tonne-kilometres (Eurostat, 1995) could be carried by 14.7 million lorries with an annual productivity of about 75 000 tonne-kilometres (load of 3 tonnes x 25 000 km). The number of lorries registered in the EU in 1995, however, was 17.9 million, or almost 20 per cent more than necessary.

With little prospect of higher earnings, road hauliers are put at a further disadvantage by the authorities, who impose a number of restrictions that are unknown in other sectors. Farmers, shopkeepers and those in other occupations who work in dispersed structures are less strictly controlled than road transport firms: admission to the occupation is restricted, driving and rest times are checked, a special driving licence is required, etc. Road infrastructure costs are not met by the road hauliers, but the savings involved are offset by time losses on roads and streets saturated by other users.

Lorry drivers have very little chance of obtaining satisfaction in discussions with their employers or the authorities. Arguments that their wages should be increased because of inflation, and that wages should be fairly related to pay in other sectors are too weak. A strike within a firm that brings all operations to a halt is not enough to impress the decision makers. In order to attain their ends, lorry drivers are often obliged to take action outside the firm that will affect the public as a whole, *i.e.* block roads, hold up private traffic, and seal off supply centres, etc. Factory workers cannot make use of this way to put pressure, but the effects of demonstrations by lorry drivers are not immediate. It is not the public who can solve the drivers' problems but their employers and the authorities, in many cases at international level.

The social partners in road transport

The importance of road transport in the current economic environment is such that many bodies are trying to resolve this sector's social problems, at both national and international level. Conflicting interests explain the existence of trade unions, employers' associations and public bodies. There are quite a few road transport trade unions in all countries and their membership amounts to about 20 to 30 per cent of all employees. These trade unions are mostly branches of a country's major unions (such as CGT or FO in France), but many specific road transport unions representing other views or types of interest have been set up. The employers' associations include carriers and forwarders with a membership comprising major international transport operators, other carriers for hire and reward and family enterprises.

At international level, employers' associations can join the International Road Transport Union (IRU) which has three sections: *i)* passenger transport; *ii)* goods transport; *iii)* own-account transport. The IRU can approach the authorities of a country at the request of a national employers' association that wishes to defend the carriers' interest. Within the EU, the Joint Committee on Road Transport is the body which addresses the sector's social issues, such as regulations on working time and conditions.

In the event of conflicts, the social partners have a key role to play in resolving problems. If the conflict involves wages, the government cannot intervene and provide financial aid for what is a private sector activity. However, if a sectoral agreement is concluded, the government may decide to extend, by decree, the provisions of the agreement to non-signatory enterprises. In this case the aim is to prevent distortions in the exercise of the activity (Poingt, 1997, pp. 6-7). International structures such as the IRU or the EU's Joint Committee on Road Transport cannot take action to resolve particular conflicts. Their role is to help create a long-term social policy.

Within the IRU, social problems are the responsibility of the Committee on Social Affairs. It addresses issues such as: the evolution of the EU's social regulations and their possible effects on non-EU countries; the EU Directive on working periods [it considers that such a provision is not desirable at European level and simply that possible adjustments to the driving and rest times stated in the European Agreement on the Work of Crews of Vehicles Engaged in International Road Transport (AETR) could, where necessary, be considered]; the application of the AETR in non-EU countries and the difficulties of enforcement owing to the disparity of the relevant provisions; contacts with trade unions (in particular the International Transport Workers Federation – ITF) relating to the convergence of the employers' and employees' interests (assistance for drivers in the event of accidents or waiting periods at frontiers, visas, etc.) (IRU, 1995, p. 14).

Road transport costs and remuneration of labour

Wage problems are the main cause of social unrest. Although inflation and wage trends in other sectors call for a mechanism for adjusting wages in road transport, no such system exists. The source of conflicts may be the difference in wages between road hauliers and other carriers, as well as the difference in wages at international or regional level. The trade unions' view is often based on the assumption that wages should be equal, irrespective of the results recorded by road transport firms. In reality, wage disparities are justified by differences in the complexity of the work carried out.

The factors that tie the hands of management in terms of wage strategy are market prices, operating costs and the impact of labour on total costs. The market price of services is continually declining, while production and labour costs are rising. From the social viewpoint, drivers' wages should rise in real terms, *i.e.* more quickly than inflation. In fact, their wages rise more quickly than total costs but more slowly than inflation.

It is very difficult to analyse the level and structure of costs in road transport firms as access to information is limited by commercial secrecy. The costs can be deduced from factor prices, but the results depend on the method used. The results obtained for 1986 from four different reports showed quite a wide dispersion (ECU/vehicle-kilometre), but it can be seen that road transport was cheapest in Spain and the Netherlands and most expensive in Germany, France and Italy (Table 1).

Table 1. Price of road transport, 1986
ECU/vehicle-kilometre

Country	Prognos Report	NEA Report	PCL Report[1]	AFTRI Report
Germany	0.78	0.97	0.82	0.89
France	0.78	0.92		0.88
Belgium	0.72	0.96	0.72	
Italy	0.80	0.99		
Netherlands	0.70	0.98	0.73	0.78
UK		0.93	0.78	0.77
Spain		0.84		0.77

PCL: Polytechnic of Central London. NEA: Transport Research and Training, Netherlands. AFTRI: French Association for International Road Transport.
Source: Fos, 1989, pp. 167-70.

According to Dutch data,[6] the level of costs for international road freight transport in the EU evened out somewhat between 1987 and 1991, but was still highest in Italy, Germany and the Netherlands and lowest in Spain, France and Belgium. These figures can be challenged by French road hauliers. According to National Regulation 83-40, French carriers have to pay their employees for the time they work whatever it involves (driving, work other than driving, standby time) (Bernadet, 1990, p. 88), which increases their costs. The data in Table 2 are therefore subject to reservations.

Differences in costs have taken on greater importance since the liberalisation of cabotage on 1 July 1998. French road transport firms consider that a Portuguese firm will be able to carry goods between Paris and Marseilles more cheaply since its costs are 30 per cent lower than those of French operators (Poingt, 1997, p. 6). After the enlargement of the EU to include Poland, the Czech Republic and Hungary, competition will be even keener, as the costs of these countries' road transport firms are on average 35 to 45 per cent lower than their competitors in the EU.

Table 2. Cost of international transport of freight by road, 1987 and 1991
Netherlands = 100

Country	1987	1991
Netherlands	100.0	100.0
Germany	99.2	101.9
France	94.6	98.4
Belgium	98.0	99.2
Italy	101.0	104.0
Spain	85.6	92.2

Source : Data published by the NEA Institute, Rijswijk, 1995.

In the 1980s, labour accounted for between roughly 27 and 39 per cent of road transport costs, depending on the country. The countries with the highest monthly labour costs were Germany, the Netherlands, France and Belgium, whether because of the level of compensation (as in Germany) or the amount of direct taxes and social security contributions (as in France). The countries with the lowest monthly labour costs were Italy, the United Kingdom and Spain (Fos, 1989, p. 167) (Table 3).

Table 3. Labour costs as a share of total costs in the road transport sector
ECU per vehicle-kilometre

Pays	Cost in ECU and as % of total	Prognos Report	NEA Report	PCL Report	AFTRI Report	Average
Germany	ECU/1 veh.-km	0.27	0.32	0.21	0.32	0.28
	% of total	34.2	33.4	25.6	36.3	32.4
France	ECU/1 veh.-km	0.26	0.32		0.34	0.30
	% of total	32.8	34.8		38.4	35.3
Belgium	ECU/1 veh.-km	0.27	0.33	0.21		0.27
	% of total	37.6	34.0	29.0		33.5
Italy	ECU/1 veh.-km	0.30	0.34			0.32
	% of total	37.8	34.2			36.0
Netherlands	ECU/1 veh.-km	0.32	0.37	0.25	0.31	0.31
	% of total	45.4	37.2	33.8	39.7	39.0
UK	ECU/1 veh.-km		0.25	0.22	0.20	0.22
	% of total		27.0	28.6	26.4	27.3
Spain	ECU/1 veh.-km		0.22		0.26	0.24
	% of total		26.3		33.6	30.0

PCL: Polytechnic of Central London. NEA: Transport Research and Training, Netherlands. AFTRI: French Association for International Road Transport.
Source: Based on information published by Fos, 1989, p.170.

The share of labour in road transport costs in 1986 was 33 per cent on average, quite high but not excessive. In the case of rail, this share often exceeded 45 per cent, which made rail less competitive.

In the 1990s the trend towards a decline in road transport prices and an increase in costs continued, but with differences among countries. It is not possible to analyse in this report the statistics for all the European countries, representative data is given for France and the Netherlands.

In France, nominal prices fell in 1993 and prices in real terms continually declined (Table 4). This was due to a very sharp fall in demand in 1993 (decline in traffic) and, more generally, to a marked increase in competition in international transport. In particular, devaluations made it possible for Italian and Spanish road hauliers to reduce their prices and step up competition in international transport.

Table 4. Price of international road freight (French carriers), 1989-93

Year	Turnover (FF billions)	Total traffic (t-km billions)	Price per t-km (average in FF)	Price per t-km (1989=base 100)	Price index (1989=100)
1989				100.0	100.0
1990	10 346	28 037	0.37	100.5	103.1
1991	11 072	29 055	0.38	102.6	106.2
1992	12 248	31 213	0.39	103.3	108.4
1993	11 326	29 788	0.38	100.8	111.1

Source: Chatelus, 1995.

In recent cost trends [published by the CNRS (National Centre for Scientific Research) for French road transport], the increase in total costs slightly exceeds inflation (Table 5). But the increase for some items is much higher, especially for labour and the replacement of tractors. However, interest payments for the replacement of equipment, insurance costs and, to a lesser extent, fuel costs are down.

Table 5. French road hauliers' costs, 1989-93

Date	31/12/89	31/12/90	31/12/91	31/12/92	31/12/93
Depreciation	100.00	97.42	102.01	101.04	83.80
Wage costs	100.00	102.96	105.33	118.56	123.41
Travel expenses	100.00	107.18	115.22	120.02	124.50
Insurance	100.00	102.67	98.35	97.95	98.87
Vehicle tax	100.00	100.74	109.56	112.01	115.83
Replacement of tractor	100.00	105.92	116.05	120.05	124.50
Replacement of semi-trailers	100.00	102.50	102.50	104.55	104.55
Fuel	100.00	103.63	92.99	93.53	104.07
Tyres	100.00	107.30	110.52	118.01	118.01
Maintenance	100.00	103.19	106.67	110.12	113.82
Tolls	100.00	100.00	108.04	112.23	117.91
Overheads	100.00	103.17	105.96	108.85	111.07
Total	**100.00**	**103.20**	**104.00**	**109.40**	**112.50**
Reminder: price index	100.00	103.10	106.20	108.40	111.10

Source: Chatelus, 1995.

As in France, wages and social security contributions in the Netherlands have risen more quickly than total costs (Table 6). Theoretically, this should mean that social problems are less serious in the sector, but since the increase in wages lags inflation, this not the case. The efforts by road transport firms to increase their productivity by cutting costs does not result in a satisfactory level of remuneration. The economic situation of the road sector must therefore be improved in general terms. The benefits of technical and organisational progress made by road transport firms can no longer go exclusively to the shippers.

Table 6. Costs of international road transport, Netherlands operators, 1992-94

Type of costs	1/01/1992 as %	1/01/1993 Base 1/01/1992=100	1/01/1994 Base 1/01/1992=100
Wage costs	47.00	104.3	104.6
Vehicle tax	1.0	133.4	155.2
Vehicle insurance	2.7	104.4	109.1
Replacement of vehicles	10.1	100.9	102.2
Fuel	15.2	108.1	113.8
Tyres	1.8	102.3	102.3
Maintenance	4.4	101.7	103.8
Financial costs	4.8	101.7	103.8
Other	13.0	101.0	103.9
Total	**100.0**	**103.4**	**104.7**

Source: Based on NEA Institute data prepared by F.G.M. Ballhaus, Rijswijk, 1994.

The discontent of drivers in firms providing road transport services for hire or reward is compounded by other economic factors. A comparison of the wages paid in road transport for hire and reward and in own-account road transport shows that the remuneration of labour is often higher in the second case. A shipper can afford to pay his drivers more than they would receive in a road haulage firm (Table 7).

Table 7. Average pay in French transport firms, 1994

Working conditions	Transport for hire or reward			Own-account transport		
	Weekly working time	Driving time[1]	Monthly wages in FF[2]	Weekly working time	Driving time[1]	Monthly wages in FF[2]
Daily return to base	49.4	0.58	7 437	42.8	0.52	7 573
Absent 2 to 4 days	54.6	0.65	7 911	52.0	0.60	8 267
Absent > 4 days	62.5	0.67	7 638	57.4	0.57	7 720

1. Driving as proportion of working time.
2. Including 13th month.
Source: Fos, 1995, p. 548.

Although they have a shorter working week, drivers in own-account transport operations are paid more. The explanation probably is that such operations are on a smaller scale than transport for hire or reward. According to the IRU, the share of own-account operations in total national traffic (expressed in tonne-kilometres) in 1984 ranged from 26.7 per cent (Greece) to 71.8 per cent (former USSR) and amounted to 14.9 per cent in intra-Community traffic (IRU, 1987). The proportion of own-account transport has probably declined in the 1990s. It is a service which has become more expensive and therefore less frequent.

Working time and conditions

The social climate in road transport firms also depends on working time and conditions. In EU member countries, not to mention non-member countries, there are considerable differences in the concept of working times.

There are no European standards in this area, but the Commission, in consultation with the social partners [Federation of Transport Unions (FST), International Road Federation (IRF), IRU and

others), is preparing the text of a directive on working time based on Directive 93/104/EC. There will be a new, wider concept of working time that includes not only driving time, but also time spent on loading and unloading, attending to boarding and alighting passengers, preparing, inspecting and maintaining the vehicle and administrative operations. The standard working week will be 48 hours, with a maximum of 60 hours provided that the 48-hour standard is respected over four months. The directive will apply only to drivers, while the other categories of personnel will be subject to the general directive on working time.

At the end of the 1980s, there were two concepts of working time in Europe, an extensive one and a restrictive one. The countries that took the extensive view were the Netherlands, Germany and France. Those that defined working time restrictively were Spain, Italy and Belgium.

In the Netherlands, the time between the start and end of the duty period was regarded as working time and paid as such. In Germany, working time comprised driving time, loading/unloading time, maintenance time, preliminaries to the start of work and any other standby time. On this basis, any time spent in the employer's service was counted and included in the working period. In France, the actual working period was equal to the working day (time between the start and end of service) minus the total duration of breaks and the time spent on washing and dressing, meals and snacks. In the case of long-distance drivers, any time spent with the vehicle other than for driving was seen as equivalent to two-thirds of actual working time (Fos, 1989, p. 167).

The concept of working time was defined restrictively in Spain where actual work comprised only driving, loading/unloading and watching over the vehicle. All the other activities involving the driver's presence were excluded from the actual working period and paid at 50 per cent of the going rate. In Italy, working time covered driving, loading/unloading and sometimes customs operations. In freight transport, time of presence was not included in working time and was paid at a third of the value in terms of time spent. In passenger transport, 60 per cent of the time of presence was included as actual working time. In Belgium the definition of working time was limited to driving time and loading/unloading by the driver. There was no legal maximum for other periods which were paid on a flat-rate basis (Fos, 1989, p. 167).

The European standard for the driver's working time is 90 hours per fortnight or 56 hours in one week (four periods of nine hours and two periods of ten hours) (Regulation 3820/85/EEC, Art. 6). This exceeds the general standard of 40 hours a week for which a reduction to 38 hours has been proposed. Statistics are lacking on the actual duration of driving time in EU member states and other countries and on the infractions reported following checks. Only extreme cases are mentioned by the media. Such statistics could confirm whether or not operators are reducing drivers' working time because of overcapacity on the road transport market.

As already noted, 14.7 million lorries in the EU with an annual productivity of 75 000 tonne-kilometres (load of 3 tonnes x 25 000 km) could meet the demand for 1 100 billion tonne-kilometres. The average distance of 25 000 km is quite low, even if it is an average figure; it means a distance of about 108 km per working day.[7] If a lorry's commercial speed is 20 km/h,[8] it would take a little over five hours a day to meet demand. Theoretically, there is therefore no reason for exceeding the weekly standard for driving time (45 or 56 hours); it would be more reasonable to reduce it to 35 hours a week.

There is, however, no lack of information indicating that drivers are required by their employers to work 54-55 hours a week and in many cases even 70 hours a week, sometimes 15 to 17 hours in one day, not to mention other extreme cases (Grassart, 1997, p. 8). These cases show that monitoring is

inadequate, as checks in practice involve only 1 per cent of road transport operations. Most offences escape notice and are not penalised.

The social climate in the road sector is affected by the number of creations and failures of firms and by fluctuations in employee numbers. The creation and failure rates depend closely on the economic situation. The creation rate is much higher in the transport sector (especially road transport) than in a national economy as a whole (three to five times higher, depending on the year), while the failure rate is also one of the highest and almost invariably exceeds the rate for all activities combined (Bernadet and Lasserre, 1985, p. 147). In France, 5 805 road transport firms were set up in 1994 (up 12 per cent from the previous year), while the number of failures was 1 632 (down 9 per cent from the previous year) (Fos, 1989, p. 547). It can be assumed that one of the causes of social problems in road transport is that the creation rate greatly exceeds the failure rate. The ideal would be a decrease in both rates.

The popularity of driving as a job seems to be in contradiction with working conditions in this sector. Drivers are exposed to stress (having to keep their eye on how others behave in road traffic), they have to put up with delays caused by traffic jams and frontier crossings, protect their lorries against theft, etc. However, it is natural that it should be more popular than working in the mines, for example.

It is not surprising that drivers demand the right to retire at 55. In some countries miners can retire at under 50, and the difference between lorry drivers and miners is not so great. This earlier retirement age would lead to additional costs which have to be paid by the owners and those who are still working.

Social issues for transport policy

Social issues are included in the statutes of many road transport bodies. But although technical, organisational and economic problems are resolved quite effectively, much has still to be done in the social field. The reason is the difficulty of analysing social issues, as it is not enough to calculate profitability or make econometric forecasts. Social issues are more complex and call for specific solutions.

The rules of the market economy are not compatible with the notion of equity. Those who work hard and contribute to progress in this sector are often unable to gain any benefit from their efforts. Competition on the road transport market has no equivalent in other transport modes. While lack of competition (as in rail transport) is not good, excessive competition is also bad. The sector has to be restructured so that it can provide low-cost services and ensure decent working conditions.

The issue in road transport policy remains the regulation of working conditions, but it is not sufficient to modify driving and rest times. The time allocated to all operations in road transport firms will have to be harmonised and made compatible with the standards in other modes. It is not enough to ensure that lorry and bus drivers rest after work, they must also be able to rest when away from home. Assistance must be provided for drivers who are involved in accidents, when they experience long delays, etc. Vehicle and cabin design must therefore be subject to social requirements and not simply to economic efficiency.

A new challenge in the social field is the elimination of the negative effects of fully liberalised access to transport markets in Europe (including cabotage). This liberalisation trend will bring a new wave of price cuts in road transport, which will benefit shippers. A larger market cannot work when there is a very large number of small firms, resulting in fierce competition and ruinous price wars. The exit from the market of a certain number of smaller firms that fuel price wars would be a positive step. An

efficient approach to restructuring could be a fiscal system in favour of groupings and the concentration of tonnage in larger and better organised firms.

The requirements of road safety and the environment conflict with the sector's social dimension. Intermodal transport seems to be the best way of reconciling these contradictory requirements. It enables drivers to save the time lost on congested roads and to rest while the vehicles are moving. Supporting intermodal transport is one way of helping to resolve social problems in the road transport sector.

Summary

The nature of social problems in road transport depends indirectly on the situation of the sector and its role in the economy and directly on this mode's specific organisation and working conditions.

The road transport sector seems to be quite attractive in economic and social terms. It is seen as one of the sectors where the idea of being one's own boss has the greatest appeal and chance of success. The belief in the possibility of improving ones social status and standard of living as a self-employed person withstands all evidence to the contrary.

The social climate in road transport is influenced by the number of creations and failures of firms and by fluctuations in employee numbers. The creation and failure rates depend closely on the economic situation. But the creation rate is higher in the transport sector (especially in road transport) than in the national economy as a whole (three to five times higher, depending on the year), while the failure rate is also one of the highest and almost invariably exceeds the rate for all activities combined.

Two-thirds of road transport firms in Europe have fewer than five employees. In such firms, employees carry out all operations relating to the provision of transport services under working conditions that have nothing in common with those in the offices of large firms. It is not logical to deter those who wish to enter the field and encourage them to work instead for a large and well-organised firm. The problem is rather one of adjusting the competitive position of small and large road transport firms.

The economic and social interests of employers and employees in major enterprises, of large and small enterprises, of owners of small and large enterprises and government, and of government and employees are not the same. Tensions are least strong between family enterprises and employees in major enterprises. Conflicts of interest are mainly connected with the remuneration of labour, but factors such as working time, overtime, holidays, pensionable age, admission to the occupation, sub-contracting, etc., can be explosive.

Employers are subject to keen competition on the road transport market and have to offer their services at low prices. It is the shippers who benefit from this situation. Their logistical costs are declining while their revenues are rising. The victims are the employees as they do not benefit from technical and economic progress in the road sector.

Lorry drivers have very little chance of obtaining satisfaction from discussions with their employers or the authorities. Arguments that their wages should be increased because of inflation and be related to pay in other sectors are too weak. A strike within a firm that brings all operations to a halt is not enough to impress decision-makers.

Wage problems are the main cause of social unrest. Although inflation and wage trends in other sectors call for a pay adjustment mechanism in road transport, no such mechanism exists. The source of conflicts may be the difference in wages between road hauliers and other carriers, as well as differences in wages at international or regional level. In the event of conflicts, the social partners have a key role to play in resolving the problem. If the conflict concerns wages, governments cannot intervene and provide financial assistance for what is a private sector activity. However, if a sectoral agreement is concluded, the government can extend, by decree, the provisions of the agreement to non-signatory enterprises in order to prevent distortions in the exercise of the activity.

The efforts by road transport firms to increase productivity by cutting costs does not result in a satisfactory pay level. The economic situation of the road transport sector must therefore be improved in general terms. Shippers should no longer be the only beneficiaries of the technical and organisational progress made by road transport firms.

Improvements in road safety and lower numbers of accidents caused by lorry drivers have been accompanied by some improvement in drivers' working conditions. However the certainty of having quite long daily and weekly rest periods but no possibility of higher earnings does not make for a relaxed social climate in the sector.

NOTES

1 . *EU Transport in Figures. Statistical Pocketbook*, DG VII 1997 (not including public passenger transport and employment in own account transport).

2. The earlier Community social provisions were defined in EEC Regulation No. 543/69 (OJ No. L 77 of 29.3.1969, p.49), last amended by Regulation 2829/77/EEC (OJ No. L 334 of 24.12.1977, p.1).

3. Article 6:
"1. The driving period between any two daily rest periods or between a daily rest period and a weekly rest period, hereinafter called "daily driving period", shall not exceed 9 hours. It may be extended twice in any one week to 10 hours.
"2. The total period of driving in any one fortnight shall not exceed 90 hours.

4. Article 8:
"1. In each period of 24 hours, the driver shall have a daily rest period of at least 11 consecutive hours, which may be reduced to a minimum of 9 consecutive hours not more than three times in any one week, on condition that an equivalent period of rest be granted as compensation before the end of the following week.
On days when the rest is not reduced in accordance with the first sub-paragraph, it may be taken in two or three separate periods during the 24-hour period, one of which must be of at least 8 consecutive hours. In this case the minimum length of the rest shall be increased to 12 hours.
"2. During each period of 30 hours when a vehicle is manned by at least two drivers, each driver shall have a rest period of not less than 8 consecutive hours.
"3. In the course of each week, one of the rest periods referred to in paragraphs 1 and 2 shall be extended, by way of weekly rest, to a total of 45 consecutive hours. This rest period may be reduced to a minimum of 36 consecutive hours if taken at the place where the vehicle is normally based or where the driver is based, or to a minimum of 24 consecutive hours if taken elsewhere. Each reduction shall be compensated by an equivalent rest taken *en bloc* before the end of the third week following the week in question.
"4. A weekly rest period which begins in one week and continues into the following week may be attached to either of these weeks.
"5. In the case of the carriage of passengers to which Article 6 (1), fourth or fifth sub-paragraphs, applies, the weekly rest period may be postponed until the week following that in respect of which the rest is due and added on to that second week's weekly rest.
"6. Any rest taken as compensation for the reduction of the daily and/or weekly rest periods must be attached to another rest of at least 8 hours and shall be granted, at the request of the person concerned, at the vehicle's parking place or driver's base.
"7. The daily rest period may be taken in a vehicle, as long as it is fitted with a bunk and is stationary."

5. For example in Poland, where the idea of restoring the Road Transport and Vehicle Inspectorate proposed in the 1995 publication on "Transport Policy" and in the publication on a "Transport Development Strategy for 1998-2002" has come to nothing.

6. Data published by the NEA Institute, Rijswijk, 1995.

7. A greater distance would mean that a smaller vehicle fleet was necessary.

8. Fos (1989, p. 171) refers to calculations based on an observed speed of 65 km/h which, taking loading and unloading times and road congestion into account, would mean travelling at over 150 km/h at the best times of the day.

REFERENCES

Bernadet, M. (1990), *L'Europe des transports routiers. Institutions-Textes-Perspectives*, Éditions Celse, Paris.

Bernadet, M. and J.-C. Lasserre (1985), *Le secteur des transports. Concurrence-compétitivité*, Economica, Paris.

Burnewicz, J. (1996*a*), "Privatisations et déréglementations du transport routier en Pologne", OECD/CEMT, Paris.

Burnewicz, J. (1996*b*), "L'indissociabilité du transport routier et du développement durable?", contribution to the XXVème Congress of the IRU, Budapest, 22-25 May 1996, first plenary session "Road Transport and sustainable Development".

G. Chatelus (1995), "Coûts et prix du transport routier international de marchandises en France. Rapport préparé pour le ministère du Transport et de l'Économie Maritime à Varsovie", INRETS, Arcueil.

European Commission – DG VII (1994), *Report by the Committee of Enquiry (B.T. Bayliss, R.J. Coleman, A. Denkhaus, H. Ghigonis, D.C. Meeus, A.M. Molinas, M.A. Ochoa, O. Olivieri, W. Röckmann, H. de Villèle) on road freight transport in the single European market. Recommendations*, Brussels.

European Commission – DG VII (1997), *EU Transport in Figures. Statistical Pocketbook*, Luxembourg.

Fos, Colette G. (1989), Coût du personnel de conduite dans la CEE, *Bulletin des Transports* nº 2327.

Fos, Colette G. de (1995), "Emploi dans les transports. Le rapport annuel du C.N.T.", *Bulletin des Transports et de la Logistique*, nº 2624.

Grassart, P. (1997), "Un routier témoigne : '24 tonnes de matières dangereuses dans le dos'", *La Vie du Rail*, 12 November.

IRU (1987), "The transport of goods by road for own account in Europe: Legislation and economic aspects", *IRU Papers*, No. 18, Geneva.

IRU (1995), *Annual Report*, Geneva.

OECD/ECMT (1997), *Statistical Trends in Transport 1965-1992*, Paris.

Poingt, M.-H. (1997), "Grève des routiers. Anatomie d'un conflit", *La Vie du Rail*, 12 November.

INTERNATIONAL REGULATORY PROVISIONS CONCERNING THE ORGANISATION OF WORKING TIME OF MOBILE WORKERS IN ROAD TRANSPORT

W. Smolders
IRU Employers' Spokesman, EU Road Joint Committee

Introduction

Social aspects of road transport is a wide-ranging subject. It includes all aspects that influence the health and safety of workers when at the disposal of the employer and all financial and other compensation that workers receive for their work. The quality of the road vehicle (driver seat, noise, safety conditions) and the quality of the road infrastructure (road surface, rest areas) are part of the social aspects of road transport. Likewise, special characteristics, such as aggressive passengers in buses or taxis, numerous pedestrian crossings in the course of the distribution or collection of goods (post, household deliveries) or increased exposure to theft, attack or corruption in certain countries, are social aspects of road transport.

For the operator, social aspects must be combined with legal, technical, economic and commercial aspects. Taking account of all these aspects, he should be able to offer an attractive transport service at a price that covers input costs and leaves a margin that rewards entrepreneurial risks and activities.

The road transport market has changed substantially over recent years. Liberalisation has led to fiercer competition of a more and more international character. The organisation of economies has changed, creating more demand for road transport. Furthermore, increased mobility and insufficient investment in road infrastructure have led to increasing congestion, hence longer driving times and a trend towards driving at times when roads are not congested. Lorry bans of different kinds (night, weekend, daytime in city centres) add to the difficulties that operators and drivers face in fulfilling social requirements, and indeed in operating efficiently.

Road transport is not a homogeneous product. There is an enormous variety of road transport services, each of which presents specific health and safety issues for the workers concerned. Selling or checking tickets in public passenger transport is different from driving a 40 tonne lorry, or a taxi, or from packing and unpacking activities related to a removal. When dealing with working time as a main social aspect of road transport, and when considering international regulatory provisions concerning the working time of mobile workers, the different needs of the different categories of road transport activities appear to be a factor of overriding importance.

It is too simplistic to argue that working time rules can be the same for all. At the very least, when introducing uniform rules, provision must be made for the possibility of adapting them to the specific characteristics of different road transport activities. This adaptation should be based on the recognition that health and safety levels implied by mobile jobs are not always the same and that business needs are different.

A final introductory remark must be made regarding the relationship between working time and other social aspects. The attractiveness of a job, and the well-being of the worker concerned, depends on a package of conditions, including:

- the duration of the work;
- the quality of the work;
- the working environment;
- the (financial) compensation.

Such a package is not necessarily helpful from the legislator's point of view. The legislator can only lay down minimum standards for each of these elements. In individual cases, an employer and a worker, or the social partners at other levels, may consider that outstanding conditions in one respect compensate for minimum or even legally sub-minimal conditions in another. For example, many professional sportsmen disregard minimum standards of health and safety in exchange for financial, other material or even non-material compensation.

The concept of a "package" exists in daily practice in road transport also. In some mobile jobs, hours are long but the working environment is appealing and the earnings are higher that those the workers concerned could earn in any other job they might be able to do. Other mobile jobs are "8 to 5" jobs in a less demanding or appealing working environment and with a lower financial compensation. The legislator cannot deal with this degree of detail; collective agreements, or to put it in a more general way, "agreements between the social partners" can.

This report deals with international legal minimum standards for the organisation of working time of mobile workers in road transport. The need for such standards was argued by the European Commission in 1990, when it made its proposal for minimum working time standards for all workers in the European Union. To date, no such standards have been adopted.

The European social partners in road transport have tried to reach an agreement on the matter. Even though the discussions and negotiations within the framework of the Joint Committee failed to produce an agreement, they nevertheless provide useful input for international authorities wishing to establish minimum standards for working hours in road transport. In particular, the need to adapt to the specific requirements of different road transport activities, and hence a role for the social partners in the fine-tuning of standards, is indispensable if legislative measures are to be implemented and complied with.

Employment in road transport

Road transport activities provide an estimated total of 6.5 million jobs in the European Union.[1] There are about 1.2 million jobs in passenger transport, some 2.1 million in road haulage for hire or reward, and 3–3.5 million in own-account transport.

Precise figures for the Union as a whole are difficult to establish. Lack of national statistical data is one reason for this. Even though the statistical source is quoted in most cases, some of the figures in Table 1 are estimates provided by trade unions and employers' associations. Another important reason, in the field of own-account transport in particular, is the lack of a uniform definition of transport activities and the existence of many jobs which include transport functions without being full-time jobs in transport. Finally, in urban passenger transport, if a company operates both bus and light railway systems, the precise number of jobs related to bus operations may be difficult to establish.

Employment in road transport of passengers

Bus and coach

Total employment in the bus and coach industry is approximately 800 000, *i.e.* the 738 100 given in Table 1 plus urban bus transport in Paris (approximately 22 000) and possibly 104 000 further jobs in Portugal and Greece. The figures for these two countries are high, relatively speaking, and may relate to all passenger transport, including taxis and other services (ambulances, etc.).

On average, in the countries that list employment in the bus and coach sectors separately, 73 per cent of jobs are in bus transport and 27 per cent in the coach sector. It should be noted that the coach sector includes some interurban transport and, in some countries, special regular services (*e.g.* transport of schoolchildren and of employees to and from work), which in other countries are counted as transport by bus. When using the 73 per cent share indicated above for the European Union as a whole, it follows that bus transport provides some 585 000 jobs and the coach industry some 215 000 jobs.

In bus transport, the share of on-board jobs in total employment is 71 per cent. In coach transport, it is 86 per cent. These values result from data for only five EU countries and should be viewed as an indicative rather than a definitive figure.

Taxi and special services

Total employment in passenger transport with vehicles for less than ten persons is estimated at 400 000 jobs. Most of these are independents, *i.e.* owner-drivers of taxis. Part-time employment is frequent in taxi transport in some countries. In Germany, for example the number of part-time drivers is 150 000 as opposed to the 75 000 jobs shown in Annex Table 1. In Denmark, the number of part-time jobs is 20 000 as opposed to 7 000 indicated in the table. The figures in the table relate to the number (known or estimated) of full-time jobs.

Employment in goods transport

Road haulage for hire or reward

There are between 2.1 and 2.2 million jobs in road haulage for hire or reward (data available for all countries except Ireland). On average, for 12 countries (European Union minus Germany, Greece and Ireland), 76 per cent of the jobs are in driving and 24 per cent in other work.

Owner-drivers represent varying proportions of total employment in the member states. High proportions of driver jobs in total employment are found in Finland (82 per cent), Italy (84 per cent) and Sweden (87 per cent) and this may be due to relatively high numbers of owner-drivers. Interestingly, this phenomenon is not observed in Spain, despite a relatively large number of individual or two-person road haulage companies.

Activities related to road transport (forwarding, etc.) have been excluded for the countries which provided this breakdown. This also influences the proportion of driver jobs in total employment.

Table 1. Employment in road transport
Thousands

		Bus and coach	Bus	Coach	Taxis & others	1 + 4	Professional road haulage	Own account		6 + 7
	A							25.0		
Austria	B							14.0		
	Total	7.5	4.0	3.5	7.5	15.0	39.0	65.0	104.0	
	A	13.2	10.0	3.2	7.0	20.2	27.0			
Belgium	B	5.3	5.0	0.3		5.3	15.0			
	Total	18.5	15.0	3.5	7.0	25.5	42.0		42.0	
	A	120.0	20.0		75.0	195.0				
Germany	B	20.0				20.0				
	Total	140.0			75.0	215.0	538.0	650.0	1188.0	
	A	9.0	6.5	2.5	7.0	16.0	45.0			
Denmark	B						6.0			
	Total	9.0			7.0	16.0	51.0			
	A	49.2	44.0	5.2	75.0	124.2	234.0			
Spain	B	13.8	12.0	1.8		13.8	80.0			
	Total	63.0	56.0	7.0	75.0	138.0	314.0	886.0	1200.0	
	A				43.0	43.0	275.0			
France	B				4.5	4.5	85.0			
	Total	111.0	65.0	46.0	47.5	158.5	360.0	325.0	685.0	
	A	27.0				27.0				
Greece	B									
	Total	27.0				27.0	45.0			
	A	88.0			75.0	163.0	252.0			
Italy	B	42.0				42.0	47.0			
	Total	130.0			75.0	205.0	299.0			
	A	4.0	3.0	1.0		4.0				
Ireland	B	1.5	1.4	0.1		1.5				
	Total	5.5	4.4	1.1		5.5				
	A						4.0			
Luxembourg	B						1.0			
	Total	1.3	0.7	0.6		1.3	5.0			
	A	22.0	18.0	4.0	12.0	34	76.0			
Netherlands	B	8.5	8.0	0.5		8.5	37.0			
	Total	30.5	26.0	4.5	12.0	42.5	113.0	113.0	226.0	
	A					57	27.0			
Portugal	B					20	17.0			
	Total					77	44.0			
	A	28.0	23.5	4.5	32.2	60.2	26.0			
Sweden	B	3.0	2.5	0.5		3	4.0			
	Total	31.0	26.0	5.0	32.2	63.2	30.0			
	A	13.0			12.0	25	32.0			
Finland	B	2.5				2.5	7.0			
	Total	15.5			12.0	27.5	39.0			
	A	105.0			50.0	155	171.0			
United Kingdom	B	43.3				43.3	51.0			
	Total	148.3			50.0	198.3	222.0			
	TOTAL	**738.1**			**400.2**	**1138.3**	**2141.0**	**2039.0**	**4180.0**	

A = mobile; B = non-mobile.
1. Actual EU totals will often be higher, because of data missing in the global table.

Own-account transport

Figures concerning employment in own-account transport are known for only five EU countries (Austria, France, Germany, the Netherlands and Spain). However, these countries count for 58 per cent of tonne-kilometres performed in own-account transport in the European Union. The total number of own-account jobs in those countries is just over 2 million. Thus, for total tonne-kilometres, employment can be estimated at (100:58) x 2 039 000 = 3.5 million.

Four of the five countries (*i.e.* except Spain) show about the same ratio between employment and tonne-kilometres. Taking these four countries as a reference to estimate employment in countries for which data are unavailable, total employment is estimated at 2.9 million.

Social partner discussion on the organisation of working time in road transport

The role of the social partners

Following a European Commission request to assist in the preparation of EU working time rules for road transport, the Joint Committee on Road Transport discussed this matter in 1997 and 1998, apparently without tangible results. Hopes that the social partners in road transport would reach an agreement on working time for mobile workers have not been fulfilled. Perhaps they did not have enough time; on the other hand, they may not have achieved an agreement even if they had six months or a year more, owing to the complexity of the issue and concern on both sides that a compromise would make things worse rather than better in some EU countries.

The Commission decided not to wait and to put forward its own proposals, although a Council decision also may take some time. Hence, mobile workers in road transport are likely only to be covered by minimum EU standards on the organisation of their working time in some years' time.

Rather than speculate as to when such rules will be implemented and what they will be like, it seems relevant to deal with problems that need to be resolved. Here, experience acquired by the European social partners, the IRU for the Employers and the Transport Trade Unions (FST) is certainly helpful.

The history of EU social dialogue on working time

The European Commission published a proposal for a directive concerning certain aspects of the organisation of working time in October 1990. In the proposal, all employed workers in the EU were included. The Council decided, however, that workers in some sectors and activities would be excluded. The Council instructed the Commission to propose specific legislation for each mode of transport, in consultation with the social partners where possible. For all transport sectors, a joint committee had been set up in the past by the Commission. The Commission therefore invited each of the joint committees to take part in the preparation of proposals that would take due account of the specific characteristics of the respective sectors, and to give joint views/suggestions, if possible.

In the Road Joint Committee, the trade union side was quite eager to discuss such a joint opinion. The employers considered that the Council had taken the right decision, for a number of reasons:

- Road transport is not a homogeneous industry. Differences between countries (geography, economic structure, general social legislation, etc.) and sub-sectors are such that the issue should be dealt with at national and sub-sector level.
- For the employer, the working time of a mobile worker is difficult to measure and to monitor. Depending on the definition and the registration method, working time could reach 24 hours per day.
- Social protection at EU level is already provided for in Regulation 3820/85/EEC on driving and rest times. Compliance with this regulation would be better for health and safety protection than the introduction of new rules. Furthermore, working time rules might be difficult to combine with this existing EU regulation.

– The competitive position of EU road transport may be affected by the increased opening of the market to non-EU transport operators.

The social partners finally agreed to undertake a joint study of existing national working time conditions. The study included a qualitative inventory of conditions of pay and investigated the enforcement of working and driving time regulations. A detailed and lengthy questionnaire was much the same as the document CEMT/CS/TR(98)6 with regard to working time and some other social conditions. The latter document concentrates on legislative provisions, however, whereas the study launched by the social partners includes collective agreements and even national practices as a basis for existing national situations.

The detailed questions and the even more detailed answers showed a wide variety of national solutions to "universal" problems, such as the definition or measurement of working time, extra compensation in the case of night work and weekend work, or the need for flexibility due to unforeseeable events (traffic condition, emergencies, etc.). The answers were therefore difficult to organise in tabular form. Moreover, many individual answers in the table required a footnote so as to avoid the danger of not comparing like with like when reading the tables and comparing countries or sub-sectors. Nonetheless, a general picture emerged with regard to a number of important aspects of working time. These results will be dealt with in the following section of this report.

In 1996 and early 1997, the results of the joint study were discussed among the European Commission services concerned (DG Social Affairs, DG Transport) and the European secretariats of the social partners. The Commission insisted that EU working time rules for road transport needed to be introduced. The social partners jointly preferred such rules to be agreed among themselves, rather than to be based on a Commission proposal and a subsequent Council decision. The employers, while maintaining their doubts about the usefulness of working time rules, increasingly considered that a new attitude was needed, because of the many workers not covered by the driving and rest time regulation, because of the need to be involved in discussions that were going to take place in any case, and because of the increasing political support in EU institutions and in member countries for a reduction in working hours in road transport.

By the time the Commission published its White Paper on the excluded sectors (July 1997), the scene was set for discussions between the social partners to begin. Therefore, in October 1997, the Joint Committee launched a series of meetings of its working party on working time. In a relatively short period, the working party prepared a framework for negotiations, setting out the principles of a possible agreement. This framework was adopted by the Plenary Joint Committee in February 1998.

The Commission issued its second-stage consultation document[2] on the matter in April 1998 and in response, in May, the social partners formally informed the Commission of their intention to reach an agreement. The May date is relevant, as the Commission had to give the social partners a period of nine months to reach agreement. The Commission chose to consider that the negotiation period started in October 1997 and accorded the social partners only until 30 September 1998. It also reduced the scope of a possible agreement to mobile workers in the road transport industry, arguing that mobile workers in own-account transport belong to sectors already covered by the 1993 directive and that non-mobile workers in the transport sectors should be brought under the scope of that directive. The Commission indicated, however, that it would forward proposals for directives to the effect that mobile workers in own-account transport and owner-drivers in the road transport industry would be subject to the working time provisions adopted for mobile employed workers in the road transport sector.

The working party of the Joint Committee finalised a draft agreement in August 1998. This draft agreement was studied at national level by the member organisations of FST and IRU. Even though quite a large number of members on both sides were in favour of it, there was also opposition on both sides. Therefore, the agreement could not be approved on 18 September.

In the short period that remained until the deadline set by the commission, the president of the joint committee proposed a compromise solution. In the final plenary negotiations on this proposal, principles that had already been agreed in February and texts of articles that had previously been reviewed and approved were suddenly contested again. Under these circumstances, no agreement could be signed.

Summary

The social partners made a joint study of existing national legislation, collective agreements and national practices concerning the organisation of working time, conditions of pay and the enforcement of working time and of driving and rest time rules.

The findings of the study were used during the discussions and later during the negotiations of the social partners. The social partners intended to reach an agreement on working time for mobile workers in the road transport industry under the terms and conditions of the Social Protocol Procedure established in the Maastricht Treaty.

The social partners failed to reach an agreement before the deadline of 30 September 1998 imposed by the Commission. The Commission then announced that it would soon submit its own proposals to the Council.

The framework for EU rules on working time in road transport

Limits on working time in road transport are of paramount importance, not only for the health and safety of the workers concerned but also for road safety. The importance of harmonized time limits is explained by the international character of competition in road transport, and to some extent by the need for minimum standards at EU level, as part of the social dimension of the Union.

Particular aspects of road transport need to be taken into account, however, as rules should not only exist on paper but also be implemented and complied with:

- Legal and safety protection is generally meant for the benefit of employed workers. The legislator would not wish, normally speaking, to impose working time limits on entrepreneurs. This would not make much sense, because it is impossible to enforce such limits. In road transport, there are many independent drivers. It is not too difficult for employed drivers to become owner-drivers, and the change may take place at the request of the employer rather than on the initiative of the worker concerned. Care must therefore be taken that measures designed to promote the health and safety of mobile workers do not affect this category adversely.
- There are many mobile road transport workers outside the transport sector. According to data collected by the EU social partners, the number of workers in own-account transport (companies moving the goods they produce, trade, etc., as an ancillary activity) equals the number of workers in the road transport industry (more or less 3 million each). The nature of the activities of mobile workers in own-account transport is not different from

that in the road transport industry. Therefore the legal conditions for the organisation of working time must be the same.

- Mobile workers in road transport often work alone, away from the company office. They are responsible for registering their working hours, except for driving hours when the vehicle is equipped with a tachograph. There are therefore risks of false registration of working hours, to the "benefit" of the worker or to the "benefit" of the employer if the worker so agrees. In the absence of proper enforcement, working time rules in road transport run a considerable risk of being neglected.

Whereas effective EU working time rules for road transport are possible only if these three specifics aspects are duly taken into account, the framework for EU rules is set furthermore by:

- Regulation 3820/85/EEC on driving and rest times;
- Directive 93/104/EC on the organisation of working time;
- existing national legislative measures.

Regulation 3820/85/EEC

The three main reasons for harmonized rules (road safety, fair competition, social protection) are covered by Regulation 3820/85/EEC. This regulation sets maximum driving time and minimum rest periods for most mobile workers in road transport, for hire or reward as well as own-account.

Indirectly, the minimum rest requirements introduce maximum working hours. There are 168 hours in a week (7 x 24) and minimum rest, on average, takes 100 hours (5 x 11 hours daily rest and 45 hours weekly rest). Hence, 68 hours remain, of which some 4 hours (5 x 45 minutes) are breaks. Therefore, if Regulation 3820/85/EEC is complied with, the average working week of the drivers concerned cannot be longer than 64 hours. On the one hand, this is well above the 48 working hours per week in the EU directive on working time. On the other hand, it makes clear that working weeks of 70 or 80 hours on average, are already illegal now.

In order to remedy such unhealthy and unsafe working conditions, proper enforcement of existing legislation may be more effective than the introduction of new rules. In any case, enforcement is the key if the hours of mobile workers are to be kept at acceptable levels. Particular aspects of enforcement will be addressed in the next section of this report.

Directive 93/104/EC on working time

From the perspective of the EU, the aim of an initiative to provide minimum health and safety standards for transport workers must be to have standards which are equivalent, if not equal, to those available to all other workers. It was not without reason, therefore, that the EU Commission included all employed workers, regardless of the sector or the activity, in its 1990 Proposal for a Directive on Working Time.

Directive 93/104/EC is therefore a second point of reference. Its essential elements are:

- a maximum working week of 48 hours, on average, over four months;
- minimum daily rest periods of 11 hours and a minimum weekly rest of 35 (11 + 24) hours;
- four weeks' paid leave;
- break(s) if the working day is longer than six hours;

- a specific working time limit for night workers and a health assessment of night and shift workers;
- much is left to the competence of the member states:
  - the definition of working time;
  - the introduction of derogations of all kinds;
  - the possibility to apply or introduce legislative measures more favourable to the protection of health and safety of workers or to facilitate or permit more favourable agreements concluded between the two sides of industry.

Importantly, Directive 93/104/EC covers just two categories of time: working time and rest periods. The concept behind this directive is a daily work period that starts when the worker comes to work and ends when he goes home again.

In road transport, there are three categories: in addition to working time and to rest periods, there are hours during which the worker is not engaged in any working activity but not fully free to go, or to do as he chooses. The distinction between working time and "availability time" is not always easy, and the transition from "availability" to "rest" may also be gradual.

In their discussions, the social partners often used the example of a coach that brings Brussels' inhabitants to Knokke beach in the morning and takes them back to Brussels in the evening of the same day. The driver of the coach works at least four hours, two in the morning and two in the evening. But what about the seven to ten hours in Knokke? Under which conditions are they a rest period? When are they sheer "availability"? Would they be working hours if the driver was instructed to stay on board the coach, or if the driver on his own initiative decided he had to stay with the vehicle or to clean it? Could such hours be just a break? From the perspective of driving and rest time, the answer is irrelevant: the hours count as part of the 68 hours that are not rest (under normal circumstances, they would not be considered as a daily rest because, as a consequence, the two driving periods of two hours each would be separate daily driving periods and an obligation to take a weekly rest would occur earlier than if the journey is taken as one daily driving period). It is clear that if these hours are working hours in the meaning of a working time regulation, the maximum number of working hours is reached very quickly.

With the exception of some trade unions and possibly of the French administration, all parties accept that such duty hours cannot count as working hours if there is a stringent legal limit to the number of working hours, such as the 48 hours in the EU directive on working time or the 35 hours for normal working time under French law. Proof of this acceptance is found in national legislation which generally entails special provisions for road transport and/or refers the matter to the social partners.

The study made by the social partners summarises the findings with regard to the definition of working time as follows. The definition of working time is essential for understanding the implication of legal limits to working time. Furthermore, at the level of collective agreements, the definition of working time is the basis for most of the provisions relating to pay and possibly other forms of compensation. The definition of working time in the legal sense may be different from the one adopted by the social partners with regard to pay. A further complication arises when hours are counted only partly as working hours as regards the legal limit and/or in agreements on pay.

The complexity of the issue is reflected in the information obtained on this matter from the national employers associations and trade unions. In terms of legal provisions, even though definitions of working time generally exist in national law, transport sectors are often mentioned as sectors where special arrangements apply or may apply if the social partners so decide.

The legal systems take two rather different approaches:

- One is based on the time during which an employee is at disposal of the employer, where certain periods of time can be exempted. Present situations in the member countries range from counting all hours except breaks (*e.g.* Germany) to excluding waiting hours and availability, or counting them for less than full time.
- The other is based on the notion of "effective" working time. Other times at the disposal of the employer do not count as working time in legal sense of the word (*e.g.* Italy) or an extra number of hours is allowed (*e.g.* Spain).

In the road transport sector, collective agreements may serve to exclude from working time definitions that are included, in principle, in the law (*e.g.* time spent on board trains and ferries in Italy). They serve in other countries to include elements that are not included in the legal provision (*e.g.* breaks in the Netherlands). They also serve to distinguish between categories of hours depending on the activity (or inactivity) for reasons relating to the legal working time limit or relating to pay (*e.g.* surveying loading or unloading of the vehicle in Belgium). Finally, they are used to introduce limits to the duration of certain activities below or above which hours are considered differently (*e.g.* minimum and maximum duration of unpaid breaks, in Italy).

In most EU countries, there are different collective agreements for different types of road transport activity, for different regions, and/or among social partners. Generally speaking, these collective agreements translate and/or extend legal provisions into conditions that satisfy the specific needs of a sub-sector.

One may easily imagine the difficulties caused by the differences in national situations when a definition must be found at EU level. The social partners intended to agree on a definition at EU level in order to promote harmonization and to establish the basis for social progress in the years to come. They failed, and one must expect that a EU directive will leave the definition of working time to the national level, as does the existing Directive 93/140/EC on working time.

The failure by the social partners in the Joint Committee to reach agreement is certainly due in part to the fact that each side based its views on different ways of implementing Directive 93/104/EC in the member countries. They argued that a European agreement should allow for maintaining such national implementation or rather that national rules should be included in the agreement, for the sake of establishing harmonized terms of competition.

One can easily imagine that the trade unions in many countries are opposed to the possibility of exceeding an average of 48 working hours per week on the basis of an individual agreement between an employer and a worker as provided for in Art. 18 of Directive 93/104/EC and in the national legislation of some member countries. Equally understandably, employers from these member countries cannot accept being deprived of this facility.

Likewise, it is easy to understand that employers, while willing to accept a European definition of working time instead of a national one, cannot agree to taking the most restrictive national definition as the European one, while trade unions from the country concerned would not wish to see a deterioration in their country as a result of the European agreement.

Existing national provisions

In addition to differences regarding the implementation of Directive 93/104/EC, there are also differences of a more general social nature between one country and another. Legal provisions on working time are part of more general social legislation which includes issues such as social security, the role of the social partners, other working conditions and sometimes even provisions relating to pay. For national governments, and even for the social partners, these general social frameworks are more important than social harmonization and health and safety protection in road transport. International rules concerning the latter will therefore be agreed and implemented only if they are compatible with the general framework at national level.

Compatibility can be obtained by allowing derogation from a directive, regulation or international agreement. An international legislative measure which, when looked at closely, is more an agreement to disagree than anything else is, however, of limited use. Here again, the lessons learned by the social partners in the course of their negotiations can be useful.

The first concepts discussed in the Joint Committee were innovative and aimed at real harmonisation. Final drafts and the President's compromise proposal were modest and included the corresponding provisions in the general directive on working time as the only possible basis for an agreement.

Failure to reach agreement may well have been caused, finally, by the opinion – on the trade union side in particular – that there is no advantage in signing an agreement which offers nothing more than the level of protection implied by existing legislation. This view may well be wrong, because the final draft agreement still contained appreciable improvements for the workers, such as a new and lower limit to working hours per single week and specific provisions for night workers.

Now, it is turn of the Commission, the European Parliament and – finally – the Council. The Council in particular will review the discussions that took place in the Joint Committee, will have to take account of different national situations and will finally take a decision which allows a sufficiently high number of member countries to maintain existing legislation.

A political problem will in the end be solved, but the effects of that solution on the protection of health and safety of road transport workers may well be modest indeed.

The issue of harmonised enforcement

The importance of harmonised enforcement

The issue of paramount importance for achieving better protection of health and safety of mobile workers in road transport is not to add legal standards but instead compliance with the existing ones. If Regulation 3820/85/EEC is complied with, workers concerned do not drive for more than 45 hours a week, on average, per two-week period. Some drivers' jobs include a significant amount of other work. But in most drivers' jobs, especially those in long distance road haulage and coach tourism, other working activities are ancillary and take up less than 10 per cent of driving time.

Long-distance transport is a very small part of total road transport, in terms both of tonnage and of employment. Far more jobs exist in urban and interurban passenger transport, in the taxi sector, in parcel deliveries, in transport for nearby markets (construction, agriculture, retail trade, etc.), where maximum permissible driving hours are hardly ever reached, where drivers go home every day and have daily and weekly rests that are well above the minimum standards.

Respecting present health and safety standards only causes a problem in long distance operations. It is a problem for many drivers themselves, as they prefer to drive and rest as they wish rather than stick to hours imposed by bureaucrats, and as they wish to make money (most drivers would not find other jobs that pay as well).

It is a problem for operators, because labour costs are a considerable part of their total costs (up to over 40 per cent of total), and because in increasingly competitive road transport markets, survival depends on the rate of vehicle use and high levels of service, including "just-in-time" deliveries.

One may question the use of new legal measures in the field of social protection if present rules are not complied with. It may be more onerous for the authorities to enforce existing rules more rigorously. But would that not also be more effective? The road transport industry, and indeed its workers, would be better off if the market forces that drive individual operators to onerous competition were counteracted by effective and harmonised enforcement, devoid of course of discrimination, and by equally effective measures in the case of repeated serious infringements.

To say that not all countries apply effective enforcement is an understatement. Annual Commission reports on the implementation and enforcement of Regulation 3820/85/EEC show encouraging signs of progress, however, and new recording equipment is likely to provide a new and better basis for enforcement.

The IRU supports the introduction of this new equipment if it is tamper-proof and serves to harmonise enforcement rather than to increase enforcement in some countries and to allow the low levels in others to continue, if it does not imply distortion of competition with operators from third countries and if it is cost-effective, in that the costs to operators of the new equipment are matched by gains from fairer competition and hence lower downward pressure on rates.

The instruments for enforcement

There is a basic difference between the driving and rest time of Regulation 3820/85/EEC and the instrument for its enforcement (Regulation 3821/85, now being amended), on the one hand, and working time rules and the enforcement thereof on the other. The driving and rest time rules, laid down in a regulation, apply directly to the drivers concerned. Certainly, national interpretations of some of the provisions of Regulation 3820/85/EEC still differ, despite an increasing number of Court rulings that progressively introduce uniformity in implementation and interpretation for enforcement.

The tachograph records driving automatically, and if fraudulent manipulation can be avoided, driving times can at least be rapidly controlled over a period of some four weeks once the new recording equipment and the related driver card replace the tachograph and the tachograph sheet. Other times are recorded correctly only if the driver puts a switch in the right position. The driver will not always do so and will not always be able to do so; for example, when other activities of the driver precede driving and are performed at a place far from his vehicle, such activities will not normally be recorded.

This in itself makes the recording equipment an inadequate means of registering working hours. Even if the driver were to stay with his vehicle during all his duty periods and manipulate the switch correctly, the adequacy of the recording equipment for registering working hours would depend on the compatibility of the definition of working time with the three types of duty time (driving, other work, availability) that can be recorded by the tachograph. The least one can say is that, at present, national definitions do not generally meet this condition, and one may doubt whether such compatibility will be achieved in the foreseeable future. A reverse approach might be considered, having "other work",

"availability" and "rest" recorded in conformity with the national (eventually even European) definition of working time, as this definition would include driving, other work activities, and -- possibly -- some forms of availability duty. This does not seem to be feasible, however, because it would affect the proper enforcement of Regulation 3820/85/EEC, which, in Articles 7 to 9 for instance, allows for qualification of certain time periods and such qualification is not necessarily what a working time definition would provide.

For all these reasons, the recording equipment specified in Regulation 3821/85 is not an appropriate instrument for registering or enforcing working hours. In any case, other instruments need to be found for the mobile workers whose driving hours are not recorded by such equipment (light duty goods vehicles, urban public transport, taxi, and many more – see Articles 4 and 13 of Regulation 3820/85/EEC).

EU member countries, under Art. 18 of the Directive 93/104/EC on working time, must implement the provisions it contains nationally and report to the Commission every five years on their practical implementation. The same monitoring mechanisms should be foreseen for working time rules in road transport.

Main problems in the field of working time provisions for mobile workers in road transport

In the discussion between the European social partners, the main controversial items were those described below.

Definition – number of working hours – derogation

The wider the definition of working time, the more hours must be permitted for doing the same work. Likewise, the easier it is to obtain derogation, the more restrictive the main rules can be. Unless the definition of working time in road transport is left to the competence of the member countries, international rules will have to provide for a combination of the three elements (definition, number of hours, derogation) that reflects the particular characteristics of the sector.

There is an important difference, however, between derogation provided for in the working time rules themselves and derogation that can be agreed among the social partners. The latter type of derogation must be negotiated, meaning that the worker side will ask for compensation, in most cases of a financial nature.

The FST and IRU joint study and the data collected by the ECMT Secretariat on the social aspects of road transport show that the maximum average working week of mobile workers allowed under national legislation and in collective agreements is in the region of 55-65 hours. Where they are lower, as for instance in Germany or Belgium, ways have been found to add hours (*Arbeitsbereitschaft* and *temps de liaison*, respectively). Detailed information for the 15 EU member countries can be summarised as follows.[3]

Seven countries apply a ***legal limit*** to the average weekly work of drivers in international transport (Austria, Belgium, Finland, France, Germany, Luxembourg and Portugal). One other country applies such a limit for national transport (the Netherlands). These same eight countries apply legal limits to the weekly work of non-driving personnel. The other seven countries have no legal limits, other than through Regulation 3820/85/EEC or through limits to hours of work in one week.

In the countries with a legal limit, the limit is 48 hours or more in four, 44 in Portugal and 40 in Austria and Belgium. In Luxembourg, 48 hours are possible only with permission from the authorities. These 48 hours are then at the same time the maximum for any single week.

Half of the employment in the road transport industry is in countries without a specific legal limit. For these countries, Regulation 3820/85/EEC sets the maximum at approximately 64 hours:
[7 x 24 hours - 45 (weekly rest) + 5 x 11 (daily rest) +/- 4 (5 x 45 minutes of break)].

The actual number of hours must be seen in relation to the definition of working time. Certain hours (waiting, availability, etc.) are included in the working time in some countries and not in others or do not count as full working hours.

Where national legal provisions relating to average weekly working time exist, collective agreements follow those provisions in six (out of eight) cases (Austria, Belgium, Finland, Luxembourg, Netherlands and Portugal). A slightly lower average is found in France and more substantial reductions appear in some collective agreements in Germany, the range being from 38 to 44 hours. Other collective agreements in Germany do not specify this matter.

Where no legal limits apply, collective agreements introduce them in three countries (Sweden, Ireland and goods transport in Denmark). The collective agreement in Denmark is not binding for all transport operators, who therefore answered that no limit existed. Similarly, the collective agreement in Ireland concerns one state-owned company. Other road transport operators are not bound by the provision; they refer to national practice, similar to that in the United Kingdom.

The provisions in collective agreements relating to average normal working hours may in particular concern the way in which hours are paid. Danish employers for instance say that 37 hours per week are agreed as normal hours. Above that, there is no limit (in most cases) to the number of hours, but they are paid as overtime hours.

Maximum weekly working hours

Legal provisions: For one single week, legal limits below the one implied by Regulation 3820/85/EEC exist in eight member countries (Austria, Belgium, France, Germany, Italy, Luxembourg, the Netherlands for domestic transport only, and Portugal. No specific legal limits exist in Denmark, Finland, Ireland, the Netherlands (for international transport) or in the United Kingdom.

In Belgian goods transport, another regime can also be followed ("flexible regime"), in which case weekly working hours can reach 72, both in one week and on average in four weeks. In Belgian passenger transport, there is a collective agreement which has subsequently been made compulsory by a legal measure.

For non-driving personnel, the same legal provisions apply as for drivers, except in Portugal (54 hours instead of 56 for drivers) and in Finland where there is a specific limit for non-driving employees but not for drivers.

Many countries set a legal limit over a four-week period to the number of working hours per period of two weeks, or a maximum number of overtime hours per day or per two or four weeks. Table 2 indicates that for employees in professional transport of goods and of passengers, when there are legal limits to the number of hours in a single week, the same limits generally apply on average over four weeks. Where no specific limits apply for one week, there are relevant limits in a four-week period

for drivers in two countries (Finland and the Netherlands) and for non-driving personnel in one (Finland).

Collective agreements: These conform to maxima laid down in national laws in five member countries (Austria, Belgium, Finland, the Netherlands and Spain). They contain lower maxima in three countries [Germany (in many cases), Italy and Portugal], and introduce maxima in the absence of legal provisions in Sweden, part of passenger transport in the United Kingdom and (rather for reasons relating to pay) in Denmark and part of road transport in Ireland.

In France, for goods transport drivers and for non-driving personnel, more hours are foreseen in the collective agreements than in the law. Certain exemptions are allowed under that law, but more importantly, the definition of working hours may be wider in the collective agreement than in the law.

In fact, the definition of working time is crucial to appreciate the number of hours indicated in Table 2. Some countries count only "effective work" or admit a number of additional hours for waiting, availability, and the like. Other countries include all hours during which an employee is at the disposal of the employer.

Table 2. Maximum average working time on a four-week period
Summary based on FST and IRU figures

	Passenger transport drivers		Goods transport drivers		Non-driving personnel	
Country	NL	CA	NL	CA	NL	CA
Austria[1]	60	60	60	60	60	60
Belgium[1]	50	50	48-72[6]	48	48-50	48
Germany[1]	60	40-70	60	41-60	60	40-60
Denmark[2]	68	-	68	47	-	42-45[5]
Spain[1]	70[5]	67-70[5]	70[5]	67-70[5]	70[5]	67-70
France[1]	48	-	48-52	46[5]-60	48[5]	48-56
Greece	n.i.	n.i.	n.i.	n.i.	-	-
Italy[3]	60-64	52	60	44-52	60-64	52-66
Ireland[2]	-	39[5]	-	39[5]	-	39[5]
Luxembourg[1]	40-48	40	48	40	40-48	40
Netherlands[4]	54	54	54	-	48	-
Portugal[1]	56	40-45	56	45	54	40-45
Sweden[2]	-	52	-	52	-	52
Finland[4]	52	52	52	52	52	52
United Kingdom[2]	-	60[5]	68	-	-	-

NL = National legislation; CA = Collective agreement; n.i. = not indicated.
Note: Legal limits are:
1. Derived from single week limit.
2. Implied by EC Regulation 3820/85/EEC.
3. 48-52 hours per week (effective working time) + maximum 48 hours in four weeks.
4. Derived from maximum per two weeks.
5. FST figures only.
6. Two systems: a traditional system (48 hours) and a "flexible regime" (up to 72 hours).

Working time rules and provisions in Regulation 3820/85/EEC

Art. 14 of Directive 93/104/EC rules that its provisions shall not apply where other Community instruments contain more specific requirements concerning certain occupations or occupational activities. There are different views on the meaning of this article in relation to Regulation 3820/85/EEC, if the directive on working time is to be applied to road transport. The crucial question is whether Regulation 3820/85/EEC can be considered a more specific health and safety instrument. If not, working time rules would come on top of the provisions in Regulation 3820/85/EEC, and the best of the two, for the workers, would apply.

In any case, there is a need to ensure that working time rules do not necessitate amendments to the driving and rest time provisions. The question as to whether or not Regulation 3820/85/EEC must be amended should be considered quite separately from the working time issue, because of the differences between the two sets of rules in their scope, in their objective, and in their significance, through the AETR Agreement, for countries outside the EU.

Specific provisions for night work(ers)[4]

For reasons relating to congestion, governments of some EU member countries promote road transport during off-peak periods. Others, by applying weekend lorry bans, force transport operations to commence on Sunday evenings, with the result that vehicles are immobilised en route to their destination. The risks of night work cannot be denied, but the health and safety of drivers could well be more at risk when they drive on congested roads during daytime than when they drive at night, so long as the maximum driving and minimum rest hours are complied with. For these reasons, many contest the need for specific limits on working hours for night workers in road transport.

In most EU countries, there are no ***legal restrictions*** on night work in road transport: out of the 15 member countries, no special legal provisions apply in ten. Furthermore, legal restrictions in Belgium restrict some types of work to male workers, if derogations are to be allowed in the collective agreements. Sweden has the most stringent conditions: daily rest must include the period from midnight to 05.00 hrs, unless work is carried out on public demand. Three other member countries rule along the lines of Directive 93/104/EC, and limit either the duration of night working periods, on average or per individual period (Germany, Spain), or the number of night shifts allowed per period (the Netherlands). The right to medical examination is mentioned for Germany and for Spain. Some other countries define night work in national law (Finland, Italy) but road transport is exempted from restrictive legal provisions.

***Collective agreements*:** Different interpretations seem to have been given to the question of night work, with employers from many countries stating that there are no restrictions and the trade unions referring to extra pay for night work, as foreseen in the collective agreements.

Collective agreements generally define the night hours entitling to extra pay, and night hours in the collective agreements may differ from those defined in the law or may establish different rates of extra payment for early and late night hours.

Derogation

Derogations foreseen in Regulation 3820/85/EEC and derogations allowed under Directive 93/104/EC on working time reflect the need to take due account of specific circumstances in a country or in a

sector or sub-sector of activity. The role of derogation articles in the EU decision-making process is set out in full above. One may regret the lower degree of harmonisation implied by possibilities for derogation: it is only realistic, however, to admit that the full harmonisation of legal provisions in the EU on almost any issue is a lengthy process, which generally starts with a modest first step.

Conclusions

Working and rest time rules are a major element of the regulatory framework that determines the social aspects of road transport. When adopting such rules, due regard must be taken of other elements (vehicle, infrastructure, lorry bans, general social framework, etc.).

Social standards in road transport finally depend more on compliance with the regulatory framework than on extensions of that framework. Strict and harmonised enforcement is vital in order to promote compliance. Such enforcement must counterbalance the pressures to disrespect rules implied by the structure and regulation of road transport markets.

At present, many important differences exist between countries in the area of working time rules for road transport. These differences relate to almost every item that working time rules would address. They also exist with regard to the role of the social partners in implementing, and fine-tuning where appropriate, working time provisions.

There is a discrepancy at present between the working hours of mobile road transport workers in practice and legally permissible working hours. One cannot conclude from the apparent disrespect of existing rules that these rules must be amended.

Working time rules for mobile workers in road transport should complement existing driving and rest time provisions, and introduce minimum health and safety standards for workers excluded from Regulation 3820/85/EEC. They should be compatible with the provisions in the regulation.

At EU level, working time provisions for road transport will inevitably be based on Directive 93/104/EC on working time. It is likely that the flexibility that this directive offers to member countries will be reflected in a Council decision on the health and safety protection of workers in road transport. It is important to recognise that the harmonisation of working time conditions is a lengthy process, and that a first step, however modest, is the start of a process that will gradually and progressively bring harmonisation and social progress.

The instrument for enforcing Regulation 3820/85/EEC (tachograph) is not suitable for enforcing working time rules in road transport. These rules must be enforced in the same way as working time rules for other sectors of the economy.

NOTES

1. B. O'Brien, W. Smolders and H. de Villèle, *Road Transport in the European Union: Aspects of the Organisation and Enforcement of Working and Driving Time Regulations*, Brussels, 1995.

2. EU social legislation, under the Social Protocol in the Maastricht Treaty, can be based on agreements between the social partners and must be based on consultation of these partners. There are two stages of consultation, the first of a rather general nature and the second concerning the proposals that the Commission intends to put forward.

3. B. O'Brien *et al*., *op. cit*., pp. 23-26.

4. B. O'Brien *et al*., *op. cit*., pp. 27-28.

SOCIAL ASPECTS OF ROAD TRANSPORT DRIVERS' WORKING HOURS

Patrick Hamelin
INRETS, Arcueil, France

Following a 1977 report and articles published in scientific journals in 1981 and 1987 (Hamelin, 1981, 1987) showed that the risk of professional drivers being involved in road accidents when working varied according to the time of day (or night) and the length of time elapsed from the beginning of the driver's service. The risk level rose dramatically after 11 to 12 hours of work. In other words, drivers who have already been driving for 11 hours are more likely to be involved in an accident than those who have been driving for only five, six or seven hours. In addition, driving during the day is less risky than driving at night. The studies also showed a link between the risk level and the organisation of drivers' work.

The results of recent studies of professional drivers carried out by physiologists (Kecklund and Akerstedt, 1993) showed a clear link between signs of the onset of drowsiness and the total duration of productive activity, including several tasks and short breaks between two work sequences. The time of day was also a factor. Drivers were more likely to show signs and feelings of fatigue during "night" schedules (20.30 hrs to 7.30 hrs) than during "evening" schedules (18.30 hrs to 4.00 hrs). The appearance of signs of drowsiness was linked not to time spent driving as such but to time spent working, of which driving is only one aspect.

Both physiological and sociological research tends to suggest that the fundamental issue in the road transport industry is not driving time but work time and working patterns. And yet it is driving time that is the guiding principle of European safety regulations. The regulation of driving time is considered to be able to fulfil a dual objective, one relating to road safety and the other to business practice. As far as safety is concerned, there is a contradiction between the results of research and the fact that the regulatory stance is based on the organisation of driving time and rest, with no reference whatsoever to the total work time involved in the completion of transport operations.

This contradiction suggests that the broad regulatory approach to a transport system under pressure needs to be rethought. Public discontent with the safety hazards and pollution caused by road haulage has now been compounded within the industry by the complaints of disgruntled drivers. These two factors challenge the basic principles behind the rise of the road haulage industry, now the dominant freight transport mode.

This report seeks to addres some of the issues in the now public debate sparked by the growth of the transport industry. It summarises the main results of research into working conditions in the industry carried out since the mid-1970s. The subject is one which the drivers themselves have brought to the attention of both the public and the government on a number of occasions (first in February 1984, then again in July 1992, November 1996 and 1997 and September 1998), namely their working conditions and hence ultimately the conditions under which the public highway is used.

In order to determine the existence of a link between the workings of the road haulage industry and the risk of involvement in accidents, the first step is to describe drivers' working conditions and to elucidate the underlying factors.

The road haulage industry

Over three-quarters of all freight in the European Union is carried by road, and similar proportions are to be found in most developed and in many developing countries. Over almost a hundred years, the road transport industry has provided ample proof of its flexibility and ease of use and its ability to adapt to changing forms of production and trade.

After a 40-year infancy marked by inventions, prototypes and the first steps towards industrial production, the First World War clearly demonstrated the advantages of roads. Underlining the flexibility of road transport, armies turned to motorised transport as a substitute for rail networks, which were partly destroyed in the conflagration.

Road transport surged during the years after that. In a context of growing demand, there was money to be made in a business that promised shorter transport times and more flexible routes, an argument still current today. The growth of the road transport industry was further stimulated by the conversion of military hardware (Liberty trucks from the United States) and the demobilisation of workers trained in mechanical engineering and driving during the war.

The rapid spread of road transport led most industrialised countries to regulate the new industry. The United States in 1920 and France in 1934 introduced legislation to regulate the rapid motorisation of road transport for technical, military and commercial reasons. From a technical standpoint, monitoring the available potential in terms of numbers of tractors and trucks had a dual civilian and military function. The civilian function concerned the use and management of infrastructure, in particular by promulgating standards for vehicle construction. The military function was to provide an assessment of the transport capacity that could be requisitioned in the event of conflict.

The civilian authorities were also responsible for supervising the commercial aspects of the business by awarding and controlling transport licences, which entitled their holders to use capacity for public transport purposes. The holder of a transport licence was entitled to use a truck of a given weight for public transport, *i.e.* to provide transport for customers. The rule thus instituted a legal distinction between the two types of use to which road vehicles may be put. In the case of "private" or "own account" transport, an economic agent uses trucks that he owns or rents to provide the transport he needs for his own activity. In the case of "public" transport, also known as "carriage for hire or reward", companies move goods from one place to another for third parties.

In the late 1970s and 1980s, the rules under which rights to transport for hire or reward were allocated (transport licences, rights in specific geographical areas) came to be regarded as obstacles to market transparency. The opacity of a segmented industry hampered the free play of competition and created niche markets that favoured the preservation of excessively high prices. The deregulation of road transport was on the agenda and would occupy not only the various players concerned but also lawyers and "experts" until the early 1990s.

Since then, drivers' working conditions, having hit the headlines, have also once more become issues of concern to governments and other institutions. Discrepancies in labour costs are now considered to undermine conditions for healthy competition on a deregulated road transport market.

The overall flexibility of the road haulage system is based to a large extent on technological and social factors that have favoured the expansion of the road transport system. Transport for hire or reward has been so successful because the work involved is organised in such a way that the use of labour conforms closely to the conditions of multi-faceted demand. The resulting division and organisation of work may maintain heavy pressure on drivers' working conditions, but it has also put road haulage companies in a position where they carry the majority of freight in most countries.

Transport firms and firms that transport their own products

Road haulage is undertaken on both by transport firms, whose chief activity is transporting goods and products for their customers, and by firms who, though their chief activity is manufacturing or trading, transport their own products themselves.

In many western countries, transport firms produce more, in terms of tonne-kilometres, than firms that transport their own products. The latter mainly transport goods over short distances, whereas transport firms provide more long distance transport, especially of an international nature. In the EU, road hauliers provide almost all international transport, while manufacturing and trading firms meet directly a significant share of domestic transport needs (Table 1).

The distinction between these two forms of road haulage is essential. In formal terms, it gives shippers a choice between buying (or renting) vehicles to transport their own goods themselves and using a carrier. This puts the third party freight market in a situation of relative structural dependence. The proportion of freight for which carriers can compete is only the complement of the proportion of freight carried directly by the firms that make or trade the goods in question.

Table 1. Share of international and domestic transport (own account/for hire or reward) in the EU and the United States
Percentage

Type of transport	International (EU)	Domestic (EU)	Total EU	United States
Private or own account	10	30	26	45
Public or for hire or reward	90	70	74	55
Total	100	100	100	100
Respective share of international & domestic)	19.9	80.1		

Source: Eurostat and Federal Highway Administration.

It is as though the less carriers charge, the more shippers use them. Deregulation and greater competition between carriers have resulted in lower prices, encouraging shippers to use carriers to transport more of their goods. If carriers' prices were to rise above a certain level, shippers would once again buy (or rent) fleets of vehicles and transport their goods themselves.

The idea here is that shippers' strategies have a profound influence on the organisation of road transport. The fact that carriers are relatively dependent on shippers does not prevent powerful transport firms from offering attractive products (in terms of transport time, technical facilities, network density and geographical coverage) that no shipper could easily replicate. Control over transport conditions is an extremely important factor for manufacturers and traders and is often reflected in their control over the organisation of exchanges and the related transport operations.

Many shippers have already invested in the organisation of transport and freight, if not in the actual haulage of goods. Where high-volume exchanges are concerned, large-scale shippers may organise and carry out transport operations either directly or through subsidiaries. They may use their own resources or turn into consignors or carriers, investing in the transport sector by creating subsidiaries.

The swarm of small and medium-sized carriers thus depend to a considerable extent on shippers and major operators who, to a certain extent, control the freight business.

Transport firms

The transport sector throughout the EU is generally fragmented (though the degree of fragmentation varies from country to country), consisting of a large number of small firms with only a handful of trucks or employees. Fragmentation is greatest in Spain, Italy and Scandinavia; France and Germany are somewhere in the middle, and there is a relatively high level of concentration in Belgium and the Netherlands.

Thus, 98 per cent of Spanish firms have between one and five vehicles. The corresponding figures are 96 per cent in Finland, 95 per cent in Italy, 91 per cent in Sweden, 84 per cent in Denmark, 83 per cent in Germany and the United Kingdom, 82 per cent in France, 68 per cent in Belgium and 57 per cent in the Netherlands. About one in five Belgian and Dutch firms has more than ten vehicles, compared with one in eight in France, one in 11 in the United Kingdom, one in 14 in Germany and one in 20 in Denmark (Dossier Europe, MELT/DAEI/SES, Paris, February 1997).

The same pattern is to be found in other parts of the world. In Australia, for example, 65 per cent of transport firms (including owner-operators) have less than five vehicles. Likewise, 84 per cent of firms in the United States with vehicles over 26 000 pounds (approx. 12 tonnes) have between one and five vehicles.

One feature common to all countries is the high degree of concentration among the transport operators which manage the largest share of transport flows. In France, for example, large firms are also the biggest subcontractors. There is a relatively high degree of concentration on the supply side also, since 20 per cent of firms generate 85 per cent of subcontracted business.

Major operators manage a substantial proportion of transport demand and organise transport chains. In many cases, especially involving non-divisible loads, occasional destinations or irregular flows, and on certain segments of the transport chain, very large carriers subcontract collection, carriage and delivery to small and medium-sized firms.

Subcontracting is especially common in the goods transport business because markets are varied, geographically scattered and seasonal and because exchanges are non-symmetrical. There are two categories of subcontracting:

- Normal, functional subcontracting, ranging from more or less frequent co-operation to partnership (*e.g.* local network complementing a national network, countries or routes not covered by the organiser, demand peaks, etc.).
- Substitution subcontracting, which may correspond to a disguised form of salaried employment that enables the "client" firm to offload responsibility for managing the workforce and fleet and merely allocate shipments. While this type of subcontracting may take place under proper financial and social conditions, it may also give rise to excesses, such as low prices for "obligated" hauliers, transfer of authorisations to

subcontractors, pressure to turn salaried drivers into self-employed subcontractors, long payment times, etc.).

Abuses in this second category of subcontracting need to be addressed: not only do they deviate from proper business practice, but they also impoverish the industry.

Subcontracting and creation/failure of firms have increased in a deregulated environment, since both phenomena serve to regulate available transport capacity. By these means, transport capacity adapts to the peaks and troughs of an industry that is not only seasonal but also cyclical. Transport is the secular arm of trade. The level of activity in the transport industry in general, and in the road haulage industry in particular, is highly sensitive to developments in the wider economy.

Thus, a real division of work exists between firms which is also reflected in the division of labour. Half the staff of large transport firms are stationary: they are clerical staff and loading bay workers whose activity concerns the allocation and management of freight flows. In small and medium-sized firms, on the other hand, 80-90 per cent of the employees are drivers.

One effect of competition between firms that provide only carriage is to encourage low haulage prices. The fact that a large number of firms are capable of providing vehicles and drivers disguises the excess costs resulting from structural imbalances by shifting the burden of reducing if not eliminating them on to small and medium-sized firms in competition with each other. Many firms, sometimes barely viable, accept work at very low prices simply in order to stay in business. By contracting for jobs with low added value or on which there are no economies of scale to be made, they reduce if not eliminate structural excess costs. The economic efficiency of this division of work requires no further proof.

Drivers' working conditions

Competition between carriers has always been fierce. For drivers, one of the results has been the maintenance of work schedules that do not comply with generally accepted standards. Such schedules have been one of the key factors behind the emergence of public (for hire or reward) transport as the dominant force in land transport.

The problem that now arises is that of the balance between different ways of representing costs, namely labour costs and the costs of pollution or public safety.

Work schedules in the road haulage industry

Even in the early days of the road haulage industry, researchers drew attention to the difficult working conditions of teams of drivers hauling loads coast-to-coast in the United States or from Lille to Marseille in France. Bernard Lahy, writing in the first issue of *Le travail humain* in 1937, wrote: "In view of the statements of the drivers, borne out by the company's engineers and our own tests of driving under identical conditions, we have decided to concentrate solely on the fatigue that a heavy goods vehicle driver may feel". But relatively little research was done into fatigue among truck drivers for many years, until the subject recently came to the fore again.

Previously, drivers drove at their own discretion. However, currently fashionable road-related technologies suggest that there are ways of automating road use that could compensate for human incompetence or irresponsibility. The possibility of producing "early warning" systems for loss of alertness has revived interest in fatigue as a subject of both debate and research. How could such

technologies be used in the context of real time management of actual situations encountered on the roads? The question remains open.

A number of systematic surveys have been carried out in the last 25 years, using different methodologies and different samples of truck drivers, some representative (France, 1983 and 1993), some not (France, 1975, Netherlands, 1986, and Germany, 1996). The results are enlightening in several respects.

Drivers from the different countries working in specialist goods transport firms have comparable working hours. A comparison of the results of the surveys carried out between 1975 and 1996 according to a common yardstick or unit, namely the length of a typical working day, showed similar orders of magnitude from one country to another that did not seem to change significantly over time (Table 2).

Table 2. Comparison of the length of a working day for truck drivers: international (Netherlands), long distance (France), various (Germany)

	France 1975 (Hamelin)	Netherlands 1986 (Ouwerkerk)	France 1983 (Hamelin)	France 1993 (Hamelin)	Germany 1996 (Garo)
Driving time	7h25	7h	7h35	7h35	6h55
Waiting time	1h45	1h30	1h10	0h55	n.a.
Loading/unloading	2h15	2h50	2h30	2h25	n.a.
Other tasks	0h25	0h50	0h30	0h30	n.a.
Total work time	11h50	12h10	11h45	11h25	11h00
Days worked per week	5.5	5.8	5.2	5.2	n.a.
Number of drivers	54	650	235[1]	315[1]	78[2]
Scope of source survey	Long and short distance drivers in the transport sector N = 140	International drivers in the transport sector N = 650	Long and short distance drivers in all sectors plus non-urban coach drivers in 1993 N83 = 940, N93 = 1250		Truck drivers in all sectors and coach drivers N = 206
Data collection method	Interview with a sample of truck drivers and worktime log kept chronologically for two weeks. Unit: 1/4 h	Interviews with drivers at Dutch border on previous day's work (disk from previous day at least, more if possible)	Interviews with a representative sample of professional drivers (trucks in 83, trucks and coaches in 93) and worktime log kept chronologically for two weeks. Unit: 1/4 h		Method not described in abstract

1. Number of drivers in the transport sector making long distance trips; more specifically, drivers away on trips for at least two consecutive days.
2. All drivers interviewed without distinction as to specialisation (long or short distance, away several days or home every day).

If the average working day lasts over 11 hours, the minimum working week must last 55 hours. This is much more than most people work, whatever their job, and goes way beyond the bounds of all rules and agreements in other areas of economic activity. The work schedules of long distance truck drivers are an anachronism in societies which regard time saving as a mark of their efficiency.

However, this comparison based on average data reduced to a typical working day conceals a wide variety of situations. A look at the average number of days worked per week, whether observed (as in the French surveys) or asserted (as in the other surveys), shows that while some drivers work 55 hours a week, others work 60 hours or more.

Lessons of the driver surveys

This analysis of drivers' working conditions can be refined by considering the results of the French surveys. Though carried out at different times, they are directly comparable because they use the same method. Drivers were asked to keep a log over a two-week period, noting time spent quarter-hour by quarter-hour on five tasks, plus rest and sleep. The random sample of drivers included salaried employees, self-employed drivers and small owner-operators, working in transport firms or in manufacturing, commercial or agricultural enterprises for which road haulage was only a secondary activity. The advantage of this method is to permit a comparison of widely differing situations. Spanning a two-week period, it also makes allowance for the fact that the length of a working day or working week is the result of a chronological sequence of different activities, each of which affects the others.

The results of the French surveys[1] show beyond all doubt that the working week of truck and coach drivers (except urban coach drivers) is consistently longer than the average for sedentary workers as a whole. This is true whatever the type of work (home each day or away two days or more), whatever the sector (transport sector or other sectors) and whatever the driver's status (employee, self-employed driver, owner-operator).[2]

Drivers employed by transport firms work longer hours than drivers employed by industrial or commercial firms that transport their own products.

Drivers returning home each day work fewer hours than drivers away two days or more. In the transport sector, for the same category (home each day or away two days or more), the overall transport time is the same for employees and self-employed drivers or owner-operators. These results were the same in both the 1983 and 1993 surveys.

Whereas working hours for drivers in the transport sector remained unchanged between 1983 and 1993 (the observed differences are not statistically significant), working hours fell for drivers employed in other sector firms who returned home every day (Table 3).

The observed working hours, equivalent for most drivers over the ten-year span, are the result of a breakdown of worktime tasks that itself showed very little change (Table 4).

Time spent on collection and delivery (or handling tasks such as docking, preparing the truck, lifting freight, completing the necessary paperwork, negotiating with the customer or bay supervisors, etc.) was similar between the two surveys. For the same category (home every day or away two nights or more), the time needed for "hands-on" operations was equivalent, whatever the sector in which the drivers were employed. Drivers away two days or more spent 12.5 hours on handling tasks if they were employed in the transport sector and 13 hours if they were employed in other sectors; the equivalent figures for drivers returning home every day were 15.5 hours and 15 hours respectively. Drivers in the same category spent about as much time loading and unloading, whatever the sector. The figure was considerably higher for drivers returning home each day employed in the transport sector, a little less so for drivers away two days. There was very little increase for drivers employed in other sectors.

Table 3. Weekly working hours and breakdown of tasks by driver category in 1983 and 1993
Salaried truck drivers

Employees, "other sectors", home every day	A. 1983 survey (N=499)	SD	%	B. 1993 survey (N=492)	SD	%	Test A ≠ B
Driving time	22.1 h	9.3	49.4	22.4 h	9.3	52.3	ns
Handling tasks	16.0 h	7.8	35.8	14.9 h	6.7	34.9	*
Waiting	1.4 h	3.2	3.0	1.4 h	2.9	3.3	ns
Other tasks	5.3 h	7.9	11.8	4.0 h	6.4	9.4	*
Working time	44.7 h	7.5	100	42.7 h	9.2	100	*
Employees, "other sectors", Away two days or more	A. 1983 survey (N=69)	SD	%	B. 1993 survey (N=42)	SD	%	Test A ≠ B
Driving time	31.2 h	9.7	61.0	32.6 h	9.9	60.5	ns
Handling tasks	12.7 h	7.3	24.8	13.0 h	6.4	24.1	ns
Waiting	2.0 h	2.8	4.0	2.5 h	5.3	4.7	ns
Other tasks	5.2 h	6.5	10.2	5.7 h	6.4	10.6	ns
Working time	51.1 h	9.8	100	53.8 h	10.5	100	ns
Employees, "transport sector", Home every day	A. 1983 survey (N=160)	SD	%	B. 1993 survey (N=284)	SD	%	Test A ≠ B
Driving time	27.1 h	9.3	56.3	28.6 h	10.5	58.5	ns
Handling tasks	16.1 h	7.9	33.5	15.5 h	8.4	31.7	ns
Waiting	1.9 h	3.7	3.9	2.6 h	4.1	5.3	*
Other tasks	3.0 h	4.7	6.2	2.2 h	4.4	4.4	*
Working time	48.1 h	7.7	100	48.8 h	11.1	100	ns
Employees, "transport sector", away two days or more	A. 1983 survey (N=150)	SD	%	B. 1993 survey (N=267)	SD	%	Test A ≠ B
Driving time	37.4 h	9.2	63.7	40.0 h	9.6	67.0	*
Handling tasks	12.8 h	6.1	21.9	12.4 h	5.6	20.8	ns
Waiting	5.1 h	4.9	8.6	4.8 h	4.7	8.1	ns
Other tasks	3.4 h	3.6	100	2.5 h	3.6	4.2	*
Working time	58.7 h	9.9	100	59.7 h	10.6	100	ns
Employees, "transport sector", away one to three nights	A. 1983 survey (N=68)	SD	%	B. 1993 survey (N=95)	SD	%	Test A ≠ B
Driving time	34.5 h	8.2	61.4	35.2 h	8.8	64.5	*
Handling tasks	13.3 h	6.1	23.7	13.0 h	5.7	23.8	ns
Waiting	4.7 h	5.1	8.4	3.9 h	4.2	7.1	ns
Other tasks	3.7 h	3.9	6.6	2.5 h	4.1	4.6	*
Working time	56.2 h	8.5	100	54.6 h	10.1	100	ns
Employees, "transport sector", away four nights or more	A. 1983 survey (N=82)	SD	%	B. 1993 survey (N=172)	SD	%	Test A ≠ B
Driving time	39.7 h	9.3	65.3	42.6 h	9.0	68.2	*
Handling tasks	12.5 h	6.1	20.6	12.1 h	5.5	19.4	ns
Waiting	5.4 h	4.7	8.9	5.3 h	4.8	8.5	ns
Other tasks	3.2 h	3.4	5.3	2.5 h	3.2	4.0	ns
Working time	60.8 h	10.6	100	62.5 h	9.8	100	ns

Each part of the table shows the results of the 1983 and 1993 surveys for a driver category (N = adjusted number). The driver category is identified in the first cell of each table. Each table contains five rows of figures in two sets of three columns, giving the average value and the standard deviation for each of the five tasks and for each survey year. Four time values are given: driving time, loading and unloading time (handling tasks), waiting time and time spent on other tasks (maintenance, etc.). The last column gives the result of a comparison of average values between the 1983 and 1993 surveys. An asterisk (*) indicates that the result is significant, the abbreviation ns that it is not.

Source: Hamelin and Lebaudy,1997.

There was little change between the two surveys in time spent waiting, except for drivers returning home each day employed in the transport sector, where there was an increase.

Driving time rose slightly over the period, though the increase was significant only for drivers in the transport sector away four nights or more. Distances travelled during the same weekly driving time increased substantially, by 20 per cent in the transport sector and 5 per cent in the other sectors. In the transport sector in 1993, drivers away two days or more travelled 11 640 km per month, up 16 per cent on 1983, while drivers returning home every day travelled 6 930 km, up 24 per cent on 1983. Their productivity increased by more than that of drivers in the other sectors, where the equivalent figures were 9 300 km for drivers away two days or more, up 7 per cent on 1983, and 4 700 km for drivers returning home every day. Self-employed drivers returning home every day travelled 6 600 km, an

increase of 24 per cent between 1983 and 1993. Of course, speeds also increased, especially for drivers in the transport sector returning home every day.

The fact that there was so little change in the duration and breakdown of tasks provides further proof, if it were necessary, that the diversity of production processes in road haulage and the economic advantage of an industry where there are few technical limitations are still based to a considerable extent on the "flexibility" of drivers' working hours, especially in transport firms.

Labour productivity has increased, in both the "carriage" segment of the transport chain (more kilometres travelled at higher speeds) and the stationary part (more daily collections and deliveries in an equivalent time).

The relative stability of the results of the surveys over a ten-year span underlines the fact that much of the road transport for hire or reward is attributable to working practices that bear little relation to the usual conditions of salaried employees in industrialised countries. During the period 1983-93, two factors are probably responsible for the fact that a truck driver's working week was much longer than generally accepted standards: deregulation, which increased competition, and unemployment, which expanded the labour supply. Perhaps more importantly, however, they put an end to the slow reduction in working hours observed in the transport sector between 1975 and 1983.

The trend towards shorter working hours, although the measurement is imprecise,[3] was too clear not to correspond to an underlying reality. The working week of drivers in the transport sector returning home every day fell from 57.7 to 48.1 hours, that of drivers away at least two days from 65 to 59 hours. The decline was due partly to the fact that drivers spent slightly less time on the road, but mostly to a substantial reduction in waiting times: 3.4 hours less for drivers returning home every day, 4.8 hours less for drivers away two days or more.

Table 4. Weekly working hours and breakdown of tasks by driver category in 1983 and 1993
Non-employee truck drivers

Non-employees, home every day	A. 1983 survey (N=41)	SD	%	B. 1993 survey (N=41)	SD	%	Test A ≠ B
Driving time	25.1 h	9.4	51.2	29.0 h	9.7	56.5	*
Handling tasks	16.9 h	10.2	34.5	15.4 h	9.6	30.1	ns
Waiting	3.3 h	5.9	6.6	3.5 h	4.1	6.8	ns
Other tasks	3.7 h	4.3	7.6	3.4	5.3	6.6	ns
Working time	48.9 h	11.3	100	51.3 h	12.5	100	ns
Non-employees, away two days or more	A. 1983 survey (N=20)	SD	%	B. 1993 survey (N=31)	SD	%	Test A ≠ B
Driving time	36.8 h	10.0	62.1	37.2 h	11.0	63.1	ns
Handling tasks	14.2 h	11.0	23.9	13.1 h	5.5	22.2	ns
Waiting	4.7 h	4.1	8.0	5.2 h	5.1	9.0	ns
Other tasks	3.6 h	4.2	6.1	3.4 h	6.2	5.8	ns
Working time	59.3 h	12.2	100	58.9 h	12.7	100	ns

Each part of the table shows the results of the 1983 and 1993 surveys for a driver category (N = adjusted number). The driver category is identified in the first cell of each table. Each table contains five rows of figures in two sets of three columns, giving the average value and the standard deviation for each of the five tasks and for each survey year. Four time values are given: driving time, loading and unloading time (handling tasks), waiting time and time spent on other tasks (maintenance, etc.). The last column gives the result of a comparison of average values between the 1983 and 1993 surveys. An asterisk (*) indicates that the result is significant, the abbreviation ns that it is not.
Source: Hamelin and Lebaudy, 1997.

For drivers away two days or more, driving time increased between 1983 and 1993 while waiting times remained stable. For drivers returning home every day, waiting times increased. The working week of drivers in the transport sector remained comparable between 1983 and 1993.

Since 1995, the French Transport Ministry has carried out a quarterly survey based on questionnaires designed to assess drivers' working hours.[4] The results obtained between 1995 and 1997 are similar to the results of the 1983 and 1993 surveys analysed here. The working week of drivers returning home every day varied between 50 and 53.3 hours and was 52.3 hours at the end of the period, 3.5 hours more than in the 1993 INRETS survey. The working week of drivers away one to three nights varied between 53 and 55.7 hours and was 55.6 hours at the end of the period, one hour more than in the 1993 INRETS survey. The results for drivers away four nights or more varied between 61.0 and 63.3 hours, the level at the end of the period, 0.8 hours more than in the 1993 INRETS survey.

The fact that drivers' temporal working conditions have changed so little is attributable to the existence of factors that resist all efforts in that direction by the government and professional organisations alike.

Coach drivers

The working conditions of coach drivers are considerably less onerous than those of truck drivers, though they still work longer hours than sedentary workers.

Most full-time drivers (55 per cent) operate in both of the two main service categories, occasional and regular (for convenience, "mixed" drivers). In this case, they work as much as drivers working only in the occasional category, most of whom provide tourism-related transport, and much more than drivers working only on regular services (Table 5).

Table 5. Weekly working hours and breakdown of tasks by driver category in 1993
Full-time employee coach drivers in the non-urban transport sector

Drivers assigned to occasional services	1993 survey (N=58)	SD	%
Driving time	30.1 h	10.1	59.4
Customer-related tasks	2.0 h	2.9	3.9
Waiting (standby time)	14.1 h	7.8	27.8
Vehicle maintenance	4.5 h	4.8	8.9
Working time	50.7 h	13.1	100
Drivers assigned to regular services	1993 survey (N=91)	SD	%
Driving time	32.4 h	7.9	73.3
Customer-related tasks	1.5 h	3.2	3.4
Waiting (standby time)	5.2 h	6.6	11.8
Vehicle maintenance	5.1 h	7.9	11.5
Working time	44.2 h	9.7	100
Drivers assigned to both occasional and regular services	1993 survey (N=185)	SD	%
Driving time	33.0 h	9.7	66.8
Customer-related tasks	2.2 h	4.5	4.5
Waiting (standby time)	8.9 h	7.1	18.0
Vehicle maintenance	5.4 h	5.9	10.9
Working time	49.4 h	11.8	100

Each part of the table shows the results of the 1993 survey for a driver category (N = adjusted number). The driver category is identified in the first cell of each table. Each table contains five rows of figures in three columns, giving the average value and the standard deviation for each of the five tasks. Four time values are given: driving time, time spent on customer-related tasks, waiting time and time spent on other tasks (maintenance, etc.).
Source: Hamelin and Lebaudy, 1997.

Standby time represents a significant proportion of coach drivers' schedules, ranging from 12 per cent for regular drivers and 18 per cent for mixed drivers to 27 per cent for occasional drivers. The amount of standby time is one of the reasons why transport firms are so keen to hire part-time workers. The decision by many carriers to reduce "downtime" by hiring part-time drivers with schedules that match the services they organise is the main bone of contention between the employers and their drivers.

The wage levels of full-time drivers are comparable to those of truck drivers. The average monthly wage of regular drivers is FF 7 400, similar to that of truck drivers returning home every day. Occasional drivers earn FF 7 860 and mixed drivers FF 8 290, the same as truck drivers away two days or more. Coach drivers and truck drivers are more likely than other salaried employees to live in rural areas and small towns.

Reasons why drivers still work such long hours

As indicated above, long working hours are a constant feature of drivers' working conditions, both over time and in different countries. However, the average values on which this finding is based are the median values of statistical distributions with relatively high scatter coefficients. This means that the working conditions of drivers in the same category (away two days or more, home the same day) actually differ considerably.

This raises the question of whether there are factors in drivers' working conditions that systematically influence the number of hours they work. In other words, are working hours and the breakdown of tasks affected by certain structural factors?

Three types of factor will be considered from the standpoint of their possible effects on drivers' working conditions: the context (especially the size of the firm), the production and work process, and the time frame of the production cycle.

Working conditions and the size of the firm

Although drivers in the "other sectors" category work shorter hours if they are employed by firms with 50 employees or more than if they are employed by firms with fewer than 50 employees, working hours in the transport sector are similar whatever the size of the firm[5] (Table 6). However, the largest firms pay better wages than small firms, whatever the sector.

The results for drivers in the "other sectors" category bear out the hypothesis advanced by economists that the bigger the firm, the better its employees' wages and working conditions are likely to be. However, the results for drivers in the transport sector partially undermine this hypothesis. Drivers in other sectors are paid higher wages in large firms for shorter working hours than in small firms, while drivers in the transport sector are paid higher wages in large firms but for equivalent working hours in both large and small firms.

This reveals a particular feature of pay structures in the transport sector. The wages of drivers returning home every day are not significantly different from those of drivers away four nights or more, even though the latter work 14 hours a week more. It is only when expenses (*i.e.* board and lodging) are added to wages that the usual pattern of higher pay for longer hours emerges among drivers in the transport sector.

In the transport sector, it is as though most large and medium-sized firms were just as ill-equipped as small firms to offset shorter working hours with economies of scale or an industrial organisation of transport operations. The fact that working hours are not affected by the size of the firm must mean that, rather than the firm organising the work carried out by drivers, it is the practical constraints of the work that determine how it is organised.

The question of industrialisation raises unexpected problems because the vast majority of transport operations are one-off operations that cannot easily be broken down into constituent elements that can be assigned to different drivers. In many cases, the driver's work is part of a sequential production process, such that when one element is completed from start to finish another element follows on. With the driver being distant from the base, the sequence is therefore itself indivisible, unless another driver is sent to replace the first and the first driver is brought home. But are such costs compatible with a long-term trend towards lower prices?

Table 6. Weekly working hours, wages and income by size of firm for each driver category, 1993

Other sectors, home every day, 1993	A. Establishments ≤ 49 employees (N=258)	B. Establishments ≥ 50 employees (N=230)	Test A ≠ B
Working hours	44.4 h	40.8 h	*
Salary (12/13)	7 292 F	7 792 F	*
Salary + expenses	7 958 F	8 485 F	*
Transport sector, home every day, 1993	**A. Establishments ≤ 49 employees (N=173)**	**B. Establishments ≥ 50 employees (N=108)**	**Test A ≠ B**
Working hours	48.7 h	48.8 h	ns
Salary (12/13)	7 120 F	7 617 F	*
Salary + expenses	8 413 F	8 781 F	ns
Transport sector, away 1-3 nights, 1993	**A. Establishments ≤ 49 employees (N=60)**	**B. Establishments ≥ 50 employees (N=35)**	**Test A ≠ B**
Working hours	54.9 h	53.8 h	ns
Salary (12/13)	7 801 F	8 026 F	ns
Salary + expenses	10 439 F	10 921 F	ns
Transport sector, away ≥ four nights, 1993	**A. Establishments ≤ 49 employees (N=103)**	**B. Establishments ≥ 50 employees (N=68)**	**Test A ≠ B**
Working hours	62.3 h	62.8 h	ns
Salary (12/13)	7 384 F	7 819 F	*
Salary + expenses	11 071 F	11 738 F	*

The driver category is identified in the first cell of each table. Each table contains three sets of figures - weekly working hours, net salary including a 13th month, income comprising salary plus expenses - for firms with less than and more than 50 employees. For firms with only one establishment, the establishment is equivalent to the size of the firm, but a firm may have several establishments. The last column gives the result of a comparison of average values between the two types of establishment. An asterisk * indicates that the result is significant, the abbreviation ns that it is not.
Source: Hamelin and Lebaudy, 1997.

The transport process, the work process and working hours

Given that the firm does not play a distinctive organising role, could certain aspects of drivers' work favour a lighter schedule?

Transport is a customised service: the practical aspects are adapted to the particular features of the exchange process between individual shippers and recipients. Often, only the price according to distance is negotiated. The practical conditions for carrying the goods, *i.e.* the conditions of collection and delivery and the journey per se, are rarely taken into account explicitly when the price is calculated. The transport operations performed by each driver are determined by a variety of practical

factors; that is a key reason why their working conditions are so varied. The high scatter coefficients for most of the activities that constitute a driver's work are clear evidence of this.

Thus, drivers in the transport sector operating on regular routes or specialised segments tend to work shorter hours than drivers carrying out much more varied types of work (different loads, products, routes, customers, etc.). Processes that can be anticipated can be organised more productively and more profitably, making it possible to save time, especially "downtime". Conversely, although the time of a trip can always be calculated, the time needed for other operations depends on the organisation of each customer – shipper, intermediary, recipient – involved in the sequence of economic exchanges and in the transport chain. Drivers have to adjust their schedules to the schedules and working practices of the places they serve. Consequently, the time needed to complete the sequence of operations they carry out in a given week is difficult to predict with any certainty. In such situations, when an abundance of factors is the distinctive feature of the service, any factor that is even slightly predictable is a resource that makes it possible to do the work in less time.

For example, drivers in the transport sector away two days or more work 55.7 hours when they specialise in the transport of a single type of product (this is the case for 17 per cent of drivers in the category) and 61.3 hours when they transport three or more different types of product (61 per cent of drivers in the category). Drivers in the transport sector with the hardest working conditions, *i.e.* those who are away four nights or more, work 57.4 and 63.8 hours respectively, according to whether they transport one type of product or several.

Factors related to the time frame of the production cycle

In many cases where drivers work in the transport sector, especially for long distance drivers away four nights or more, the transport production process merges into the driver's work process. Broadly speaking, the specific features of the production processes carried out by drivers affect their working hours more than the specific features of the transport firm that employs them. Working hours are shorter when there are elements of regularity or specialisation in drivers' work. The structure of drivers' work is determined less by the firm than by the specific features of each process, from collection through carriage to delivery.

Because of the almost infinite variety of the material and commercial characteristics of each transport operation carried out by drivers, it is unrealistic to suppose that changes affecting the structure of road transport will quickly translate into new forms of production applicable to all forms of transport service and likely to favour a significant reduction in drivers' working hours. Aspects that have a decisive influence on profitability, such as mass flows and regular traffic, are to be found in only a minority – significant but a minority nonetheless – of transport operations.

Thus, the factors that could play a part in reducing drivers' working hours are simple ones that structure production time as a whole and can thus be widely applied. One of the simplest explanations for the reduction in working hours between 1975 and 1983 is the fact that in 1975 drivers could deliver to firms that were open on Saturday morning, while many other drivers carried out routine maintenance on Saturdays. Since the early 1980s, drivers on the roads on a Saturday are returning home, having completed a production cycle. Drivers on the roads on a Sunday are gaining time on the next cycle. As all customers are closed at weekends, however, there are no collections or deliveries other than in exceptional circumstances.

The relationship between the number of days' rest and the quantity of work supplied during the week shows that drivers who have less than four days' rest in a fortnight work longer hours than those who

have four days' rest or more (Table 7). Overall, just over a quarter of all drivers have less than four days' rest in a fortnight, while the comparable figure for drivers away two days or more is a third and for drivers away four days or more is a half. In almost all cases, drivers who have less than two days' rest a week do at least the equivalent of half a day's work more.

Table 7. Number of days' rest in a fortnight and number of working hours

	A. Fewer than 4 days' rest in 14	B. 4 days' rest or more in 14	≠ A - B	Drivers with fewer than 4 days' rest in 14 (%)
Employees in transport sector	58.5 h	51.8 h	6.7 h	34.2
Away two days or more	62.7 h	57.4 h	5.3 h	42.6
Away 1-3 nights	55.3 h	54.2 h	1.1 h	25.5
Away four nights or more	64.7 h	60.1 h	4.5 h	52.1
Home each day	52.2 h	48.0 h	4.5 h	26.3
Employees in other sectors	48.8 h	42.3 h	6.5 h	21.5
Away two days or more	55.7 h	53.1 h	2.6 h	30.1
Home each day	47.9 h	41.5 h	6.4 h	20.8
Non-employees	56.2 h	52.3 h	3.9 h	39.3
Total	58.2 h	52.2 h	5.9 h	27.6

Source: Hamelin and Lebaudy, 1997.

Labour costs as a factor of international competitiveness

Comparing costs is not easy because the assumed components of costs are often defined differently. The tax base and methods of redistributing wealth may differ considerably from one country to another, meaning that aggregations of costs are frequently approximate. However, it has been possible to reconstitute the operating cost of a heavy goods vehicle, in relative terms at least, from two statistical sources (Table 8).

EU countries have similar cost structures, though a distinction can be drawn between the countries of northern Europe (Germany 106, Belgium 104, Netherlands 104), where costs are highest, and the countries of southern Europe, where costs are lower (Spain 90 and probably Portugal and Greece as welltries like France (100) and Italy (97) fall somewhere in the middle, while the countries on the EU's eastern border form a distinct group (Hungary 77, Poland 76).

Table 8. Production costs of long distance road haulage in various countries
Percentage

Estimates from two sources	France	Hungary	Poland	Spain	Italy	Germany	Belgium	NL
Credit + insurance + amortisation	*19.1*	*23.4*	*23.1*	*20.0*	*19.3*	*18.7*	*18.6*	*18.3*
Fuel, tyres, tolls	*32.3*	*39.5*	*39.0*	*33.7*	*32.5*	*31.6*	*31.5*	*31.0*
Wages + charges and expenses	*31.2*	*15.8*	*16.9*	*28.1*	*30.7*	*32.7*	*33.0*	*34.0*
Non-chargeable costs	*17.4*	*21.3*	*21.0*	*18.2*	*17.5*	*17.0*	*17.0*	*16.7*
	100	100	100	100	100	100	100	100
Wages and wage costs	24.8	8.5	10.1	22.7	24.9	25.6	26.5	27.9
Overall relative cost index France = 100	100	77	76	90	97	106	104	104

The figures in italics are indicative only. The breakdown of operating costs across several items is based on the assumption that equipment and financial costs are already largely similar in the different countries and that the relations between the different items have not fundamentally changed.
Source: NEA, "omparaison du coût de transport routier international dans 8 pays européens"; DTT, "Coût d'exploitation d'un camion de gros tonnage".

In a single market, equipment, maintenance, insurance and financial costs should ultimately be homogeneous. In the EU, credit, insurance and amortiztion costs and costs relating to the truck and its operation are similar to within 1-2 per cent. The difference in labour costs is significantly greater, between 1 and 6 per cent. However, this is nothing compared to the difference between labour costs in eastern Europe and in the EU.

The issue of labour costs highlights a number of vital factors for the road haulage industry. First, the industry is not going to be able to do without drivers any time soon, and they represent about a quarter of operating costs. Second, autonomy and pay are factors that are going to influence an individual's decision to enter the occupation and, having become a driver, to remain in the business or leave.

Drivers in the "other sectors" category are better paid than drivers in the "transport sector" category unless expenses are included. Here again, it is only when expenses are included that drivers in the transport sector have higher income than those in other sectors.

Since wages or income (wages plus expenses) are valued in relation to what is accessible on the local labour market, clearly the differential in relation to other jobs may be judged on the basis of available income and a social scale situating the position of the individual in a given environment. For the sake of consistency, drivers' monthly wages and income have been compared with the net wages of male manual workers and their hourly wages with the hourly wage of male manual workers and the minimum hourly wage.

It has been shown on several occasions (Griffiths *et al.*, 1993; Hamelin, 1993, 1997*a*, 1997*b*) that the financial incentive to enter the occupation is based on the fact that in comparison with non-mobile jobs for which drivers might be qualified, driving enables them to acquire more income. The net wage of drivers in the transport sector had fallen to almost the same level as that of male manual workers in 1993, whereas in 1983 it was 7.5 per cent higher. Of course, male manual workers have a higher hourly wage, though the hourly wage of drivers in the transport sector is equivalent to that of male manual workers if expenses are included. As they work long hours, they accumulate more income each month. Although the net wage remained unchanged in relative terms between 1983 and 1993, income including expenses rose faster than the wage of a male manual worker.

Drivers' average hourly wage traditionally used to be higher than the minimum hourly wage. However, this differential was eroded between 1983 and 1993, since the number of drivers at or below the minimum hourly wage doubled, rising from 18 per cent of drivers away four nights or more to 36 per cent.

In addition, productivity increased in direct relation to drivers' loss of autonomy. Previously multi-skilled, they often acted as sales agents capable of negotiating a return load as well as being responsible for the smooth progress of the transport operation. With the arrival of more sophisticated means of communication, the firm knows exactly where a driver is in the transport process and can monitor his progress if not impose specific procedures. The picture that emerges is one of more work and tighter controls for falling relative wages and an income level that is maintained only with difficulty. It is hardly surprising that the occupation has become "less attractive" to the point where the difficulty of finding "good drivers" is a source of concern in the industry.

However, carriers have always complained about the difficulty of finding "good drivers". The criteria for judging whether a driver is good or not may change from one period to another, but they share the same ultimate goal, namely finding drivers capable of transporting goods reliably and safely. They must also be capable of doing so from collection to delivery, taking a positive attitude to the many

imponderables inherent in any operation that involves three if not four types of player: the shipper, the recipient, the carrier and possibly a charterer. Each one approaches the practical aspects of the transport operation from a different standpoint.

Reflecting these difficulties, all studies of drivers in the transport sector produce the same findings: high turnover, health problems and the problems of externalising the social costs of work carried out under extremely demanding conditions. They bear witness to the difficulty of the job, especially that of remaining in the business throughout a working life. Not surprisingly, drivers with less favourable pay and hours are more likely to move into other jobs (Griffiths *et al*., 1993; Hamelin, 1993, 1997*a*).

Hitherto, newcomers have been attracted into the profession by the autonomy that long distance driving guarantees. However, this autonomy is now under threat from new working practices. Drivers are now much more dependent on the operational centre, which is in direct contact with customers and manages all relations with them, leaving the driver with little to do except obey instructions from dispatchers.

The problem is therefore one of ensuring loyalty in an industry where the difficulties of a change in working practices are linked precisely to the fact that drivers used to accept a trade-off between onerous working conditions on the one hand and autonomy and income on the other. Now firms are looking, if not to rationalise and automate the transport chain, then at least to control the activity of individual drivers more closely. They are also looking to standardise wages and resources. The labour issue is posed in different terms.

Conclusion

International competition has been extremely fierce within the European Union for a number of years, leading to a steady decline in transport prices. Economists consider that players are likely to find themselves competing on an increasingly equal footing as far as the equipment costs of transport are concerned. Labour costs are another matter, however. Wage levels vary considerably from one country to another for historical reasons. Moreover, in their labour laws different countries use different definitions of key concepts such as work time and the yardstick by which it is measured (annual, monthly, weekly), giving rise to distortions that are the subject of complaints by national industry lobbies.

As far as wage levels are concerned, the distortions are real. As regards the definition of work time, however, day-to-day practice seems to have settled this somewhat academic debate. National labour laws may differ within the European Union, each country sticking to its own system; nevertheless, international truck drivers on European roads have highly comparable working hours.

The state of affairs is this: in labour matters, the only common law applicable to European carriers is Regulation EEC No. 3820/85, the so-called safety regulation, drawn up in 1985. Firms calculate their cost price on the basis of a comparison with other European carriers, not the “national exception” that each country’s particular labour laws represent.

The EU security regulation is *de facto* the lowest common denominator of labour law (Table 9), applicable to all drivers, whatever their country of origin or status (employee or non-employee). As it only covers driving and rest, it allows for actual working hours that are entirely compatible with survey findings.

Table 9. Summary of the terms of European legislation on driving hours and their interpretation in France between 1976 and 1982 in the form of ministerial instructions

	Daily driving time	Maximum driving time	Maximum weekly driving time	Average weekly driving time
EEC Regulation 1969	8h / day * 6	9h / day * 2	48 - 50 h	48 h
Cavaillé instructions 1976	9h / day * 6	10h / day * 3	54 - 57 h	48 h
EEC Regulation 1985	9h / day * 6	10h / day * 2	54 - 56 h	45 h

Until the new European safety regulation (EEC 3820/85) was introduced in September 1985, setting a new average of 45 hours, drivers were not supposed to drive for more than 48 hours a week on average over a 12-week period.

If all drivers spent as much time on the roads as the EU regulation allows, what would their weekly working hours be? Assuming that the relationship between driving time and total work time observed during surveys is valid, the possible amount of work for long distance drivers under the 1969 or 1985 regulations would be greater than the findings of the 1983 survey and equivalent to the findings of the 1993 survey. Under European law, it is possible to work 60 hours a week, if average requirements are applied (see Table 10), and 74 hours if the authorised maximum of 56 hours driving time is used one week in two. Matters become more complicated over several consecutive weeks because drivers are required to take at least 36 consecutive hours of rest after six days of work and not to exceed an average of 90 hours of driving over two weeks. However, controls that enable inspectors to determine the consistency of a set of disks over more than one week are infrequent and difficult enough to leave plenty of room for manoeuvre. Officials carrying out controls concede that it is extremely easy for drivers to produce a piece of paper showing that they were on holiday the previous week.

Contrary to some assertions, European regulations are applied in the majority of cases, although national regulations – in this case French law (decree 83/40) – may not be (Table 11).

Table 10. Theoretical calculation of permitted work time under EU rules on average driving time

Salaried employees in the transport sector	Home each day		Away two days or more	
	1983 survey	1993 survey	1983 survey	1993 survey
Weekly work time	48.1 h (7.7)	48.8 h (11.1)	58.7 h (10.0)	59.7 h (10.0)
Driving time (%)	56.3	58.6	63.7	67.0
Possible weekly work time under 1969 and 1985 EEC regulations	48h/-0.563 = 85.3 h	45h/-0.586 = 76.8 h	48h/-0.637 = 75.4 h	45h/-0.670) = 67.2 h

Source: Hamelin (1997*b*).

Table 11. Proportion of drivers in each category whose weekly working hours or driving time exceed the rules laid down in the agreement of November 1994, EU regulations and national labour law
Percentage

	Share of total population	Drivers working ≥ 60h / week A	Drivers working ≥ 60h and driving > 45h B	Drivers > EU rules, driving > 45h C	Drivers > labour law working > 52h D
Transport sector employees	47.8	31.3	14.6	16.8	56.1
Away ≥ two days	23.2	50.8	25.5	26.4	76.0
Away 1 - 3 nights	8.2	32.0	14.1	14.1	55.8
Away ≥ 4 nights	14.9	61.1	31.7	33.2	86.6
Home each day	24.6	12.9	4.3	7.7	37.7
Other sector employees	46.3	7.2	1.8	3.0	15.6
Away ≥ two days	3.6	25.8	6.4	9.8	54.8
Home each day	42.7	5.6	1.4	2.4	12.2
Non-employees	5.9 (N=72)	29.9	12.0	14.7	52.9
Total	100 (N=1150)	20.0	8.5	10.3	37.1

Until the new European safety regulation (EEC 3820/85) was introduced in September 1985, setting a new average of 45 hours, drivers were not supposed to drive for more than 48 hours a week on average over a 12-week period. The table reads as follows: salaried drivers in the transport sector represent 47.8 per cent of the population, 31.3% work more than 60 hours, 16.8 per cent more than 45 hours. As 14.6 per cent work more than 60 hours and drive more than 45 hours, those who drive more than 45 hours and work less than 60 hours only represent 1.2 per cent (C – B) and 56.1 per cent work more than 52 hours.
Source: Hamelin (1997*b*).

In the transport sector, 56.3 per cent of drivers work more than 52 hours a week, as do 51.1 per cent of non-employees. Moreover, 76 per cent of drivers away two days or more exceed both the average and maximum work times laid down in national legislation.

In terms of the European safety regulation, 97.2 per cent of employed drivers in the "other sectors" category, 83.3 per cent of employed drivers in the transport sector and 85.1 per cent of non-employees drive less than the 45 hour weekly average. Even among drivers in the transport sector away four nights or more, who work the longest hours of all, two-thirds drive no more than 45 hours a week on average and therefore comply with EU regulations. Of those who work more than 60 hours, half drive no more than 45 hours.

Among drivers driving more than 45 hours, 80 per cent work at least 60 hours and 70 per cent work 64 hours or more; among drivers driving between 42 and 45 hours, 60 per cent work at least 60 hours and 38 per cent work 64 hours or more.

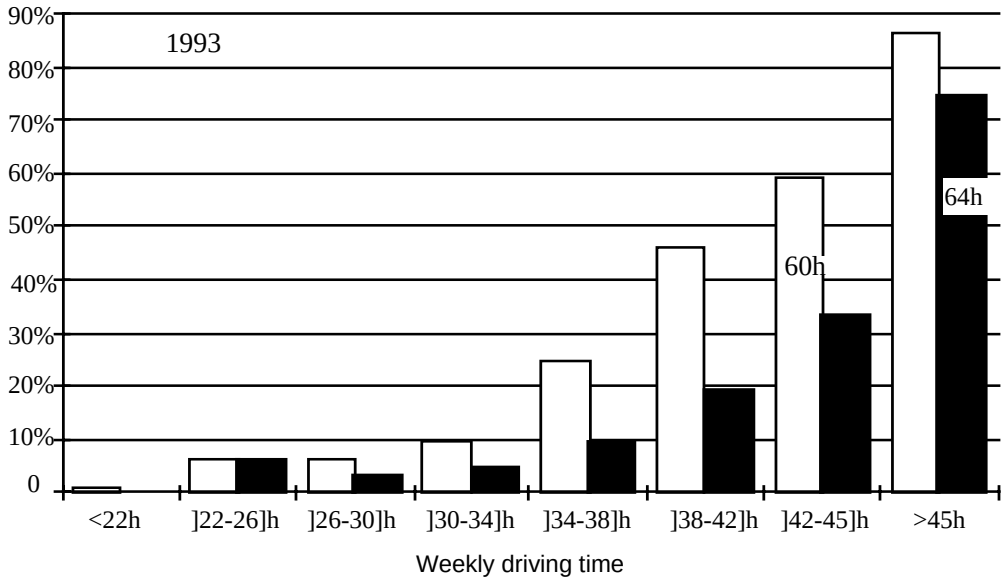
The ratio of driving time to work time, determined by the length of "breaks in production" (*i.e.* checking loads and paperwork, loading and unloading), also affects drivers' daily working patterns. Among drivers in the transport sector away two days or more who drive no more than 38 hours, 77 per cent work on average at least 12 hours a day, and 52 per cent work on average at least 13 hours a day. In other words, driving for less than 40 hours a week – a driver's main activity – is no guarantee of a shorter working day.

In view of actual working conditions, the work time formally allowed by European regulations is in contradiction with the current state of knowledge concerning the probability of drowsiness and the increased risk of accidents. As mentioned at the beginning of this paper, both depend on total work time. Legislation that concerns only driving time endorses rather than eliminates legal risk taking.

Moreover, European regulations, by laying down rules for driving only, authorise what most national labour laws prohibit, invalidating them in practice. This is hardly likely to help simplify the application of explicit rules.

Although this dual contradiction is not easy to resolve, working regulations and road safety rules need to share a common rationale if progress is to be made. It is simply not possible to regard as inevitable a situation in which drivers work 15 hours a day on average when the risk of an accident is twice as great after 12 hours.

Figure 1. Proportion of drivers in the transport sector working 60 hours or more or 64 hours or more according to their weekly driving time



Source: Hamelin and Lebaudy, 1997.

European rules are both relatively simple and fairly widely applied. Moreover, imposing a time limit on the overall production cycle assumed by a single driver is the way to reduce differences in working practices and eliminate excesses. Total work time and driving time are linked: drivers driving less than 38 hours a week are less likely to work more than 60 hours a week than drivers driving more than 42 hours (Figure 1). Surely the problem lies in the fact that the European regulation is not strict enough, since it authorises 45 hours driving time on average (*i.e.* more than the average of many employed drivers, not counting stationary work). The only way to find a realistic compromise to solve the problem is for all sides to co-operate.

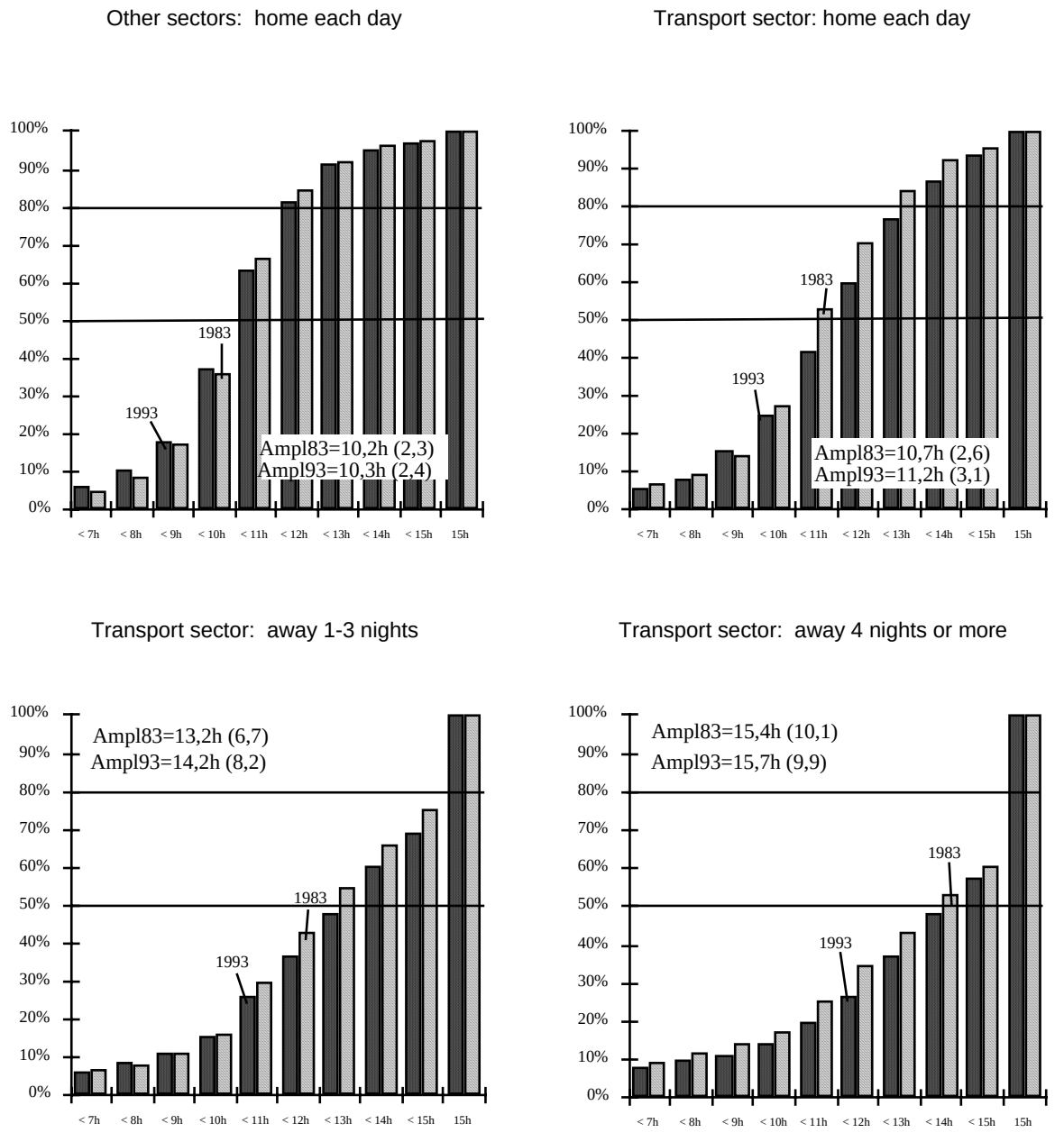
If nothing were to change, we would find ourselves facing the same conclusions in 2005 as in 1975. The working week was no shorter in 1993 than in 1983, and no shorter in 1997 than in 1995. As there was no reduction in drivers' workloads between 1983 and 1993, it has probably remained, like their weekly working hours, at the same level (Figure 1). However, the average work span, as defined in the INRETS survey (the duration of work between two periods of at least six consecutive hours of rest) remains the same after an interval of ten years and is well above the threshold at which risk related to the amount of working time previously carried out increases, *i.e.* 11 hours (Hamelin, 1987).

Figures indicating cumulative work spans show that if a third of the work spans of drivers returning home each day in other sectors surpass 11 hours, in the transport sector, they surpass 11 hours for over

half, three-quarters and eight-tenths of drivers who returning each day, are away one to three days, and are away at least four nights, respectively (Figure 2).

Accumulating both long work spans and long working weeks does not seem likely to help lower the risks of accident involvement, even if, as was demonstrated in 1987, drivers that are most exposed to time-related dangers compensate for part of that risk through know-how acquired to the repeated need to manage difficult conditions (Hamelin, 1989).

Figure 2. Cumulative distributions of work spans for salaried professional drivers, 1983 and 1993



Source: Hamelin and Lebaudy, 1997.

NOTES

1. The French surveys were designed and carried out by Patrick Hamelin with Marie Josée Mure in 1975 for ONSER, with Marie Josée Mure and Marie Ange Cambois in 1983 for IRT/INRETS, and with Marie Lebaudy in 1993 for INRETS.

2. For the following commentary, please refer to Tables 3, 4 and 6.

3. The reduction was not measured precisely because the sample for the 1975 survey, unlike the 1983 and 1993 surveys, was not random.

4. 300 drivers are interviewed each quarter when they stop at some of the special truck stops set up on the outskirts of towns and cities with high volumes of through traffic. They answer a set of questions about the time spent on each of the different tasks during the previous week. Only drivers in the transport sector using these truck stops are interviewed.

5. The result is identical whether the comparison is made between firms with 100 employees or more and smaller firms or between firms with a single establishment and firms with several. However, it is likely that a more detailed analysis based on a larger sample would reveal subtler differences.

REFERENCES

Griffin, G. C. *et al*. (1993), "Job satisfaction of US Commercial Drivers", Upper Great Plains Transportation Institute, North Dakota State University.

Hamelin, P. (1981), "Les Conditions de travail des conducteurs routiers et la sécurité routière", *Le Travail Humain*, P.U.F, vol. 44, n°1, Paris.

Hamelin, P. (1987), "Lorry drivers' time habits in work and their involvement in traffic accidents", *Ergonomics*, vol. 30, n° 9, p. 1323, Taylor & Francis, Londres.

Hamelin, P. *et al*. (1989), "Working conditions of drivers in road transport", *Actes INRETS*, No. 23, Paris.

Hamelin, P. (1993) in *Les routiers, des hommes sans importance : ils roulent pour tous*, éditions Syros, Paris.

Hamelin, P. (1997*a*), "Les conditions de travail et les carrières des conducteurs de poids lourds : analyse des résultats de l'enquête auprès des conducteurs de poids lourds, menée en 1993, comparaison avec ceux de 1983", INRETS, Paris.

Hamelin, P. (1997*b*), "Le transport routier : un mode de production performant en tension", in *Les raisons de la colère*, Editions de l'Atelier, Paris.

Hamelin, P. et M. Lebaudy (1997), "Les conditions temporelles de travail des conducteurs de poids lourds, analyse des résultats de l'enquête de 1993, comparaison avec ceux de 1983", INRETS, Arcueil.

Kecklund, G. Göran and T. Äkerstedt (1993), "Sleepiness in long distance truck driving : an ambulatory EEG study of night driving", *Ergonomics*, vol. 36, n° 9.

SOCIAL ASPECTS OF ROAD TRANSPORT: MAIN SIMILARITIES AND DIFFERENCES BETWEEN EAST AND WEST AS SEEN BY HUNGARY

József Pálfalvi
Institute of Transport Science (KTI), Budapest, Hungary

Introduction

Negotiations between the European Union and a number of central and eastern European countries, including Hungary, over future membership of the Union in 1998. The negotiations will probably be a lengthy affair and will focus on areas in which there are significant differences between the two groups. Since road transport has not developed along the same lines in eastern and western Europe in the last 40 to 50 years, the settlement of the differences in the road transport sector will probably be one of the main issues in the negotiations.

Until the end of the 1980s, most transport undertakings in central and eastern Europe were state-owned. Road transport was operated by one or more trusts (for example, in Hungary, by the Volán Trust on the domestic market and by Hungarocamion on the international field market). For this reason, there was no competition on the domestic market. Road transport regulation was therefore highly centralised and relatively simple.

The start of the 1990s saw the creation of tens of thousands of road transport firms each of which had only a few lorries and drivers. State control, which was formerly quite strict, has been relaxed (even non-existent in the private sector), as has the defence of the sector's various interest groups. Along with the ageing of the vehicle fleet, the sector's social provisions are now the main problem in road transport.

General overview

A brief description of the present transport market and general economic situation should make it easier to understand the harmonisation problems confronting road transport in Hungary.

Present situation of road transport in Hungary

The state of road transport in Hungary in the latter half of the 1990s can be summarised as follows (Rojkó, 1998):

- the transport market has been fragmented, the domestic market is affected by overcapacity, and the limited capacity in international transport is mainly due to the small number of transport permits.

- owing to keen competition, road transport prices have collapsed.
- Hungary has already accepted the requirements for access to the European Union's market, but its carriers cannot draw on the same capital resources as EU road transport operators.

In recent years, the economic changes (the "return" to economic growth, the stop to a declining or flat GNP) have been reflected in freight transport activity and rates. The trend in foreign trade has been reversed (most freight is now carried to Western Europe and not to Eastern Europe), and the road transport sector has had to adjust to the change. Many enterprises, especially those operating on the domestic market, have had to abandon the most necessary investments and modernisation projects.

Despite economic growth, Hungary's road infrastructure is under-developed and its situation has remained unchanged in that the only resources provided by the government are in the form of "leftovers". Of the HUF 450 billion[1] in revenue paid into the national budget by the road transport sector, only 18 per cent (or HUF 82 billion) is allocated to road infrastructure development, compared with 30 per cent of revenue in the EU (Pálfalvi, 1998).

The tax burden on road transport undertakings exceeds the average. Transport statistics are not reliable and some carriers are not included in the data (Pálfalvi, 1997). The vehicle fleet is obsolete in terms of road safety and environmental protection standards.

In addition to resolving these technical problems, Hungary has to incorporate EU rules on working and rest times into its legislation. The social provisions applicable to Hungarian road transport can therefore be brought into line with those of the EU only on a gradual basis and in the light of the country's interests.

Harmonising road transport regulations

Following this overview of the road transport situation in Hungary, the areas in which Hungary's road transport regulations are to be harmonised with those of the EU (Ruppert and Honti, 1997; Pálfalvi, 1997) should be reviewed. The following list, which is not intended to be exhaustive, covers only those areas in which major efforts will be required in coming years:

- competition policy: legislation for the various transport modes;
- accession requirements: harmonisation of Hungarian regulations with Council Directive No. 92/26 (good repute, financial standing, professional competence) particularly with regard to passenger transport;
- freight and passenger transport: repeal of the limitation on international transport permits;
- cabotage: at present prohibited in Hungary but liberalised in the European Union;
- the transport of special goods: for example the transport of live animals and their protection during transport;
- vocational training, driving licences, traffic rules: standardised European driving licence, business training;
- social regulations: working and rest times, enforcement;
- economic issues of transport: contributions, motorway tolls, public service requirements;
- vehicle technical regulations: replacement of the vehicle fleet, vehicle size and weight standards.

The AETR and the central and eastern European countries

Along with Lithuania and Romania, Hungary is not a party to the AETR (European Agreement on the Work of Crews of Vehicles Engaged in International Road Transport) – unlike Bulgaria, the Czech Republic, Estonia, Latvia, Poland and the Slovak Republic. While not exhaustive, the following information is available on social provisions in a number of these countries (Tóth, 1997).

- in international road transport the Czech Republic observes the AETR regulations which do not apply to domestic operations:
  - the maximum working time is ten hours,
  - rest time is at least 12 hours between two duty periods,
  - uninterrupted driving time is four hours followed by 30 minutes' rest,
  - one hour is allocated to work other than driving (presence), following by rest.
- in Poland the regulations for drivers' working hours in domestic road transport differ from the AETR provisions. Drivers' working time is regulated by the Ministry of Transport and the Maritime Economy, but the adjustment of regulations to conform to the AETR is under way. In accordance with the amendment to the AETR (24.2.1993), the use of tachographs is compulsory on vehicles engaged in international road transport.
- in Romania regulations for drivers are governed by the General Labour Code. In the case of freight transport movements programmed between the different parts of the country, transport safety factors are taken into account, daily working time does not exceed eight hours and compulsory rest periods are enforced.

As already mentioned, Hungary is not a party to the AETR. The social regulations for domestic road transport are governed by the Labour Code (1992), but the AETR provisions are observed in international transport. Additionally, the AETR regulations are also observed by some undertakings (especially those which were originally state-owned). The use of the tachograph is compulsory only on vehicles engaged in international transport.

In short, the reality of the situation is that the application of social provisions at the domestic level in central and eastern European countries differs radically from that at the international level. The use of the tachograph is not compulsory on vehicles engaged in domestic transport (except in Poland), and the recording of driving and rest times – depending on the type of transport activity – is often simply a theoretical requirement which is not consistently enforced, although it is compulsory for vehicles carrying international freight.

In the central and eastern European countries which are not yet parties to the AETR, international transport operators are not obliged to implement the AETR provisions on driving and rest times and in any case there is no control system. Owing to the lack of equipment and personnel, a control system cannot be set up in the short term.

A long and complicated procedure will be necessary to address social issues in central and eastern European countries. In the case of Hungary, for example, the following steps might be proposed:

- if there is to be a standardised legal basis, Hungary's accession to the AETR must be prepared without delay;
- national and international transport must be regulated on the basis of provisions similar to those of the EU;

- a standardised control system must be set up (regulations, equipment, networks, penalties, etc.) in agreement with the other countries in the region so as to avoid unfair competition;
- subsequently the aim must be to comply with EU provisions.

It must be pointed out that the harmonisation of Hungarian social legislation with Community provisions on driving and rest times will require more drivers, which will cost Hungary several billion forints since current wage levels are not attractive enough.

Comparison of EU provisions with Hungarian regulations

In the EU the general working conditions applicable to wage earners (for example working hours) are treated separately from driving and rest times in freight and passenger transport. Since the general provisions do not apply (with the possible exception of owner drivers) to workers employed as vehicle crew members, this study will only address the social issues in connection with harmonisation requirements which concern the latter category.

Driving and rest times for vehicle crews are regulated by the following three international legal instruments, none of which applies to Hungarian citizens or to transport undertakings registered in Hungary if they are engaged in domestic transport:

- Agreement No. 153 of the International Labour Organisation (ILO) and Recommendation No. 161;
- With regard to driving and rest times for those employed in international freight and passenger transport, the AETR to which all the EU countries and most central and eastern European countries are parties (but not Hungary);
- Regulation 3820/85/EEC which is compulsory for all EU countries, and which will also apply to Hungary after its admission to the EU.

The EEC regulation was issued under the title "The harmonisation of certain social legislation relating to road transport". According to Art. 19, the regulation is binding in its entirety and directly applicable to all member states. Art. 5 of the regulation states the provisions for the minimum age of drivers engaged in the carriage of goods and passengers.

"1. The minimum ages for drivers engaged in the carriage of goods shall be as follows:
   a) for vehicles, including, where appropriate, trailers or semi-trailers, having a permissible maximum weight of not more than 7.5 tonnes, 18 years;
   b) for other vehicles, 21 years, or 18 years provided that the person concerned holds a certificate of professional competence recognised by one of the member states confirming that he has completed a training course for drivers of vehicles intended for the carriage of goods by road, in conformity with Community rules on the minimum level of training for road transport drivers.

"2. Any driver engaged in the carriage of passengers shall have reached the age of 21 years. Any driver engaged in the carriage of passengers on journeys beyond a 50 kilometre radius from the place where the vehicle is normally based must also fulfil one of the following conditions:
   a) he must have worked for at least one year in the carriage of goods as a driver of vehicles with a permissible maximum weight exceeding 3.5 tonnes;
   b) he must have worked for at least one year as a driver of vehicles used to provide passenger services on journeys within a 50 kilometre radius from the place where the

vehicle is normally based, or other types of passenger services not subject to this regulation, provided the competent authority considers that he has by so doing acquired the necessary experience;

c) he must hold a certificate of professional competence recognised by one of the member states confirming that he has completed a training course for drivers of vehicles intended for the carriage of passengers by road, in conformity with Community rules on the minimum level of training for road transport drivers."

In Hungary drivers engaged in passenger transport must be at least 21 years of age, while drivers engaged in freight transport must be at least 18. Since the differences between the EU and the Hungarian regulations are minimal and the additional expenditure involved is negligible, harmonisation in this case does not pose any problems.

Working and rest times

A few articles from Regulation 3820/85/EEC may help to make the comparison clearer.

With regard to driving time, Art. 6 states that:

"1. The driving period between any two daily rest periods or between a daily rest period and a weekly rest period, hereinafter called 'daily driving period', shall not exceed 9 hours.
It may be extended twice in any one week to 10 hours.
A driver must, after no more than 6 daily driving periods, take a weekly rest period. ....
"2. The total period of driving in any one fortnight shall not exceed 90 hours."

Article 7:
"1. After 4-and-a-half hours' driving, the driver shall observe a break of at least 45 minutes, unless he begins a rest period.
"2. This break may be replaced by breaks of at least 15 minutes each distributed over the driving period or immediately after this period...
"3. ...in the case of national carriage of passengers on regular services, member states may fix the minimum break at not less than 30 minutes after a driving period not exceeding 4 hours...
...
"5. The breaks observed under this Article may not be regarded as daily rest periods."

Article 8:
"1. In each period of 24 hours, the driver shall have a daily rest period of at least 11 consecutive hours, which may be reduced to a minimum of 9 consecutive hours not more than three times in any one week, on condition that an equivalent period of rest be granted as compensation before the end of the following week.
On days when the rest is not reduced in accordance with the first paragraph, it may be taken in two or three separate periods during the 24-hour period, one of which must be of at least 8 consecutive hours. In this case the minimum length of the rest shall be increased to 12 hours.
"2. During each period of 30 hours when a vehicle is manned by at least two drivers, each driver shall have a rest period of not less than 8 consecutive hours.
...

"6. Any rest taken as compensation for the reduction of the daily and/or weekly rest periods must be attached to another rest of at least 8 hours and shall be granted, at the request of the person concerned, at the vehicle's parking place or driver's base.
"7. The daily rest period may be taken in a vehicle, as long as it is fitted with a bunk and is stationary."

An important aspect of the regulation is that it does not exclude taking into consideration either local circumstances concerning continuity of hours of driving and rest periods or a gradual period of implementation.

According to the Hungarian Labour Code, the average duration of the working day is eight hours over a period of two to six months depending on the type of collective contract, while the maximum number of hours in any working day must not exceed 12.

In the case of a continuous activity – and regular domestic transport is classified as such – the average daily rest period is at least eight hours and drivers must be given a weekly rest period of at least 42 consecutive hours.

One of the main differences between the EU regulation and the Hungarian Labour Code is that the former refers to driving (and rest) time and the latter to working time.

Working and rest times are generally regulated by local collective contracts based on the Labour Code, with conditions that are less strict than those laid down in international agreements. As regards the working and rest times for vehicle drivers engaged in regular national and international passenger services, Art. 117 of the Labour Code gives the possibility of departing from the Code in connection with the collective contract system. Since 1992 working and rest times have been regulated by this system. However, this type of regulation does not extend to all operators, since passenger transport is not provided exclusively by Volán carriers (still owned by the State)[2].

Another important difference is that in Hungary the regulations for the working and rest times of drivers engaged in passenger transport are less strict, do not apply to all road passenger transport operators and are therefore at the lower sectoral level.

The Collective Sectoral Contract (CSC) includes social provisions for road haulage, but they are not applicable on a general basis to privatised road hauliers.

Under the CSC the working day lasts nine hours (out of a 24-hour period), and may reach 11 hours in a semi-continuous activity and 12 hours in a continuous activity. In the event of variable working hours, the working time of employees on standby may not be less than four hours and may not exceed 15 hours, unless the period of work is followed by a day or at least 24 hours of rest. Under this system working time is defined as the duty period.

The CSC partly regulates the working and rest times for vehicle crews engaged in regular road passenger transport. The working day is nine hours on average. In domestic transport the working time between two rest periods may be 15 hours, or 16 hours three times a week at most, unless otherwise stated by the collective contract concerned (in international transport the AETR provisions are applied).

The third important difference is that the regulation refers to driving hours and the Labour Code to working hours, which makes it difficult to compare the two systems.

In the case of drivers engaged in road passenger transport, actual driving time cannot exceed ten hours on local services or 12 hours on intercity services.

The fourth significant difference is that maximum driving time in Hungary is one hour longer than in the EU on local services and three hours longer on intercity services.

In Hungary, after five hours of uninterrupted driving, the driver is entitled to 30 minutes' rest (within his working time). He may take several breaks, ideally of not less than 10 minutes each. The maximum uninterrupted driving time for drivers engaged in passenger transport is 4.5 hours, after which the driver is entitled to 30 minutes' rest on domestic passenger services and 45 minutes on international passenger services (the latter provision complies with the EEC regulation).

One of the most important differences is that maximum driving time over a fortnight is limited to 90 hours in the EU, while in Hungary it is limited under the CSC to 200 hours a month. The aim here is to keep relatively short driving times so as to give the driver a balanced workload. However, over the longer term, this leads to higher numbers of periods of service.

The fifth important difference is that the maximum driving time rule is in the interest of drivers in EU member states, while in Hungary it is in the interest of the employers since the driving period is longer.

Rest time is regulated by the CSC. Drivers must have at least nine hours' rest between the end of work and the start of work on the next day. Drivers engaged in road passenger transport must have two rest days a week or 42 consecutive hours of rest.

The sixth main difference is that the EU regulation provides for at least 11 rest hours in a 24-hour period, while the CSC or the Labour Code requires only nine consecutive hours over the same period.

Recording equipment

Council Regulation (EEC) No. 38520/85 is supplemented by Council Regulation (EEC) No. 38521/85 on recording equipment of the kind that complies with the requirements of the regulation and its Annexes I and II. On the basis of this regulation, it can be decided when recording equipment must be used or which vehicles can be exempted.

In other words, this regulation means that a member state may either require operators providing regular passenger services by road to draw up a service timetable and duty roster in accordance with Art. 14 of Regulation 3820/85/EEC. According to this article, their vehicles may be obliged to or may not need to be equipped with recording systems.

The service timetable and duty roster are not a problem for Hungarian operators providing regular passenger services since they have used the system for many years (an inheritance from the planned economy). The main difference between the EU and Hungary concerns working and rest times and the methods of enforcing them.

There is no problem either with regard to drawing up a service schedule for international services whose route terminals are located within a distance of 50 kilometres as the crow flies from a frontier between two ECMT member states and whose route length does not exceed 100 kilometres. In accordance with bilateral agreements on regular services, the service timetable is already drawn up in advance, with the agreement of the authorities in the States concerned. For these services a duty roster

must be set up which serves as a check on regulation times if recording equipment is not used[3]. Council Regulation 3820/85/EEC sets out the obligations and prohibitions applicable to operators:

> Article 10
> "Payments to wage-earning drivers, even in the form of bonuses or wage supplements, related to distances travelled and/or the amount of goods carried shall be prohibited, unless these payments are of such a kind as not to endanger road safety."
>
> Article 15
> "1. The transport undertaking shall organise drivers' work in such a way that drivers are able to comply with the relevant provisions of this regulation and of Regulation 3821/85/EEC.
> "2. The undertaking shall make periodic checks to ensure that the provisions of these two regulations have been complied with. If breaches are found to have occurred, the undertaking shall take appropriate steps to prevent their repetition."

Member states assist each other in complying with the regulation and in checking compliance with it. Under this mutual assistance provision, the competent authorities are to send one another all available information concerning breaches of the regulation committed by non-residents and any penalties imposed by a member state on its residents for such breaches committed in other member states.

Before Hungary joins the EU, the implementing order will have to be enacted, implementation, procedures and enforcement will have to be planned, and penalties for infringements drawn up.

The Hungarian regulations concerning recording equipment (decrees No. 6/1990 KöHÉM; No. 7/1991 KHVM; and No. 16/1992 KHVM) require the use of a tachograph in vehicles engaged in international freight and passenger transport. The installation of these tachographs, their type approval, calibration and use comply with the AETR provisions and their annexes, which are also in line with the EU provisions.

Taking into account the exemptions listed in Art. 4 and the exceptions listed in Art. 13 of Regulation 3820/85/EEC, recording equipment will also have to be used in national road transport by the time Hungary joins the EU.

At present, the specialist staff of the General Transport Inspectorate are responsible for checks on road transport operators. These checks cover:

- the right to operate the vehicles (checks on transport permits);
- the personnel (competence of the management and drivers);
- the existence and validity of driving licences;
- the state of vehicles and validity of technical standards;
- the management, use and completion of transport documents and other certificates;
- the existence of international road transport permits and their scope.

As can be seen, there are no checks on road transport operators with regard to social provisions.

In addition to the adjustment of working and rest times, it must be stressed that the harmonisation of social provisions also calls for a complete overhaul of the control system, which at the very least requires a new attitude of mind and new methods.

Effect of introducing EU provisions in Hungary

Following this brief review of the similarities and differences between the EU and Hungary, it should be pointed out that there is one area in which social regulations could be harmonised on a voluntary basis and therefore more easily.

The provisions of Regulation 3820/85/EEC do not concern local or suburban passenger transport and routes of less than 50 km. But in practice the provisions can be applied to them, although this is not required at the time of accession or subsequently. Decent conditions for drivers and the reduction of risk factors in short-distance passenger transport are just as important as on intercity or long-distance routes. The application of the regulation to such types of transport would therefore be useful even if it is not compulsory. From this viewpoint it is worthwhile examining the application of social provisions to transport undertakings belonging to local authorities.

The situation is quite different in the case of freight transport. Under Art. 117 of the Hungarian Labour Code, the only possibility of departing from the Code is in passenger transport. The EU regulation applies to the national vehicle fleet and crews as a whole. At present 10 to 20 per cent of all Hungarian drivers come under the CSC, while the remaining 80 to 90 per cent are subject only to the general provisions of the Labour Code or to management/labour agreements based on the Labour Code. The acceptance and entry into force of Regulation 3820/85/EEC would put a stop to this situation and impose binding standards applicable to the entire sector.

In the following sub-section we analyse the effect which the introduction of EU regulations would have in three areas: domestic transport, international transport, and domestic controls (Tóth, 1997).

The social, occupational and financial consequences of the planned changes will be examined in turn, with regard to both freight and passenger transport.

Domestic transport

The change in the working conditions in domestic transport will be the crucial issue for the introduction of the EU regulation, the consequences of which can be summed up as follows.

In regular domestic passenger services, positive effects can certainly be expected, mainly in the period following harmonisation, since in the EU States the working and rest times governed by the Council regulation are in the interest of vehicle crews, transport safety, competitiveness and quality of service. But in this area, a positive impact can be achieved only by meeting other requirements, including technical criteria.

As already noted, current regulations in Hungary are less stringent than international standards, so accession will call for strenuous efforts. All regular passenger transport enterprises still owned by the State have undertaken to work towards the social standards applied in the EU countries, but under the CSC little progress has been made because of conflicting interests and the additional expenditure involved in applying international standards.

With regard to the conflicting interests, it is necessary to bear in mind the continuing influence of Hungary's former command economy. In the regular passenger transport field, business policy, vehicle operation, maintenance of the level of service, and the limits to the management system in force for the labour force and their wages tend to maintain high service times. It is in the interest of firms engaged in regular passenger transport to operate with the minimum number of drivers

consistent with the law. As for the drivers, the fact that they want their working time to be spread over a minimum number of days (allowing them free time in which to earn more money[4]) also contributes to maintaining the *status quo*. Most drivers therefore take on average a fortnight to do their regulatory 178 hours a month. Aligning Hungarian with European standards in this respect would increase the number of working days by four to six days, modify the work schedule which has been in force for over ten years and reduce drivers' standards of living. In order to avoid this, their wages would have to be increased by 20 to 25 per cent. Nonetheless, a high proportion of resignations and the recruitment and training of new drivers would have to be envisaged.

From the viewpoint of the financial impact of accession to the Union, the additional manpower needed for regular domestic passenger transport and the increase in the wages of present employees are the main cost factor. On intercity routes (exceeding 50 km), a 10 per cent increase in manpower, or 900 more employees (costing HUF 0.9 billion) will be necessary. The wage bill increase and training costs for all those employed in regular passenger transport could amount to HUF 3.8 to 4.8 billion.

The average workforce of operators has to be increased if service times are to be brought into line with those of the EU. As drivers' service times rise, the level of employment and earnings should rise. However, any increase in transport prices to offset a loss in earnings would result in a further decline in travel demand, which has been on a downtrend for years, and in a decrease in company receipts. Drivers could hardly be expected to take a wage cut of almost 10 per cent as a result of the measures taken to comply with EU provisions.

The requirements to be made for the transformation of the present system are also to be seen in other areas. Although lower in value, the extra cost of changes in the administrative system is likely to attain HUF 50 to 80 million.

At present the cost of modifying domestic irregular passenger transport cannot be estimated. But it can already be said that it would lead to a demand for qualified drivers and additional investment for administrative changes.

The application of the EEC regulation could result in changes in non-regular intercity passenger transport and own-account bus transport. The standardisation of working and rest times has long since been under way. But in this case too more drivers would be needed.

As in regular passenger services, positive effects are to be expected in domestic freight transport by adopting the EU standards. Regulation 3820/85/EEC applies not only to the transport of goods and passengers for hire and reward, but also to own-account transport with the use of a company's own vehicles. In the case of freight, provisions applicable to domestic traffic as a whole will probably have a positive impact on road traffic safety.

An increase in manpower will, however, be required. Long-distance road hauliers will only be able to respect the EU's driving and rest time standards if they increase the number of drivers. Working conditions are the responsibility of the employers who therefore also have to meet the extra costs involved. Only estimates are available for the additional number of employees required. If it is not feasible to have two driving periods of 4 and a half hours with 45 minutes of rest in between, 10 to 15 per cent more drivers will have to be recruited. The additional costs of implementing EU standards, meaning the recruitment of 2 000 to 3 000 drivers, would amount to HUF 2.5 to 3.5 billion.

The problems concerns freight transport as well as passenger transport. In a system of 16 to 20 hours service time, driving times of 10 to 15 hours are not possible, so that the recruitment of more drivers will in any case be necessary. This is one of the crucial points in meeting accession conditions, since

the occupational requirements for drivers are higher in passenger transport. Training and recruitment on such a scale can be carried out only gradually, over a period of two to three years.

International transport

Adjusting Hungary's legal system to EU provisions would have a minimal effect on the personnel management of Hungarian undertakings engaged in international transport. Although for the time being Hungary is not a signatory to any of the relevant international regulations, the AETR provisions have been applied to the crews of vehicles and operating abroad, as the competent authorities could enforce respect of the AETR in all EU member states and in all countries that are parties to it.

It must be stressed that, with regard to international transport operations by vehicles registered in Hungary, the implementation of the AETR or the relevant EEC regulation provisions does not involve any requirements beyond current practice.

Domestic controls

Accession to the AETR would mean that Hungary, in accordance with AETR provisions, would have to check foreign vehicles crossing its territory in the same way as vehicles registered in one of the EU member states and those of countries not belonging to the EU. Following accession to the EU, the provisions of Regulations 3820/85/EEC and 3821/85/EEC would also apply to domestic transport.

In both cases, the Hungarian authorities would have to require operators to install and use recording systems, but would also have to provide the necessary personnel and technical equipment for the control body.

Precise information on the tachographs used in vehicles operating intercity and long-distance routes is not readily available, even if this equipment meets EU requirements for recording equipment. As an initial estimate, it can be assumed that at least 3 000 buses would have to be equipped, roughly at a cost of HUF 500 million.

At the present time, the costs of the body that will analyse the files cannot be estimated. This body will, however, certainly be an additional cost factor (hardware, software, programmes, personnel, etc.). Expenditure on verification (equipment and organisation) will affect the entire vehicle fleet engaged in inter-city transport. It would be consistent with EU provisions if – as in Western European countries – the use of recording equipment and control books is compulsory only on routes of over 50 km. With the introduction of control books, there will obviously be no need for the purchase of more equipment. However, the increase in the number of employees for the analysis of the control book data will result in additional costs.

The data on the cost structure for the vehicle fleet engaged in freight transport are incomplete and unreliable, for nothing is known about the number of vehicles used for long-distance domestic transport. The installation of tachographs is therefore desirable, although the EU regulation simply requires the use of control books. At a very rough estimate, an additional expenditure of about HUF 0.5 to 1 billion would be needed for the provision of tachographs and the complementary system in vehicles engaged in long-distance domestic freight transport.

Lastly, the effects of the control system can be seen from two viewpoints:

- One strictly concerns a policy issue: it must be realised that the central and eastern European countries (prior to accession) do not have a positive attitude to the observance of the AETR provisions in all cases. In addition, the present limitation on freedom of movement is not fully understood by undertakings in the EU member states.
- The other concerns the creation of the control body. According to our estimate, the staffing, technical and administrative costs of a control body would amount to HUF 1 to 1.5 billion.

To sum up, it can be said that:

- The adoption by Hungary of the EU's social provisions for lorry drivers would have positive effects, as it would give crews better protection than at present, improve road safety, eliminate the distortion of competition and improve quality of service.
- On the other hand, the adoption of the EU provisions – except in international transport – would be disadvantageous in the short term as it would mean a sharp fall in the drivers' standard of living or additional costs that would add to the existing overcapacity on the transport market.

Requirements for the introduction of EU provisions

Given the present situation of the Hungarian transport market and what little information we have on possible financial resources, a gradual approach should be taken to the introduction of EEC Council Regulations 3820/85/EEC and 3821/85/EEC. This is why the social provisions have to be implemented in at least two stages:

- the EEC Council regulations must be implemented gradually but ***without delay*** (in one or two years, i.e. by the year 2000) and accession to the AETR must be settled as soon as possible (in 1999);
- ***pending accession*** to the EU (the date is not yet known), when Regulation 3820/85/EEC will be in force in Hungary, the following additional costs must be taken into account:
  - at least HUF 3.8 to 4.8 billion for regular passenger transport, which will have to be funded partly out of the national budget and partly by the undertakings concerned;
  - at least HUF 3.1 to 4.4 billion for non-regular passenger transport and domestic freight transport (very rough estimate), to be funded by the undertakings;
  - a negligible sum in the case of international transport;
  - about HUF 1.9 to 3.1 billion for the creation of the agency to monitor observance of the new provisions and for the technical equipment required by it.

The additional costs for the introduction of international standards are shown in Table 1. Some of these costs would be met by the bodies concerned, which could reduce their expenditure by improving their operational efficiency. Some costs would also be met by the employment agencies, since there would be more opportunities for the unemployed (provided they are properly trained) owing to the substantial increase in manpower needs. The other additional costs would have to be covered by the national budget prior to accession. The government's role would have to be made clear with regard to:

- the contribution from the central or local authority budgets, which is essential if the public service obligation to provide regular passenger services is to be maintained;
- the creation and operation of the central control base monitoring the introduction and enforcement of the new social provisions in the transport field.

Table 1. Estimated costs of compliance with EU regulations

	Billion HUF	Million ECU
Regular domestic passenger transport		
Additional wage and public costs	0.9-1.3	3.46-5.0
Training costs for additional drivers	0.2	0.76
Compensation for the wage deficit	2.6-3.2	10.0-12.3
Administrative costs	0.05-0.1	0.19-0.38
Sub-total	3.75-4.8	14.4-18.5
Non-regular domestic passenger transport		
Additional wage and public costs	0.5-0.8	1.92-3.07
Training costs for additional drivers	0.1	0.38
Sub-total	0.6-0.9	2.3-3.5
Domestic freight transport		
Additional wage and public costs	2.0-3.0	7.69-11.53
Training costs, tests	0.4	1.53
Initial and equipment expenses	0.01-0.05	0.04-0.19
Administrative costs	0.03-0.05	0.11-0.19
Sub-total	2.44-3.5	9.4-13.5
Control system		
Passenger transport – basic technical costs (tachographs, decoding equipment, software, etc.)	0.42-0.5	1.61-1.92
Control book	0.02-0.05	0.08-0.19
Freight transport: basic technical costs (tachographs, decoding equipment, software, etc.)	0.5-1.0	1.92-3.85
Control body (personnel costs, control stations, monitoring body, etc.)	1.0-1.5	3.85-5.77
Sub-total	1.94-3.05	7.5-11.7
Total	8.73-12.25	33.6-47.1

Source: Tóth, 1997, p. 37.

NOTES

1. ECU 1 = HUF 260 (October 1998).

2. In each of Hungary's administrative areas a state-owned carrier is required to provide medium and long-distance passenger services.

3. The EU member states are discussing the introduction of an all-electronic system to replace the tachograph.

4. It should be pointed out that in Hungary a considerable number of employees take on another job in their free time to supplement their low wages. Some of this extra work – accurate data are not available – comes under the grey or black economy, which explains why the country seems more developed than the official statistics would seem to suggest.

REFERENCES

Munka Törvénykönyve [Labour Code] (1992), évi XXII. Törvény [Law No. 22 of the Republic of Hungary, Budapest.

Pálfalvi, József (1997), *Korszerû statisztikai mintavételi eljárások a közlekedési jellemzõk meghatározására* [Modern sampling methods for the definition of transport characteristics], KTI Report, Budapest.

Pálfalvi, József (1998), *A társadalmi-gazdasági feszültségek feloldásának finanszírozhatósága a médianyilatkozatok alapján* [Financing the cost of reducing economic and social tensions, based on statements in the media], KTI Report, Budapest.

Rojkó, Julia (1998), "(Köz)úton Európába" [En route to Europe], *Autóközlekedés*, Budapest.

Ruppert, László and Péter Honti *et al*. (1997), *A közúti közlekedési jogharmonizáció* [Harmonization of road transport legislation], KTI Report, Budapest.

Ruppert, László and József Pálfalvi (1997), *Az EU csatlakozás felé … Az ipar átvilágítása és az iparpolitika feladatai. II/C4 Infrastruktúra (közlekedés – szállítás)* [Towards accession to the EU... Industry analysis and industrial policy action], KTI Report, Budapest.

Tóth, Lajos (1997), *A közlekedésben foglalkoztatott utazószemélyzet munkafeltételeire vonatkozó EU-rendeletek magyarországi bevezetésének feltételei* [Requirements for the introduction in Hungary of EU social provisions for transport workers], KTI Report, Budapest.

HEAVY LORRY DRIVERS: SOME VIEWS ON THE TIMING OF WORK AND RELATED QUESTIONS

Professor Torbjörn Åkerstedt
National Institute for Psychosocial Factors and Health and Department of Public Health Sciences, Karolinska Institute, Sweden

Introduction

This report represents a researcher's view of some important questions regarding work environment issues for drivers of heavy trucks. It is based on a general impression gathered from a local debate involving labour unions, employers, safety organisations and research (own and that of others).

One issue presently discussed concerns international "outsourcing" of companies, trucks and drivers. This type of activity – "cabotage", out-placement (stationing drivers in other companies), hiring of non-nationals as drivers, or moving part of a company across a border to reduce costs – occurs to a considerable extent and is apparently a matter of great concern for the labour unions involved. At least one case of such "outsourcing" is presently being tried in court. It is expected that these developments will increase and may eventually give rise to considerable conflict. There is as yet, however, only limited research data in this area.

A (related) issue which is gaining in importance involves long periods of driving spent away from home. Clearly, the social problems, particularly for married workers, may be considerable. There are, however, very little data on this topic.

At present, much attention appears to be devoted to fatigue-related topics. Work hours are a central issue in Swedish (and European) long-haul transport. From the point of view of labour unions, the duration of the working day/week is a major issue, as is the way in which non-driving work hours should be regulated and how the problem of night driving with long work hours should be addressed. These issues have been the focus of several research projects at the Swedish Working Life Institute as well as at the National Institute of Psychosocial Factors and Health and the Karolinska Institute. Some of this work has also focused on fatigue countermeasures, such as napping, food, noise, light, temperature, etc.

On the basis of present discussions in Sweden and research carried out, this report attempts to review current knowledge on fatigue, safety and the "timing" of work. Some of the review will be based on Swedish work, but work in other countries will also be considered. For some issues, there will not be sufficient knowledge available for the transport area, and data obtained from other occupational groups will be examined.

Some new Swedish data for heavy vehicles

Before addressing the issue of fatigue, it may be useful to look at some of the more recent data on heavy vehicles. The Swedish Road and Traffic Administration (Ö. Johansson, personal communication) estimates heavy truck use of public roads at 2 700 million vehicle kilometres a year. This corresponds to 7.7 per cent of the total traffic load. The number of heavy trucks involved in reported accidents was 2 077 (out of 21 000 vehicles involved in accidents and excluding car/animal accidents). This yields an average risk ratio of 0.77 per million vehicle kilometres. The organisation has also computed risk related to type of road and finds that motorways have the lowest accident risk (0.42 per million) and that this value triples or quadruples in dense traffic regardless of the type of road.

Fatigue: general views

There is no proper definition of fatigue, but it generally means a state of reduced ability or propensity to perform, usually due to previous extended or intensive activity, but also to factors like extended wakefulness, reduced sleep, or being in the low phase of the circadian metabolic cycle (Thorndike, 1926; Bartlett, 1953; Grandjean, 1979; Holding, 1983; Brown, 1994). To a great extent, "fatigue" is used synonymously with "sleepiness", although the latter term mainly refers to the rather limited aspect of maintaining wakefulness. Sleepiness has been defined simply as the "tendency towards sleep" (Dement and Carskadon, 1982) and is amenable to measurement through subjective ratings or neurophysiological indicators of the appearance of sleep (see below). Obviously, common sense tells us that driving will be influenced by fatigue. This topic has not received as much attention as might be expected. However, several government or related agencies or organisations have tried to estimate the role of fatigue in highway crashes. Some of those attempts are summarised below.

The Road and Safety Bureau of New South Wales (1993) determined that fatigue was behind 6 per cent of all road accidents, 15 per cent of all fatal ones, and 30 per cent of all fatal ones in rural areas. The US National Transportation Safety Board (NTSB) (1990*a*, 1995) found that fatigue was the most common contributor to crashes in which a truck driver was fatally injured, and that it might account for 30-40 per cent of accidents. The US Department of Transport Truck Safety Summit (US Department of Transportation, 1995) listed fatigue as the number one priority for study and management. According to the US National Highway Traffic Safety Administration (1994), single vehicle crashes in which no alcohol is involved account in the United States for 28 per cent of all fatal crashes, 26 per cent of all injury only crashes and 28 per cent of all property damage only crashes. Accidents in which only alcohol is involved account for less.

Among independent researchers, Maycock (1996) estimated from police data in England that fatigue accounted for 0.5-3.7 per cent of accidents. He gave a questionnaire to 9 000 drivers and found that 10 per cent of their accidents were related to fatigue, early morning driving, motorway, and youth (Maycock, 1997). Hawarth *et al.* (1989) and Williamson *et al.* (1992) have concluded that large proportions of heavy vehicle accidents may be fatigue-related. Corfitsen (1986) studied "unexplained" fatal road accidents and found that alcohol could explain only a part of the increased risk at night. He suggested fatigue as the main contributor. Knipling and Wang (1995) estimated that 1-3 per cent of all crashes are due to fatigue, but used very restrictive criteria. It has been suggested that the contribution of sleepiness/fatigue to accidents may be greatly underestimated since it is seldom a primary focus in the investigation of an accident and since information is often difficult to get (Dinges, 1995).

Summala and Häkkinen (1994) studied 1 200 fatal fatigue accidents (specialist teams investigating) based on interviews with survivors and other observations. The other vehicle (where it existed) served

as "control". Fatigue was less involved in fatal accidents involving truck drivers than in those involving car drivers (4.5 vs. 8.2 per cent). Alcohol was much more common among car drivers than among truck drivers (17 vs. 0 per cent). Fatigued truck drivers at fault had a slightly longer driving time (significant at over ten hours), with no difference in time awake, or sleep length. Car drivers at fault had slept a shorter time. Car drivers involved in accidents had driven much shorter distances than truck drivers. Car drivers at fault had a clear peak at 04.00 hrs, whereas truck drivers did not. Fatigue as a cause in car drivers at fault did not change with age, but interacted with time of day – young drivers more often fell asleep at night and old drivers in the afternoon.

Langlois *et al.* (1985) studied single-vehicle accidents due to fatigue and computed risk by dividing by number of cars (only for urban areas, as rural ones had too few measuring points). Type of vehicle (tractor trailer + truck vs. passenger car) and age were also used. Maximum monthly frequency and risk for all vehicles occurred in June/July (rural 85-115 per million, central 9-12 per million, risk 115-150 per million. Only rural was significant (= risk not significant). Maximum weekly frequency and risk for all vehicles occurred on Saturday and Sunday (risk = 4). Maximum hourly frequency and risk occurred at 03.00-04.00 hrs (risk almost unanalyseably high approximately 0.05 at peak vs. 0.001 at day – RR 60-70). Rural accident frequency was similar for trucks and cars, although trucks had a plateau at 02.00-06.00 hrs. As drivers' age increases, the night-time peak for rural passenger cars shifted from night to afternoon.

There is a clear element of subjectivity in the choice of cases in the studies discussed above. This increases the risk of confusion, particularly if factors like "night driving" are included among the fatigue criteria. There is a need for exact definitions of the criteria used. Horne and Reyner (1995*b*) studied 606 sleep-related vehicle accidents and seem to have been the first to define "sleep-related" carefully: no alcohol, vehicle ran off the road or into the back of vehicle in front, no signs of brakes being applied, no speeding or driving too close to vehicle in front, no mechanical defect in the vehicle (no blow-out), good weather conditions including clear visibility, police officers at the scene suspected sleepiness as a primary cause, driver must have been able to see any turn in the road or vehicle in front for several seconds. Sleep-related accidents were prominent at night and around 15.00-16.00 hrs.

Accidents and timing

Another approach which avoids the subjectivity involved in selecting accidents on the basis of being "fatigue-related" is to look at the 24-hour pattern of single vehicle accidents, or other temporal aspects, such as the duration of the work period. Below, the material is divided according to drivers and other occupational groups.

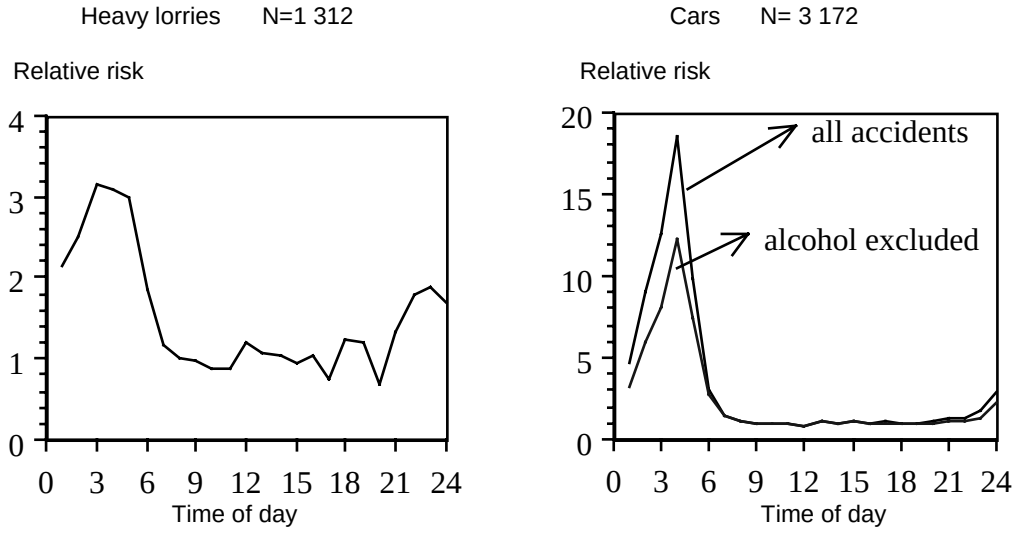
Drivers

As an example, the result of one such study carried out in Sweden is summarised below. The aim was to examine the daily pattern of four types of accidents for cars and trucks ($\geq$ 3.5 tons). Data on four types of accidents between 1987 and 1991 were collected from the National Bureau of Statistics, which records all reported road accidents involving an injury. This collection provided 3 172 "single vehicle accidents", 3 700 "rear-end accidents", 972 "overtaking/change of lane accidents" and 1 285 "oncoming vehicle accidents". However, there were few accidents with injury for truck drivers. Therefore, data on *all* road accidents with respect to trucks (provided by the Swedish National Road Administration) were used. This register provided 1 312 "single vehicle accidents" for trucks. Data was collected from five European trunk roads, predominantly with motorway characteristics. The Swedish National Road Administration provided data on exposure (traffic intensity per hour for cars

and trucks separately, at least one data point per road). Risk ratios were calculated in one-hour segments (accidents/exposure per time unit), with the average risk between 08.00 hrs and 16.00 hrs used as a reference (=1).

The figures below show the relative risk of single vehicle accidents (alcohol-related accidents excluded). For trucks, the risk for single vehicle accidents increased at night, with a peak of 3.8 between 03.00 hrs and 05.00 hrs. Also, trucks showed higher night-time risks during the weekend (peak of 6.0 between 04.00 hrs and 06.00 hrs). No clear seasonal variation was found. For cars, single vehicle accidents peaked at 04.00 hrs and showed much higher risks during the night than during the day. When alcohol-related accidents were included, the night-time peak increased to 18. The night-time risk was higher during the weekend (a peak of 16.7 at 04.00 hrs) compared to Monday-Friday (peak of 13.3 at 04.00 hrs). There was also a more pronounced night-time risk during the spring and early summer (April-June, peak of 25.3 at 04.00 hrs). The risk of a fatal single vehicle accident was 35 times higher at 04.00 hrs than during the day. The risk of severe injury and of minor injury also peaked at 04.00 hrs, although with a lower risk than for fatal accidents (severe: 27; minor: 19). The risk for oncoming vehicle accidents was somewhat increased during the night, although to much lower levels than for single vehicle accidents (Figure 1).

Figure 1. Single vehicle accidents for heavy lorries and cars



Several similar studies have been carried out, for example by Harris (1977) and Hamelin (1987), who studied single vehicle truck accidents and computed risk (using exposure). They found a peak at 05.00 hrs, but no afternoon peak. Similar observations were made by Lauber and Kayten (1988) and by Lavie *et al.* (1987). The latter also found a secondary peak in the afternoon. Baker studied single vehicle accidents (cars and trucks) and computed risk (divided by estimated miles travelled). He found a strong increase at 02.00-05.00 hrs, but no afternoon peak. Both Harris and Hamelin also found increased risk with increasing duration of driving, accelerating beyond nine hours of driving. Pokorny *et al.* (1981) studied bus driver accidents related to exposure (vehicle-miles) but did not have any data for the period between 01.00 and 05.00 hrs

In a recent publication, the NTSB (1995) searched for the immediate causes of fatigue-induced accidents. It was found that the most important factors were the amount of sleep obtained during the preceding 24 hours and the split-sleep patterns, while the length of time driven seemed to play a minor

role. The NTSB also found that the Exxon Valdez accident in 1989 was due to fatigue caused by reduced sleep and extended work hours (NTSB, 1990*b*).

Most of the discussion above has concerned night work. However, it should be kept in mind that a secondary peak of performance decrease is frequently observed around 14.00-16.00 hrs (Prokop and Prokop, 1955; Bjerner *et al.*, 1955; Hildebrandt *et al.*, 1974; Harris, 1977), *i.e.* corresponding to the end of conventional morning shifts or to the beginning of afternoon shifts. The study by Bjerner *et al.*, for example, yielded an error peak (in reading off and writing down gauge values) at 15.00 hrs, one hour after the start of the afternoon shift. The rise, however, started around 11.00 hrs during the morning shift. Thus, the afternoon performance decrease cannot simply be an effect of the hours worked or of some start-of-shift inertia.

Other groups

For air transport, a study by Caesar (1987) revealed that 75 per cent of all aircraft losses since 1959 have been the result of cockpit crew error. Ribak *et al.* (1983) found that military flight accidents increase in the early morning, and Price and Holley (1981) have argued that many civil air transport accidents may be caused by fatigue due to work scheduling. The loss ratio of aircraft (per section flown) for long haul operations is consistently almost three times higher than for short- and medium-range operations (Caesar, 1987). Furthermore, Lyman and Orlady (1981) found that the Aviation Safety Report system for 1976-80 showed that 21 per cent of incidents were "fatigue-related". Most occurred between 0.00 hrs and 06.00 hrs and generally during the descent, approach, and landing phases.

The National Transportation Safety Board concluded that fatigue caused the crash of American Airlines flight 808 at the US Naval Air Station at Guantanamo Bay, Cuba, in 1993 (NTSB, 1994*a*). The crew had had 18 hours of duty and had been flying for nine hours and had slept less than five hours during the previous 24 hours. It also concluded that a large number of US flight accidents over the last 20 years have been due to fatigue (NTSB, 1994*b*). Neville *et al.* (1994) tried to monitor fatigue in USAF crews during "Operation Desert Storm". Their results showed that pilot error was related to fatigue and that recent sleep history was directly related to fatigue during flying. This emphasis on fatigue is also reflected in NASA's "Fatigue Countermeasures Program" (Rosekind *et al.*, 1994*a*).

The fewer data available on conventional industrial operations (Ong *et al.*, 1987; Wojtczak-Jaroszowa and Jarosz, 1987) indicate that accidents tend to occur, not surprisingly, when activity is at its peak. The most carefully executed study, from car manufacturing, seems to indicate a moderate increase (30-50 per cent) in accident risk on the night shift (Smith *et al.*, 1994). The Association of Professional Sleep Societies' Committee on Catastrophes, Sleep and Public Policy (Mitler *et al.*, 1988) has, however, put forward an interesting analysis. Their consensus report notes that the nuclear plant meltdown at Chernobyl occurred at 01.35 hrs and was due to human error (apparently related to work scheduling). Similarly, the Three Mile Island reactor accident occurred between 04.00 hrs and 06.00 hrs and it was not only the stuck valve that caused a loss of coolant water but, more importantly, the failure to recognise this event which led to the near meltdown of the reactor. Similar incidents, although the final stage was prevented, occurred in 1985 at the David Beese reactor in Ohio and at the Rancho Seco reactor in California. Finally, the committee stated that the NASA Challenger space shuttle disaster stemmed from errors in judgement made in the early morning hours by people who had had insufficient sleep (through partial night work) for days prior to the launch. Yet, in all of these accidents, the technical aspects have received practically all official attention. The human aspects (*e.g.* night work) have yet to receive serious consideration.

Several studies have tried to evaluate the costs to society of alertness-related accidents and loss of performance. One estimate exceeds $40 billion per year in the United States (Leger, 1994).

Psychophysiological studies of fatigue and timing

The relation between work hours and accidents seems well established but needs to be confirmed by studies of drivers in which physiological and psychological indicators of fatigue and sleepiness are monitored.

Drivers

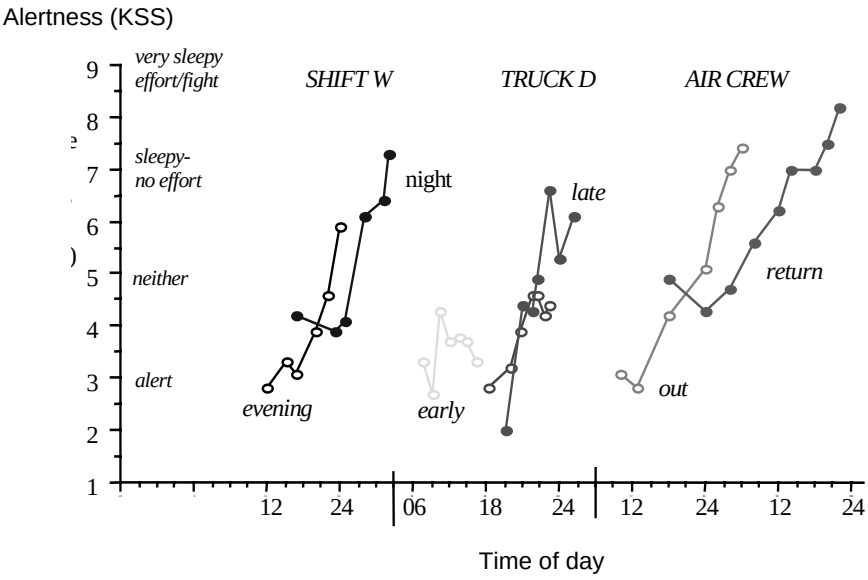
One such study investigated 18 truck drivers driving from Malmö in southern Sweden to Stockholm (500 km) (Kecklund and Åkerstedt, 1993). One group which started around 21.00 hrs and reached Stockholm around 07.00 hrs showed a clear increase in EEG-based measures of sleepiness, mainly alpha (8-12 Hz) and theta (4-8 Hz) activity. In addition, subjective sleepiness increased in parallel with changes in the EEG. Interestingly, total work time and short breaks were rather closely related to such changes. Day drivers or evening drivers showed no clear tendency towards sleepiness. Recently, a large study of 80 US and Canadian drivers across several days found considerable drowsiness according to videotapes of facial expressions and electro-encephalograms (EEG), particularly during night driving (Wylie *et al.*, 1996; Mitler, 1997). The authors concluded that the time of day (night) was more important than the duration of the drive as a cause of fatigue.

Figure 2 illustrates the development of subjective fatigue in long-haul night driving (as discussed above) and compares it with fatigue in other occupational groups using the Karolinska Sleepiness Scale (KSS) (Åkerstedt and Gillberg, 1990). Nuclear power station technicians doing maintenance work inside nuclear reactors show a steep increase in sleepiness during the night shift, from 3 (“alert”) to 7 (“sleepy but not fighting sleep”). Long-haul truck drivers show a similar increase and air crew on westward (Stockholm-Los Angeles) transmeridian flights even exceed 7 and finish close to 9 (“very sleepy, fighting sleep, an effort to stay awake”) towards the end of the return flight.

Caille and Bassano (1977) demonstrated strongly increased alpha and theta activity (spectral analysis) towards the end of a task involving driving a car at night. Very similar results from simulated night driving have been presented by Fruhstorfer *et al.* (1977). The latter also demonstrated a parallel increase in the duration of eye blinks and a decrease of EOG velocity.

For practical and ethical reasons, the relation between sleepiness and actual driving performance is difficult to study experimentally. A driving simulator is the natural alternative. One such study compared daytime and night-time performance of professional drivers on a simulated truck driving task (Gillberg *et al.*, 1996). Nine professional drivers participated. The effects on driving were small but significant: night driving was slower and speed and lane position varied more. Subjective and EEG/EOG sleepiness were clearly higher during night conditions.

Figure 2. Comparison of subjective alertness in three occupational groups



Interestingly, the development of physiological and behavioural sleepiness in the driver (at least in a simulator) usually appears to be perceived psychologically (Reyner and Horne, 1998*b*). That is, sleep-related accidents are always preceded by increased sleepiness for some time (about an hour). However, beyond the increase in sleepiness, there appears to be no "final warning" before the driver falls asleep and causes an accident.

In a different type of field study, Philip *et al.* (in press) studied car drivers living in northern France who were driving essentially straight through to Spain or Portugal. The drivers were approached at a rest station in Bordeaux and asked to carry out performance tests and fill out questionnaires. The results show a clear relationship between duration of the drive and (poor) performance on a neurobehavioral test (serial reaction time).

Other groups

A study of train drivers revealed that a quarter of the drivers showed pronounced increases in alpha (8-12 Hz) and theta (4-8 Hz) activity, as well as in slow eye movements (SEM) towards the early morning. Such changes did not occur during day driving (Torsvall and Åkerstedt, 1987). The correlation with sleepiness was quite high (r = .74). In some instances, obvious performance lapses, such as driving through a red light, occurred during bursts of slow eye movements (SEM) and alpha/theta activity.

It has been demonstrated that long-haul pilots exhibit EEG sleep events while on duty (Rosekind *et al.*, 1994*a*, 1994*b*, 1995*a*, 1995*b*). Several studies by German, British, and Dutch groups have shown similar results (Gundel *et al.*, 1995; Samel *et al.*, 1997*a*; Samel *et al.*, 1997*b*).

Process operators in the paper industry exhibited not only sleepiness-related increases in alpha and theta activity, but also actual sleep (Torsvall *et al.*, 1989). Incidents of sleep occurred in approximately a quarter of the subjects. They usually occurred during the second half of the night shift but never in connection with any other shift. There was no official awareness that sleep would or could occur

during work hours. The subjects themselves were unaware of having slept, but were aware of sleepiness.

Not only is the night shift affected by sleepiness. The return to day work is associated with a considerable increase in sleepiness. Furthermore, early morning shifts (starting between 04.00 and 07.00 hrs) may be perceived as very fatigue-inducing (Kecklund *et al.*, 1994*b*). In particular, difficulty in waking and the associated inertia may be the most important disadvantage of shift work from the point of view of the shift worker (Åkerstedt *et al.*, 1991). The earlier the shift starts, the more sleepiness will be experienced during the day (Kecklund *et al.*, 1994*b*). The effect of early starts may also be seen in pilots on long-haul flights (Gander and Graeber, 1987)

Some methodological points

It should be emphasised that the occurrence of sleep incidents during night work discussed above are serious and comparable to those seen, for example, in narcoleptic patients (Broughton *et al.*, 1988), although the duration of the bouts is shorter and temporally rather restricted. It should also be emphasised that the EEG changes described above for shift workers are clearly related to performance lapses and errors (Daniel, 1966; O'Hanlon and Beatty, 1977; O'Hanlon and Kelley, 1977; Torsvall and Åkerstedt, 1988). Thus, high levels of alpha and or theta power density are largely incommensurate with perceptual or cognitive performance – the very sleepy individual is not functioning properly, has major difficulties keeping his eyes open and is aware of "fighting sleep" (level 8-9 on the KSS scale) (Åkerstedt and Gillberg, 1990). Incidentally, the amount of alpha power density is usually directly related to the duration of eye closure – long blinks – and much of the EEG delta power activity seems to be due to eye-blink artefacts (Torsvall and Åkerstedt, 1985).

Furthermore, a number of laboratory studies show that when work/activity extends through the night, the hours between 4.00 and 7.00 show a strong increase in alpha and theta activity in ambulatory or sedentary subjects (Åkerstedt and Gillberg, 1990), and a major decrease (down to 2-4 minutes) in sleep latency (Carskadon and Dement, 1977; Webb, 1978; Walsh *et al.*, 1986). The latter corresponds to the post-night shift sleep latencies in the field studies cited above. If these levels were observed during a day shift, they would be interpreted as pathological sleepiness. They also fall below the levels seen in connection with moderate intake of alcohol (Roehrs *et al.*, 1989, 1993) or hypnotics (Roehrs *et al.*, 1989, 1993).

It should be emphasized that fatigue/sleepiness is not only a problem because it leads to falling asleep at the wheel. It is also well established that fatigue impairs the ability to maintain lateral road position and constant speed (Mackie and Miller, 1978; Ranney and Gawron, 1987; Brookhuis and de Waard, 1993).

The mechanism behind timing and fatigue

Obviously, night and early morning work can cause excessive fatigue and high levels of risk of accident. In order to understand and prevent these effects, it is necessary to have a clear view of the mechanism involved. The main factors are discussed below (disease and drugs are beyond the scope of this paper).

The factors behind fatigue/sleepiness

Displaced work hours conflict with the circadian and homeostatic regulatory systems, the basic biological principles that regulate the timing of rest and activity. The effects are shortened sleep, an unfavourable time for work, extended wakefulness, the duration of the drive, and the level of stimulation.

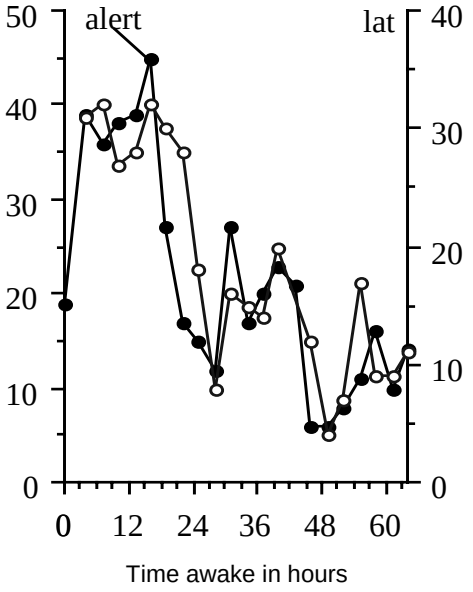
The most important factor may be the ***circadian rhythm***. A number of studies involving normal night-time sleep (Folkard and Monk, 1985), sleep deprivation (Fröberg *et al.*, 1975), spontaneous desynchronisation (Wever, 1979; Czeisler *et al.*, 1980), and forced desynchronisation (Folkard *et al.*, 1985; Dijk *et al.*, 1992) have shown that alertness and performance show a daily pattern, with a maximum in the late afternoon and a trough in the early morning around 05.00 hrs. The early morning circadian nadir (low point) of alertness is the main contributor to sleepiness during late night and early morning work. At the circadian nadir, work will be carried out at low levels of physiological activation, subjective alertness, or behavioural efficiency (Figure 3). The latter two variables are affected in concert owing to a homeostatic drop in alertness (time awake) (see below). The circadian regulatory system also causes disturbed daytime sleep (also see below) and thus contributes indirectly to reduced alertness. As a matter of fact, night work would not present any problems (except for reduced visibility due to darkness) if our biological clock could be eliminated.

Another obvious cause of sleepiness is the number of ***hours spent awake***. This factor, which is also increased by delaying work hours, is less established for shift work, but early experimental data from sleep deprivation studies clearly show a pronounced fall in alertness and performance over time, levelling out towards days 3-4 (controlling for circadian influence) (Williams *et al.*, 1959; Fröberg *et al.*, 1975). Figure 3 illustrates the steep fall in alertness and performance during 64 hours of sleep deprivation, together with the superimposition of the circadian component (Gillberg and Åkerstedt, 1981; Åkerstedt *et al.*, 1982). Recent studies have found the same phenomenon of gradual fall in alertness/performance in connection with forced desynchronization (Folkard and Åkerstedt, 1991; Dijk *et al.*, 1992).

The effects of prior time awake should be viewed against the fact that the night shift starts 10-16 hours after rising, in contrast to the 1-2 hours of wakefulness before the morning shift, or the 4-6 hours before the afternoon shift. Thus, night work is usually preceded by an extended period of time awake, compared to the morning and evening work periods. Similarly, the early start of morning work will involve a longer period of wakefulness than a later start, and this will increase afternoon sleepiness (Kecklund *et al.*, 1994*b*).

A third cause of fatigue is ***shortened sleep***. It is an obvious suspect in shift work sleepiness because of the reduction in length of sleep in connection with night and morning shifts. Thus, day sleep after night work and early night sleep before morning work is 2-4 hours shorter than night sleep (Ehrenstein *et al.*, 1970; Foret and Lantin, 1972; Foret and Benoit, 1974; Foret and Benoit, 1978; Matsumoto, 1978; Tilley *et al.*, 1981; Torsvall *et al.*, 1981; Torsvall *et al.*, 1989; Åkerstedt *et al.*, 1991). Essentially, the effect of curtailed sleep rises exponentially; that is, a one-hour loss has little effect, whereas a two-hour loss has a considerably larger effect on sleepiness and performance capacity (Gillberg, 1995). Fragmentation is another important issue, perhaps in particular with respect to sleep in a moving vehicle. This may impair much of the recuperative value of sleep (Gillberg, 1995).

Figure 3. Results from 64 hours of sleep loss
Subjective alertness and time elapsed – latency (lat) to the first performance miss on a vigilance test
N = 12

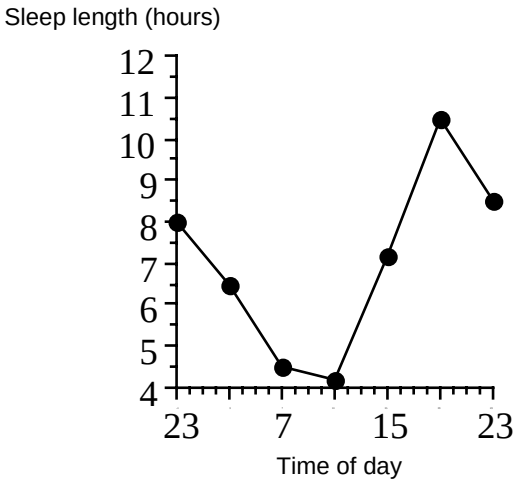


The reason for shortened sleep

The reason for truncated sleep is a strong time of day effect (Åkerstedt and Gillberg, 1981). As bedtime is displaced from conventional hours, sleep length falls to about 4.5 hours for morning to noon bedtimes, and then recovers towards the following evening (Figure 4). The effect is obviously circadian and closely related to the body temperature cycle (Czeisler *et al.*, 1980). Thus, it is very difficult to sleep at the acrophase (maximum) of the body temperature rhythm and very easy at the nadir (minimum). Dijk *et al.* (1994) have recently suggested that the circadian rhythm of sleep propensity serves to consolidate sleep and wakefulness. One should keep in mind, however, that length of sleep is also determined by prior wakefulness. Thus, a period of sleep of five hours at noon after a night shift would shrink to 3.5 hours if a two-hour nap were permitted during the night, or to two hours if a full night's sleep (7-8 hours) were permitted (Åkerstedt and Gillberg, 1986).

The reasons for shortened sleep before the morning shift is partly the need to terminate sleep very early in the morning without being able to advance bedtime to fully compensate (Folkard and Barton, 1993). The latter failure may be partly social, but there is also a strong circadian influence on sleep latency, making early initiation of sleep difficult (Åkerstedt *et al.*, 1992).

Figure 4. Total sleep time (TST) when sleep is displaced to different times of day, with 16 to 40 hours of prior time awake
N=8



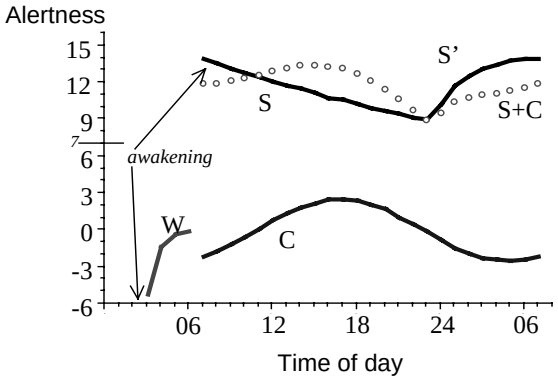
A model for predicting fatigue/sleepiness

Observations such as these have led to the development of a quantitative model of alertness regulation to be used to predict fatigue in connection with irregular work hours. The inspiration for the development of the model was the "two-process model of sleep regulation" which had shown that sleep length and slow wave activity could be described by a combination of homeostatic and circadian influence (Borbély, 1982). This model was based on the amount of EEG slow wave activity during sleep, but it seemed likely that a similar approach could be used to model and predict variations in alertness.

Using subjective alertness data from a number of experiments of altered sleep/wake patterns, it was found that alertness was predictable from three parameters: C, S and W. C represents sleepiness due to circadian influences and has a sinusoidal form with an afternoon peak (Figure 5). S is an exponential function of the time since awakening; it is high on awakening, falls rapidly initially and gradually approaches a lower asymptote. At sleep onset, S is reversed (S') and recovery occurs in an exponential fashion which initially increases rapidly but subsequently levels off towards an upper asymptote. Total recovery is usually accomplished in eight hours. The final component (not indicated in Figure 5) is W, awakening or sleep inertia. The input to the model is the time of rising and going to bed for the period investigated.

Predicted alertness is expressed as the arithmetic sum of the functions S + C (W is excluded). The scale of the model ranges normally from 1-21 (and was originally a visual analogue scale); in practice, "3" corresponds to extreme sleepiness and "14" to a high level of alertness and "7" to a sleepiness threshold (EOG slow eye movements) (Folkard and Åkerstedt, 1991; Åkerstedt and Folkard, 1995). In the figure, S+C shows predicted alertness when wakefulness is extended by 8 hours (to 24 hours), as is frequently the case, for example, with a first night shift. This particular prediction assumes that awakening occurs at 07.00 hrs after eight hours of sleep, with no sleep thereafter (due to the night shift) until 07.00 hrs the following day. The combined effect of S+C (a long time awake and the circadian downswing) yields a fall in alertness during the night, with a trough in the early morning. After sleep begins, the steep recovery in S together with the circadian upswing causes a rapid increase in (latent) alertness during sleep.

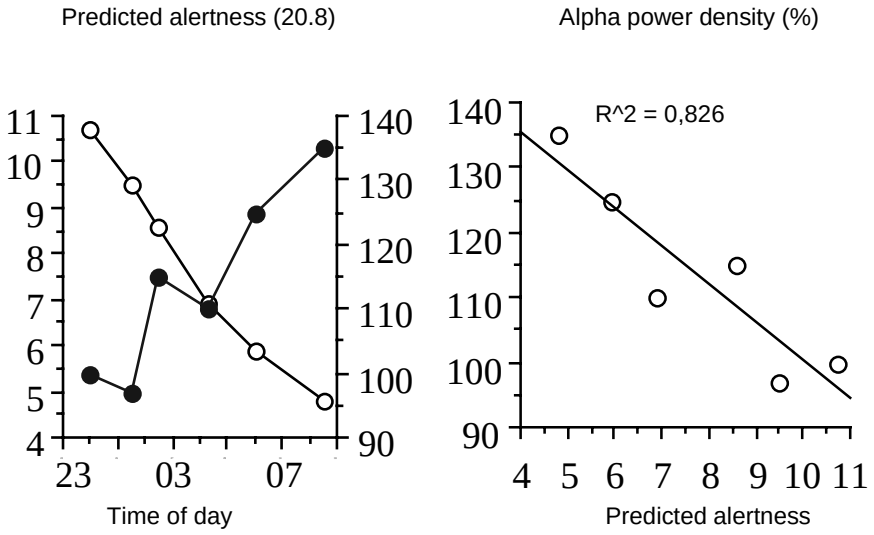
Figure 5. The main components of the three-process model of alertness regulation



The validity of the model was tested against laboratory and field studies of irregular work hours, using subjective alertness as well as EEG alpha and theta power density during waking (open eyes). On the whole, validation analyses showed that predicted medium to high alertness (8-14) seems to lack increased alpha activity, whereas the increase is sharp below 7 – more than double in two of the studies (Åkerstedt and Folkard, 1995). Very similar results were observed for the EOG in the original validation studies (Folkard and Åkerstedt, 1991). Thus, it seems that predicted values around 5-3 may be characterised by pronounced intrusions of sleep-related EEG and EOG changes even in the active individual. In other words, there is a clear risk of behavioural malfunction.

Validation against performance was investigated, for example, by trying to predict performance on a 30-minute vigilance task (12 subjects, 32 signals) from a study of 64 hours of sleep deprivation (Gillberg and Åkerstedt, 1981). To continue the validation work, an attempt was made to predict alpha power density in two field studies with ambulatory EEG recordings. The first concerns 15 truck drivers during a night drive (Kecklund and Åkerstedt, 1993). On the whole, alpha power density rises as predicted alertness falls (Figure 6). The right part of the figure illustrates the close relation between the alpha power density and predicted alertness. Baseline levels (100 per cent) coincide with predicted levels of 10 and above and characterise daytime driving (not covered in the figure). This means in effect that the relation between predicted alertness and alpha (and theta) intrusions is curvilinear, since daytime values (not indicated on the figure) oscillate closely around 100 per cent – the point of inflection appears around the level of 7-8. This is very close to the earlier observation that SEM (as well as alpha and theta intrusions) are completely absent for high to medium levels of alertness (14-9) but start to appear around 7 together with perceptions of “fighting sleep” (Folkard and Åkerstedt, 1991).

Figure 6. Left: Predicted alertness and EEG alpha power density during driving against time of day Right: Regression of EEG alpha power density vs. predicted alertness.



Scheduling factors

Apart from the basic aspects of duration and displacement of work hours, certain important properties of work schedules need to be considered. Many have not been investigated in relation to truck driving, but most of the results are applicable.

The duration of the work period

The length of a work shift is a parameter that can be expected to influence sleepiness. Several studies of accidents involving truck drivers (Harris and Mackie, 1972; Harris, 1977; Hamelin, 1987) have demonstrated a U-shaped relation between hours driven and accidents; after an initial "warm-up" period, accident risk is low, and there is an increase towards 11 hours of driving. In a study of car drivers, Philip *et al.* (in press) found that the duration of the drive is the most important predictor of reduced reaction time when braking. Many of the studies cited earlier fail to find that duration of driving (within legal limits) has a great effect.

In the laboratory, performance usually falls over time if learning effects are eliminated (Davies and Parasuraman, 1982). Still, in one study of policemen, Peacock *et al.* (1983) found no effect on overall alertness due to a change from eight-hour (nine shifts across eight days) to 12-hour shifts (two nights, one free, two days, three free). However, the distribution of free days changed at the same time. A study of nurses (Colligan and Tepas, 1986) and another of industrial shift workers (Mills *et al*., 1983) produced similar results.

Rosa and Colligan (1989) used two-hourly ratings in a field experiment and demonstrated that the 12-hour night shift produced higher ratings of fatigue than the eight-hour night shifts. Nonetheless, employees preferred the 12-hour shift because it meant an extra day off. Positive effects of shorter night shifts have been demonstrated by Williamson *et al.* (1994).

Taken together, the results support to some extent the common-sense notion that fatigue/sleepiness are a function of the length of time worked. This may be exacerbated if days freed by long hours are frequently used for holding a second job.

Breaks

The break may be seen as a form of recuperation similar to sleep, and data in fact show increased alertness after breaks. However, the effects can seldom be separated from food intake or other activities during the break (Ellingstad and Heimstra, 1970; Hoffman *et al.*, 1971; O'Hanlon, 1971; Hoffman *et al.*, 1972; Lisper *et al.*, 1986). Truck drivers' EEG pattern becomes more alert after a break from driving (Landström *et al.*, 1988) and the same is true for simulated car driving (Lisper and Eriksson, 1980; Horne and Reyner, 1995*a*). In all studies, sleepiness recurs quickly, and it seems to take a very short time before pre-break levels of fatigue are reached.

With respect to accidents, Ouwerkerk *et al.* (1986) found that accident risk increased with decreased number of breaks. Philip *et al.* (in press) also found that the duration of breaks was positively related to performance on neurobehavioral tests in connection with long-haul car driving. These observations suggest that breaks to raise alertness during a spell of driving should be inserted at relatively short intervals and combined with food intake and physical activity (Englund *et al.*, 1985). However, breaks are unlikely to affect sleepiness induced by circadian or homeostatic factors and should be reserved for sleepiness due to time on the task, but the effect is temporary.

Sufficient time between shifts

Most shift schedules have 16 hours of free time between shifts. Some schedules have an extremely quick rotation and reduce the free time between shifts by several hours so that the free period between shifts is about eight hours. Some studies have examined the effects on sleep duration of such "quick changeovers". Knauth *et al.* (1983) showed that sleep was clearly reduced during quick changeovers and other studies give similar findings (Totterdell and Folkard, 1990; Kurumatani *et al.*, 1994). Kurumatani *et al.* found a very high correlation (0.95) between the length of free time between shifts and sleep duration. They concluded that one needs at least 16 hours of free time for a period of sleep of seven or eight hours. When a morning shift or a day shift was followed by a night shift (with less than six hours of free time in between), sleep lasted less than three hours. Presumably, hours of sleep were curtailed by a combination of competing activities and circadian effects.

The number of consecutive night work periods

One important characteristic of the shift system is the number of night shifts in a row. In one study of paper industry workers, Fröberg *et al.* (1972) found that rated activation improved somewhat over seven successive night shifts, although normal day levels were never reached. Similarly, for newspaper printers, short-term adjustment over seven night shifts involved a slight shift of the circadian peak towards the late part of the night shift (Åkerstedt *et al.*, 1977). On the other hand, the trough remained at its ordinary position at the end of the night shift. Similarly, Kecklund *et al.* (1994*b*) found that sleepiness was most pronounced on the first night shift. Presumably, this was due to increased prior time awake. Most shift workers are awake for at least 13 hours before the start of the first night shift, whereas time awake decreases by at least four or five hours before the start of the remaining night shifts. It should be pointed out that although some adjustment appears after several

nights, sleepiness is still higher than for day shifts, including a higher incidence of dozing off at work than during the morning and the afternoon shift.

Dahlgren (1981) found no adjustment of activation among rapidly rotating (two to three days on the night shift) three-shift workers, but a *reduction* of the mean level. Chaumont *et al.* (1979) found some (cosinor) phase adjustment of "vigour" in rotating three-shift workers, but also a reduced mean level. Williamson and Sanderson (1986) found that alertness and general well-being in three-shift workers improved when a two- to three-day rotation was substituted for the old seven-day rotation. Minors and Waterhouse (1985), on the other hand, found no differences in alertness between night working nurses (12-hour shifts) with few (one to three) or many (four or more shifts) in succession. Nevertheless, the latter reported better sleep and general well-being. The general impression is that night-shift sleepiness gradually delays its appearance over successive shifts. There is no indication, however, that more than a marginal adjustment takes place.

The number of successive work periods may also influence the time it takes to readjust to daytime life. Meijman (1981) demonstrated that four days seem necessary for recuperation after a seven-day night shift schedule. Morriseau and Persensky (1994) demonstrated that overtime work was directly related to reported frequency of incidents in the nuclear industry. Kecklund *et al.* (1994*a*) found that most shift workers reported that they needed at least two days (with two normal sleep episodes) to recover after a spell of night work (three shifts in a row). The same study also showed that the need for recovery increased by one day when the spell of night work increased to seven shifts in a row. There is also evidence from jet-lag studies that it takes up to four days for sleep and wakefulness to recover after an acute shift of the sleep/wake pattern due to large time zone transitions (Lowden and Åkerstedt, 1994; Suvanto *et al.*, 1993).

Clockwise rotation

Another important aspect of the shift schedule may be the direction of rotation. Since the free-running period of the human sleep/wake cycle averages 25 hours and since it can be entrained by environmental time cues only within 1-2 hours of the free-running period, phase delays are easier to accomplish than phase advances (Czeisler *et al.*, 1980). For the rotating shift worker this implies that schedules that delay, *i.e.* rotate clockwise (morning to afternoon to night) are preferable to those that rotate counter-clockwise (Barton and Folkard, 1993). There have, however, been very few practical tests of this theory, particularly in relation to sleepiness. Czeisler *et al.* (1982) demonstrated that a change from counter-clockwise to clockwise rotation, together with a change from a seven-day to 21-day rotation, improved production and well-being in three-shift workers. Orth-Gomér (1983) found that a change in the same direction in rapidly (one-day) rotating police officers reduced blood pressure and improved well-being. It appears, however, that similar effects may be obtained simply by having the night shift moved from the start to the end of the shift cycle (Fredén *et al.*, 1986).

Other fatigue-related factors

Sleep in a truck berth

A particular aspect of transport work is that long-haul truck drivers frequently take their major sleep period in their truck. There are indications that this may impair sleep, alertness and safety (Hertz, 1988; Williamson *et al.*, 1992; Williamson *et al.*, 1996). In particular, the articles by Williamson *et al.* demonstrated that "two-up" driving (two drivers taking turns driving) is associated with increased fatigue, presumably due to poor sleep quality in a moving vehicle. Other factors involved may be

increased exposure to environmental disturbances (like noise), but also poor bed quality, cramped quarters, or perceived vulnerability to sleeping "outdoors".

Two experiments were carried out to determine whether sleep is more disturbed in a truck berth than in a comfortable bed indoors, and whether berth sleep in a location severely disturbed by noise (of the truck) is more disturbed than berth sleep in a quiet location (Kecklund and Åkerstedt, 1996). Experiment A included eight subjects who slept in the laboratory and in a truck berth under quiet conditions. Experiment B involved six subjects who slept in a truck berth under both quiet and noisy/disturbed conditions (frequent occurrences of 80 decibels). Polysomnography showed that EEG recordings did not show that sleep was affected by sleeping in a truck, even when it was parked at a noisy location (truck terminal). However, the truck berth and cabin was of high quality, and it is conceivable that sleep in older types of trucks may be disturbed. Sleeping conditions may of course be exacerbated by other factors. The study did not address the question of sleep in a moving vehicle.

Naps

Apart from scheduling work hours to permit long sleep, most irregular work schedules will require the availability of opportunities to nap. Naps clearly attenuate the negative effects of sleep loss. A two-hour nap makes for alertness even after more than two nights without sleep (Lumley *et al.*, 1986; Dinges *et al.*, 1987, 1988) and a 30-minute nap had positive effects after one night without sleep (Naitoh *et al.*, 1993; Gillberg *et al.*, 1994). In relation to driving, a nap seems to have effects similar to those of large doses of caffeine (Horne and Reyner, 1996).

Work/activity

Increased traffic density, with greater variation in sensory input, maintains alertness better than monotonous driving on main roads (Bodén and Dureman, 1970; Lecret, 1970; O'Hanlon, 1971). Driving on ordinary main roads is also more advantageous in terms of alertness than driving on motorways (Fruhstorfer *et al.*, 1977). Highway driving involves focusing closely on an environment with comparatively little variation, compared to what is required for most other occupations. Thus, there is a low amount of sensory input, while the central nervous system is activated through *changes* in sensory input (Morruzzi and Magoun, 1949). Repetition of the same stimulus will cause habituation, that is, reduction and eventual cessation of the activation response (Sharpless and Jasper, 1956). However, small variations in the characteristics of a stimulus, for example the frequency of a tone, will arouse. Novel and sudden stimuli will always evoke arousal responses, so called "orienting reflexes" (Sokolov, 1963). In line with the neurophysiological observations, any situation that creates monotony (absence of stimuli, sequences of similar stimuli, etc.) will impair alertness and performance (Wilkinson, 1964; Wilkinson, 1969; Kjellberg, 1977).

There does not seem to be any clear relation between alertness, physical activity and performance (Englund *et al.*, 1985). However, physical work, with its increased sensory stimulation, should also cause increased alertness, at least during the work, but apparently not afterwards, as indicated by driving simulator performance (Horne and Foster, 1995). Very heavy physical work, however, has effects on alertness as it results in a more rapid onset of sleepiness (Horne, 1981).

There is also much indirect evidence that fatigued individuals use increased physical activity (including simply standing up and walking about) as a favourite countermeasure, for example in control rooms (Queinnec *et al.*, 1984; Åkerstedt *et al.*, 1987). While this may be of little use to the

truck driver while driving, it may be of some use during breaks. Also, increased incentive to work may increase alertness under conditions of sleep loss (Horne and Pettit, 1985).

Food intake

Research on the effect of food intake on alertness is limited and most knowledge is speculative. Using fasting and feeding and judicious use of alertness-inducing caffeine and theophylline, as well as carbohydrates and proteins, to affect catecholamines and indoleamines, a schedule was designed which seems to have some effect on adjustment (Ehret, 1981; Ehret and Scanlon, 1983).

Hulbert (1972) and Lisper *et al.* (1986) have shown that food breaks have positive effects on drivers' performance. Hulbert's study showed, among other things, that the risk of falling asleep was reduced if sugar intake was increased. Current theories indicate that fat and proteins improve alertness less than sugar. Heavy food intake can lead to an increased risk of sleepiness (Smith and Miles, 1986*a*; Smith and Miles, 1986*b*). There are therefore grounds for assuming that moderate intake of food containing carbohydrates can increase alertness significantly. Rapidly absorbed sugars are assumed to have more positive effects than carbohydrates that take longer to metabolise.

As expected, intake of caffeine and tea has positive effects on alertness and performance (Regina *et al.*, 1974), although only for one to two hours, as demonstrated in a driving simulator (Horne and Reyner, 1996).

Food intake does not, however, seem to be an effective general countermeasure to fatigue, since the effects are not impressive and may vary among individuals.

Sound

Laboratory (Landström, 1987) and field studies (lorry drivers) (Landström *et al.*, 1988) have shown that low-frequency noise and monotonous noise can cause tiredness, whereas high-frequency sound may have an alerting effect (Landström and Lundström, 1985; Nilsson *et al.*, 1988; Landström, 1990).

Considering the arousal effects of sudden stimuli (Morruzzi and Magoun, 1949; Sharpless and Jasper, 1956; Sokolov, 1963), noise should be a possible countermeasure to fatigue. It has performance-enhancing effects in vigilance tests (Hockey, 1970). Also less unpleasant sound, *e.g.* from a radio, may have alerting effects (Fagerström and Lisper, 1977), although this has not been clearly established. Reyner and Horne (1998*a*) found that listening to the car radio may give the driver the impression of being more alert, whereas, in reality, driving performance and objective sleepiness remain unimproved.

Recently, it was found that alertness could be induced in sleep-deprived subjects through a combination of four different tones (frequencies 3050, 3700, 5800 and 10750 Hz at 45 dB) (Landström *et al.*, 1996, 1998, submitted-a). The different tones were generated for a duration of 52 ms each, covering 3-7 second bursts. The duration of the bursts (3-7 seconds) was randomised and separated by randomised 60-300 second intervals of quiet. The method was tested by 12 professional drivers at 70 dBA for a field situation with background noise using a small cassette radio. The results showed strongly improved subjective alertness and positive feasibility ratings (including interest in having the system installed in the vehicle).

The findings indicate that sound (noise) may be used to raise alertness levels at work. However, the method may be restricted to specific and temporary tasks, as the experience is somewhat unpleasant.

Temperature

The degree of alertness is usually reduced upon exposure to high temperatures (Prokop and Prokop, 1955; Mackie *et al*., 1974; O'Hanlon and Kelly, 1974). The optimal comfort level for sedentary work is often given as around 25°C. High room temperatures of 30-35°C may mean a shift towards a deterioration in alertness and performance, but the results are not entirely conclusive.

As with other stimuli, however, it should be possible to increase brain arousal through changes in temperature levels. While very little data are available, one car simulator study using the ventilation system at full capacity did not improve alertness (Reyner and Horne, 1998*a*). In a more sophisticated study, increased levels of EEG alpha activity were used to trigger a 10 °C drop in temperature (in one minute) (Landström *et al.*, submitted-b, submitted-c). The EEG indices of sleepiness were immediately blocked. After some minutes, drowsiness gradually returned, resulting in a new triggered temperature reduction. As a result, sleepiness was kept at a considerably lower level.

The method was tested in trucks in which a 10 °C reduction of the comfort temperature (27-30 °C) was achieved in one minute by using a computer to regulate the vehicle's cooling and air-conditioning system. The driver could activate the computer when drowsiness appeared. The length of the cooling periods varied between four and eight minutes, and the randomised intervals varied between five and eight minutes. Subjective alertness was significantly increased. The overall impression is that the temperature approach has some merit but seems less sensitive than noise and is more unpleasant. Thus acceptability may be a problem.

Lighting

In addition to changes in the circadian phase, changes in light stimulation will also activate the reticular system. Pin *et al.* (1969) showed higher alpha activity, reduced heart rate, greater variability in pulse and heightened blink frequency when driving in the dark compared to driving in daylight. Taking diurnal periodicity into account, these patterns indicate greater sleepiness during driving in the dark.. Similar effects have been demonstrated by Badia *et al.* (1991). Bright light thus seems to be a logical countermeasure to fatigue, but there is a lack of systematic field studies of its effects on alertness.

Ventilation

Investigations by Prokop and Prokop (1955) have shown that poor ventilation causes drowsiness in connection with driving and other work. The negative effects of inadequate ventilation systems are often combined and include raised concentrations of carbon monoxide and carbon dioxide, deterioration in temperature regulation, insufficient air change or high levels of monotonous ventilation noise (Edmondson and Oldman, 1974; Miller, 1976; Harris, 1977; Fuller, 1978). A study by Bockel (1969) showed a 25 per cent deterioration in performance for vehicle drivers exposed to 60 ppm CO over 90-minute periods. Statistically detectable performance effects due to air conditions have been demonstrated (McFarland, 1973; Miller, 1972). Miller has also described how optimised ventilation systems can help improve the alertness and performance.

Conclusions

The available data clearly indicate that long-haul truck driving is subjective to impairment and increased accident risk due to night driving, loss of prior sleep and lengthy work hours, and particularly to combinations of these factors. In addition, monotony, but also factors like infrasound, high cabin temperature, and eating patterns may impair safety.

Estimates of the role of fatigue in truck accidents vary between 3 and 40 per cent, depending on the definition of “fatigue-related” and the source of the study. Fatigue, then, would be a major cause of heavy vehicle accidents.

Whereas monotony may often be a contributing factor, factors related to the timing of work are most important. The major one probably is night driving and is clearly partly biological, in that drivers are affected by the 24-hour (circadian) low point. The associated loss of performance capacity and alertness is exacerbated by extensions of time spent awake and by sleep loss. In fact, the effects on alertness and safety are now predictable using straightforward mathematical algorithms.

The duration of the drive is probably somewhat less important as long as it is within the legal limit. Breaks and the activities undertaken during breaks (napping, eating, caffeine intake, exercise, etc.) clearly play an important role. There may also be synergy effects between the duration of the drive and factors like sleep loss or circadian low. The effects of lengthy drives may be exacerbated if breaks or normal nightly sleeping are lessened. There is however, an urgent need for research on the interaction of driving hours and circadian/sleep loss factors. A closely associated question is the effect of non-driving work immediately preceding a drive of maximum duration.

However, on the basis of present knowledge, conclusions can be drawn about suitable preventive action in terms of working hour regulations, education/information, provision of adequate rest areas, etc. In closing, it should be emphasised that the present paper does not cover drug use and sleep disorders, both of which need to be considered when discussing fatigue on the roads.

REFERENCES

Åkerstedt, T. and S. Folkard (1995), "Validation of the S and C components of the three-process model of alertness regulation", *Sleep*, 18(1), pp. 1-6.

Åkerstedt, T. and M. Gillberg (1981), "The circadian variation of experimentally displaced sleep", *Sleep*, 4, pp. 159-169.

Åkerstedt, T. and M. Gillberg (1986), "A dose-response study of sleep loss and spontaneous sleep termination", *Psychophysiology*, 23, pp. 293-297.

Åkerstedt, T. and M. Gillberg (1990), "Subjective and objective sleepiness in the active individual", *Int J Neurosci*, 52, pp. 29-37.

Åkerstedt, T., M. Gillberg and L. Wetterberg (1982), "The circadian covariation of fatigue and urinary melatonin", *Biol Psychiatry*, 17, pp. 547-554.

Åkerstedt, T., K.I. Hume, D.S. Minors, J.M. Waterhouse and S. Folkard (1992), "Sleep on a shortening day/night schedule:, *Electroencephalogr Clinical Neurophysiol*, 82, pp. 102-111.

Åkerstedt, T., G. Kecklund and A. Knutsson (1991), "Spectral analysis of sleep electroencephalography in rotating three-shift work", *Scand J Work Environ Health*, 17, pp. 330-336.

Åkerstedt, T., P. Patkai and K. Dahlgren. (1977), "Field studies of shift work: II. Temporal patterns in psychophysiological activation in workers alternating between night and day work", *Ergonomics*, 20, 621-631.

Åkerstedt, T., L. Torsvall, K. Gillander and A. Knutsson (1987), "Inactivity, night work and fatigue", in B. Knave and P.G. Widebäck (eds.), *Work with display units*, Elsevier Science Publishers, New York.

Badia, P., B. Myers, M. Boecker and J. Culpepper (1991), "Bright light effects on body temperature, alertness, EEG and behavior", *Physiology and Behavior*, 50, pp. 583-588.

Bartlett, F.C. (1953), "Psychological criteria of fatigue", in W.F. Floyd and A.T. Welford (eds.), *Symposium on fatigue*, Lewis, London.

Barton, J. and S. Folkard (1993), "Advancing versus delaying shift systems", *Ergonomics*, 36(1-3), pp 59-64.

Bjerner, B., Å. Holm and Å. Swensson (1955), "Diurnal variation of mental perfomance. A study of three-shift workers", *Br J Ind Med*, 12, pp. 103-110.

Bockel, J. (1969), "Elusive polluter", *Science News*, *96*, pp. 480-481.

Bodén, C. and I. Dureman (1970), "Performance in simulated car driving after sleep deprivation with and without a mild tranquilizer", *Psykologiska Institutionen*, Uppsala Univ. Rappor 89.

Borbély, A. (1982), "Sleep regulation: Circadian rhythm and homeostasis", in D. Ganten and D. Pfaff (eds.), *Sleep: Clinical and Experimental Aspects*, Springer Verlag, Berlin.

Brookhuis, K. and D. de Waard (1993), "The use of psychophysiology to assess driver status", *Ergonomics*, 36, pp. 1099-1110.

Broughton, R., W. Dunham, J. Newman, K. Lutley, P. Duschesue and M. Rivers (1988), "Ambulatory 24 hour sleep-wake monitoring in narcolepsy-cataplexy compared to matched controls", *Electroencephalogr Clin Neurophysiol*, 70, pp. 473-481.

Brown, L. (1994), "Driver fatigue", *Hum Factors*, 36(2), pp. 298-314.

Caesar, H. (1987), "Safety statistics and their operational consequences", *Proceedings of the 9th Orient Airlines Association Flight Safety Seminar*, Manilla, Philippines.

Caille, E.J. and J.L. Bassano (1977), "Validation of a behavior analysis methodology: variation of vigilance in night driving as a function of the rate of carboxyhemoglobin", in R.R. Mackie (ed.), *Vigilance*, Plenum Press, New York.

Carskadon, M.A. and W.C. Dement (1977), "Sleepiness and sleep state on a 90-min schedule", *Psychophysiology*, 14(2), pp. 127-133.

Chaumont, A.J., A. Laporte, A. Nicolai and A. Reinberg (1979), "Adjustment of shift workers to a weekly rotation", *Chronobiologia*, 6 (suppl.), pp. 27-36.

Colligan, M.J. and D. Tepas (1986), "The stress of hours of work", *Am Ind Hyg Assoc J*, 47, pp. 686-695.

Czeisler, C.A., Moore-Ede, M.C. and Coleman, R.M. (1982), Rotating shift work schedules that disrupt sleep are improved by applying circadian principles, *Science, 217*, 460-463.

Czeisler, C.A., E.D. Weitzman, M.C. Moore-Ede, J.C. Zimmerman and R.S. Knauer (1980), "Human sleep: its duration and organization depend on its circadian phase", *Science*, 210, pp. 1264-1267.

Dahlgren, K. (1981), "Adjustment of circadian rhythms and EEG sleep functions to day and night sleep among permanent night workers and rotating shift workers", *Psychophysiology*, 18, pp. 381-391.

Daniel, R.S. (1966), "Electroencephalographic pattern quantification and the arousal continuum", *Psychophysiology*, *2*(2), pp. 146-160.

Davies, D.R. and R. Parasuraman (1982), *The psychology of vigilance*, Academic Press, London.

Dement, W.C. and M.A. Carskadon (1982), "Current perspectives on daytime sleepiness: the issues", *Sleep*, 5, pp. 56-66.

Dijk, D.J. and C.A. Czeisler (1994), "Paradoxical timing of the circadian rhythm of sleep propensity serves to consolidate sleep and wakefulness in humans", *Neuroscience Letters*, 166, pp. 63-68.

Dijk, D.J., J.F. Duffy and C.A. Czeisler (1992), "Circadian and sleep-wake dependent aspects of subjective alertness and cognitive performance", *J Sleep Res, 1,* pp. 112-117.

Dinges, D.F. (1995), "An overview of sleepiness and accidents", *Journal of Sleep Research*, 4, pp. 4-14.

Dinges, D.F., M.T. Orne, W.G. Whitehouse and E.C. Orne (1987), "Temporal placement of a nap for alertness: contributions of circadian phase and prior wakefulness", *Sleep*, 10(4), pp. 313-329.

Dinges, D.F., W.G. Whitehouse, E.C. Orne and M.T. Orne (1988), "The benefits of a nap during prolonged work and wakefulness", *Work and Stress*, 2(2), pp. 139-153.

Edmondson, J. and M. Oldman (1974), "An interview study of heavy goods vehicle drivers", Inst of Sound and Vibration Res, Univ of Southampton, Contract Report 74/14.

Ehrenstein, W., W. Müller-Limmroth, K. Schaffler and C. Thébaud (1970), "Polygraphische Schlafuntersuchungen des Tagschlafs nach einer Nachtschicht und des Nachtschlafs nach einer Tagschicht an acht Krankenschwestern", *Pflügers Arch*, 319, pp. 121.

Ehret, C.F. (1981), "New approaches to chronohygiene for the shift worker in the nuclear power industry", in A. Reinberg, N. Vieux and P. Andlauer (eds.), *Night and Shift Work: Biological and Social Aspects,* Pergamon Press, Oxford.

Ehret, C.F. and L.W. Scanlon (1983), *Overcoming Jet Lag*, Berkely Books, New York.

Ellingstad, V. and N. Heimstra (1970), "Performance changes during the sustained operation of a complex psychomotor task", *Ergonomics*, 13, pp. 693-705.

Englund, C.E., D.H. Ryman, P. Naitoh and J.A. Hodgdon (1985), "Cognitive performance during successive sustained physical work episodes", *Behav. Res. Meth. Instr. and Comp.*, 17(1), pp. 75-85.

Fagerström, K.O. and H.O. Lisper (1977), "Effects of listening to car-radio, experience and personality of the driver on subsidiary reaction time and heart-rate in a long-term driving task", in R.R. Mackie (ed.), *Vigilance*, Plenum, New York.

Folkard, S. and T. Åkerstedt (1991), "A three process model of the regulation of alertness and sleepiness", in R. Ogilvie and R. Broughton (eds.), *Sleep, Arousal and Performance: Problems and Promises*, Birkhäuser, Boston.

Folkard, S. and J. Barton (1993), "Does the 'forbidden zone' for sleep onset influence morning shift sleep duration?", *Ergonomics*, 36(1-3), pp. 85-91.

Folkard, S., K.I. Hume, D.S. Minors, J.M. Waterhouse and F.L. Watson (1985), "Independence of the circadian rhythm in alertness from the sleep/wake cycle", *Nature*, 313, pp. 678-679.

Folkard, S. and T.H. Monk (1985), "Circadian performance rhythms", in S. Folkard and T.H. Monk (eds.), *Hours of work – temporal factors in work scheduling*, John Wiley, New York.

Foret, J. and O. Benoit (1974), "Structure du sommeil chez des travailleurs à horaires alternants", *Electroencephalogr Clin Neurophysiol*, 37, pp. 337-344.

Foret, J. and O. Benoit (1978), "Shiftwork: The level of adjustment to schdule reversal assessed by a sleep study", *Waking and Sleeping*, 2, pp. 107-112.

Foret, J. and G. Lantin (1972), "The sleep of train drivers: An example of the effects of irregular work schdules on sleep", in W.P. Colquhoun (ed.), *Aspects of Human Efficiency. Diurnal Rhythm and Loss of Sleep*, The English Universities Press Ltd., London.

Fredén, K., T. Åkerstedt, K. Olssen and K. Orth-Gomér (1986), "Positive effects of displacing night work to the end of the shift cycle", in M. Haider, M. Koller and R. Cervinka (eds.), *Night and Shift Work: Long Term Effects and their Prevention*, Peter Lang, Frankfurt am Main.

Fröberg, J.E., C.G. Karlsson and L. Levi (1972), "Shift work. A study of catecholamine excretion, self-ratings and attitudes", *Studia Laboris Salutis*, 11, pp. 10-20.

Fröberg, J.E., C.G. Karlsson, L. Levi and L. Lidberg (1975), "Psychological circadian rhythms during a 72-hour vigil", *Försvarsmedicin*, II, pp. 192-201.

Fruhstorfer, H., P. Langanke, K. Meinzer, J.H. Peter and U. Pfaff (1977), "Neurophysiological vigilance indicators and operational analysis of a train vigilance monitoring device: a laboratory and field study", in R.R. Mackie (ed.), *Vigilance*, Plenum Press, New York.

Fuller, R. (1978), "Effects of prolonged driving on heavy goods vehicle driving performance", Report to US Army Research Institute for the Behavioural and Social Sciences, Alexandria, Virginia.

Gander, P.H. and R.C. Graeber (1987), "Sleep in pilots flying short-haul commercial schedules", *Ergonomics*, 30, pp. 1365-1377.

Gillberg, M. (1995), "Sleepiness and its relation to the length, content and continuity of sleep", *Journal of Sleep Research*, 4 (suppl. 2), pp. 37-40.

Gillberg, M. and T. Åkerstedt (1981), "Possible measures of 'sleepiness' for the evaluation of disturbed and displaced sleep", in A. Reinberg, N. Vieux and P. Andlauer (eds.), *Night and shift work: biological and social aspects*, Pergamon Press, Oxford.

Gillberg, M., G. Kecklund and T. Åkerstedt (1996), "Sleepiness and performance of professional drivers in a truck simulator – comparisons between day and night driving", *Journal of Sleep Research*, 5, pp. 12-15.

Gillberg, M., G. Kecklund, J. Axelsson and T. Åkerstedt (1994), "Counteracting sleepiness with a short nap", *J Sleep Res*, 3, suppl.†1, p. 90.

Grandjean, E. (1979), "Fatigue in industry", *Br J Ind Med*, 36, pp. 175-186.

Gundel, A., J. Drescher, H. Maass, A. Samel and M. Vejvoda (1995), "Sleepiness of civil airline pilots during two consecutive night flights of extended duration", *Biological Psychology*, 40, pp. 131-141.

Hamelin, P. (1987), "Lorry driver's time habits in work and their involvement in traffic accidents", *Ergonomics*, 30, pp. 1323-1333.

Harris, W. (1977), "Fatigue, circadian rhythm and truck accidents", in R.R. Mackie (ed.), *Vigilance*, Plenum Press, New York.

Harris, W. and R.R. Mackie (1972), *A Study of the relationships among fatigue, hours of service and safety of operation of truck and bus drivers* (Tech. Rep. No. 1727 2), Human Factors Research, Inc., Goleta, California.

Haworth, N.L., C.L. Heffernan and E.J. Horne (1989), *Fatigue in truck crashes* (3), Monash University Crash Research Centre.

Hertz, R.P. (1988), "Tractor-trailer driver fatality: the role of nonconsecutive rest in a sleeper berth", *Accid Anal and Prev*, 20(6), pp. 431-439.

Hildebrandt, G., W. Rohmert and J. Rutenfranz (1974), "12 and 24 hour rhythms in error frequency of locomotive drivers and the influence of tiredness", *Int J Chronobiol*, 2, pp. 175-180.

Hockey, G.R.J. (1970), "Signal probability and spatial location as possible bases for increased selectivity in noise", *Quarterly Journal of Experimental Psychology*, 22, pp. 37-42.

Hoffman, H., H. Mayer, M. Grundei and W. Meir (1971), "Verke hrsmedizinische Untersuchung zur Frage des Kreislaufverheitens, der körperliche und seelischen Belastung von Kraftfahrzeugführern in verschiedenen Fahrzeugtypen und aug Fernfahrten", *Zentralblatt für Verker hrs-Medizin*, 17, pp. 193-224.

Hoffman, H., H. Mayer, M. Grundei and W. Meir (1972), "Experimentelle Nachprüfung der mit einem Fragebogen gewonnen Ergebnisse von O und L Prokop über Ermüdung bei Kraftfahrzeugführern", *Zentralblatt für Verker hrs-Medizin*, 18, pp. 65-116.

Holding, D.H. (1983), "Fatigue", in G.R.J. Hockey (ed.), *Stress and Fatigue in Human Performance*, Wiley, Chichester.

Horne, J.A. (1981), "The effects of exercise upon sleep: A critical review", *Biol Psychol*, 12, pp. 241-290.

Horne, J.A. and S.C. Foster (1995), "Can exercise overcome sleepiness?", *Sleep Research*, 24A.

Horne, J.A. and A.N. Pettit (1985), "High incentive effects on vigilance performance during 72h of total sleep deprivation", *Acta Psychol*, 58, pp. 123-139.

Horne, J.A. and L.A. Reyner (1995*a*), "Falling asleep at the wheel", Report for UK Department of Transport.

Horne, J.A. and L.A. Reyner (1995*b*), "Sleep related vehicle accidents", *British Medical Journal*, 310, pp. 565-567.

Horne, J.A. and L.A. Reyner (1996), "Counteracting driver sleepiness: effects of napping, caffeine and placebo", *Psychophysiology*, 33, pp. 306-309.

Hubert, S. (1972), "Effects of driver fatigue", in T. Forbes (ed.), *Human Factors in Highway Traffic Safety Research*, Wiley, New York.

Kecklund, G. and T. Åkerstedt (1993), "Sleepiness in long distance truck driving: an ambulatory EEG study of night driving", *Ergonomics*, 36(9), pp. 1007-1017.

Kecklund, G. and T. Åkerstedt (1996), "Sleep in a truck-berth: a study of EEG recorded sleep, subjective sleep quality and daytime sleepiness", *Journal of Sleep Research*, 5, suppl. 1, p. 106.

Kecklund, G., T. Åkerstedt and M. Gillberg (1994), "Sömnighet, arbetsmiljö och olyckor: slutrapport", *Stressforskningsrapporter*, p. 251.

Kecklund, G., T. Åkerstedt, A. Lowden and C. von Heidenberg (1994), "Sleep and early morning work", *J Sleep Res*, 3, Suppl. 1, p. 124.

Kjellberg, A. (1977), "Sleep deprivation and some aspects of performance, I. Problems of arousal changes", *Waking and Sleeping*, 1(2), pp. 139-143.

Knauth, P., E. Kiesswetter, W. Ottman, M.J. Karvonen and J. Rutenfranz (1983), "Time-budget studies of policemen in weekly or swiftly rotating shift systems", *Appl Ergonomics*, 14(4), pp. 247-252.

Knipling, R.R. and J.S. Wang (1995), "Revised estimates of the US drowsy driver crash problem size based on general estimates system case reviews", paper presented at the 39th Annual Proceedings, Association for the Advancement of Automotive Medicine, Chicago.

Kurumatani, N., S. Koda, S. Nakagiri, A. Hisashige, K. Sakai, Y. Saito, H. Aoyama, M. Dejima and T. Moriyama (1994), "The effects of frequently rotating shiftwork on sleep and the family life of hospital nurses", *Ergonomics*, 37(6), pp. 995-1007.

Landström, L. and R. Lundström (1985), "Changes in wakefulness during exposure to whole body vibration", *Electroencephalogr Clin Neurophysiol*, 61, pp. 411-415.

Landström, U. (1987), "Laboratory and field studies on infrasound and its effects on humans", *J Low Freq Noise Vib*, 6(1), pp. 29-33.

Landström, U. (1990), "Noise and fatigue in working environments", *Environment International*, 16, pp. 471-476.

Landström, U., M. Byström, B. Nordström, R. Wibom and T. Åkerstedt (1996), "Laborativa studier avseende ljusexponering och dess inverkan på sömnighet", *Arbetslivsrapport (Arbetslivsinstitutet)*, 28, pp. 4-21.

Landström, U., K. Englund, B. Nordström and A. Åström (1998), "Laboratory studies of a sound system that maintains wakefulness", *Perceptual and Motor Skills*, 86, pp. 147-161.

Landström, U., K. Englund, B. Nordström and A. Åström (submitted-a), "Field studies of a waking sound system".

Landström, U., K. Englund, B. Nordström and A. Åström (submitted-b), "Field studies of a waking temperature lowering system".

Landström, U., K. Englund, B. Nordström and A. Åström (submitted-c), "Laboratory studies of a waking temperature lowering system".

Landström, U., S. Lindblom Häggqvist and P., L. *et al*., (1988), "Low frequency noise in lorries and correlated effects on drivers", *J Low Freq Noise Vib*, 7(3), pp. 104-109.

Langlois, P.H., M.H. Smolensky, B.P. Hsi and F.W. Weir (1985), "Temporal patterns of reported single-vehicle car and truck accidents in Texas, USA during 1980-1983", *Chronobiol Int*, 2(2), pp. 131-146.

Lauber, J.K. and P.J. Kayten (1988), "Sleepiness, circadian dysrhythmia and fatigue in transportation system accidents", *Sleep*, 11, pp. 503-512.

Lavie, P., M. Wollman and I. Pollack (1987), "Frequency of sleep related traffic accidents and hour of the day", *Sleep Res*, 16, p. 275.

Lecret, F. (1970), "Summary of driver vigilance research conducted by ONSER's psychophysiological laboratory", information from ONSER, Division de psychologie de la conduite, Laboratoire de psychophysiologie, Monthery, France.

Leger, D. (1994), "The cost of sleep-related accidents: A report for the National Commission on Sleep Disorders Research", *Sleep*, 17(1), pp. 84-93.

Lisper, H.O. and B. Eriksson (1980), "Effects of the length of a rest break and food intake on subsidiary reaction-time performance in an 8-hour driving task", *Journal of Applied Psychology*, 65, pp. 117-122.

Lisper, H.O., H. Laurell and J. van Loon (1986), "Relation between time of falling asleep behind the wheel on a closed track and changes in subsidiary reaction time during prolonged driving on a motorway", *Ergonomics*, 29, pp. 445-453.

Lowden, A. and T. Åkerstedt (1994), "Jet lag in air crew – a 9 day field study", *Stress Research Reports*, 241, pp. 1-29.

Lumley, M., T. Roehrs, F. Zorick, J. Lamphere and T. Roth (1986), "The alerting effects of naps in sleep-deprived subjects", *Psychophysiology*, 23(4), pp. 403-408.

Lyman, E.G. and H.W. Orlady (1981), "Fatigue and associated performance decrements in air transport operations", NASAAmes Res Center, cr166167.

Mackie, R., J. O'Hanlon and M. McAuley (1974), "A study of heat, noise and vibration in relation to driver performance and physiological status", Human Factors Research Incorporated, Report 1735, Santa Barbara Research Park, Goleta, California.

Mackie, R.R. and J.C. Miller (1978), *Effects of hours of service, regularity of schedules and cargo loading on truck and bus driver fatigue* (DOT-HS-5-01142), Human Factors Research Inc.

Matsumoto, K. (1978), "Sleep patterns in hospital night nurses due to shift work: an EEG study", *Waking and Sleeping*, 2, pp. 169-173.

Maycock, G. (1996), "Sleepiness and driving: the experience of UK car drivers", *Journal of Sleep Research*, 5, pp. 229-237.

Maycock, G. (1997), “Sleepiness and driving: The experience of U.K. car drivers”, *Accident Analysis and Prevention*, 29, pp. 453-462.

McFarland, R. (1973), “Low level exposure to carbon monoxide and driving performance”, *Archives of Environmental Health*, 27, pp. 355-359.

Meijman, T.F. (1981), “Analyse subjective de la récupération aprËs les postes de nuit dans le cas de rotation lente (7 jours)”, *Trav Hum*, 44, pp. 315-323.

Miller, J. (1972), “Commercial vehicle occupational health hazards”, Society of Automotive Engineering Congress, Detroit.

Miller, J. (1976), “Efforts to reduce truck and bus operator hazard”, *Human Factors*, 18(6), pp. 533-550.

Mills, M.E., B. Arnold and C. Mooney Wood (1983), “Core-12: a controlled study of the impact of 12-hour scheduling”, *Nurs Res*, 32, pp. 356-361.

Minors, D.S. and J.M. Waterhouse (1985), “Circadian rhythms in deep body temperature, urinary excretion and alertness in nurses on night work”, *Ergonomics*, 28, pp. 1523-1530.

Mitler, M.M., M.A. Carskadon, C.A. Czeisler, W.C. Dement, D.F. Dinges and R.C. Graeber (1988), “Catastrophes, Sleep and Public Policy: Consensus Report”, *Sleep*, 11, pp. 100-109.

Morisseau, D.S. and J.J. Persensky (1994), “A human factor focus on work hours, sleepiness and accident risk”, in T. Åkerstedt and G. Kecklund (eds.), *Work Hours, Sleepiness and Accidents*, IPM and Karolinska Institute, Stockholm.

Morruzzi, G. and H.W. Magoun (1949), “Brain stem reticular formation and activation of the EEG”, *Electroencephalography and Clinical Neurophysiology*, 1, pp. 445-473.

Naitoh, P., T. Kelley and H. Babkoff (1993), “Sleep inertia: best time not to wake up?”, *Chronobiol Int*, 10(2), pp. 109-118.

Neville, K.J., R.U. Bisson, J. French, P.A. Boll and W.F. Storm (1994), “Subjective fatigue of C-141 aircrew during operation Desert Storm”, *Hum Factors*, 36(2), pp. 339-349.

Nilsson, L., B. Morén, J. Törnros and U. Landström (1988), “The influence of noise, infrasound and temperature on driver performance and wakefulness during standardized conditions”, Third International Conference on the Combined Effects of Environmental Factors, ICCEF 88, 15-18 August, Tampere, Finland.

NTSB (1990*a*), “Fatigue, alcohol, other drugs and medical factors in fatal-to-the-driver heavy truck crashes”, National Transportation and Safety Board. Safety Study, NTST/SS-90/01.

NTSB (1990*b*), “Grounding of the US tankship Exxon Valdez on Bligh Reef, Prince William Sound near Valdez, Alaska, March 24, 1989”, National Transportation Safety Board Maritime Accident Report, NTSB/MAR-90/04.

NTSB (1994*a*), "Aircraft accident report. Uncontrolled collision with terrain. American International Airways flight 808", National Transportation Safety Board, Washington DC, NTSB/AAR-94/04.

NTSB (1994*b*), "A review of flightcrew-involved major accidents of US Air carriers, 1978 through 1990", National Transportation Safety Board, Washington DC, SS-94/01.

NTSB (1995), "Factors that affect fatigue in heavy truck accidents", National Transportation Safety Board. Safety Study, NTSB/SS-95/01.

O'Hanlon, J. (1971), "Heart rate variability – a new index of driver alertness/fatigue", Human Factors Research Inc., Report 1712-I, Goleta, California.

O'Hanlon, J. and G. Kelly (1974), "A psycho-physiological evaluation of devices for preventing lane drift and run-off-road accidents", Human Factors Research Inc., Technical Report 1736-F, Santa Barbara Research Park, Goleta, California.

O'Hanlon, J.F. and J. Beatty (1977), "Concurrence of electroencephalographic and performance changes during a simulated radar watch and some implications for the arousal theory of vigilance", in R.R. Mackie (ed.), *Vigilance*, Plenum Press, New York.

O'Hanlon, J.F. and G.R. Kelley (1977), "Comparison of performance and physiological changes between drivers who perform well and poorly during prolonged vehicular operation", in R.R. Mackie (ed.), *Vigilance*, Plenum Press, New York.

Ong, C.N., W.O. Phoon, N. Iskandar and K.S. Chia (1987), "Shiftwork and work injuries in an iron and steel mill", *Appl. Ergonomics*, 18, pp. 51-56.

Orth-Gomér, K. (1983), "Intervention on coronary risk factors by adapting a shift work schedule to biological rhythmicity", *Psychosom. Med.*, 45, pp. 407-415.

Ouwerkerk, F.v., W.v.d. Hoeven, J. O'Hanlon and M. Onnen (1986), "Arbeidsomstandigheden van internationale vrachtwagenchauffeurs", VK 86-04, Haren: Verkeerskundig Studiecentrum.

Peacock, B., R. Glube, M. Miller and P. Clune (1983), "Police officers' responses to 8 and 12 hour shift schedules", *Ergonomics*, 325, pp. 479-493.

Philip, P., J. Taillard, M. Quera Salva, B. Bioulac and T. Åkerstedt (in press), "Simple reaction time, duration of driving and sleep deprivation in young versus old automobile drivers", *Journal of Sleep Research*.

Pin, M., F. Lecret and M. Pottier (1969), "Les niveaux d'activation lors de différentes situations de conduite", *Cahiers d'Etudes de l'ONSER*, 19.

Pokorny, M.L.I., D.H.J. Blom and P. van Leeuwen (1981), "Analysis of traffic accident data (from busdrivers): an alternative approach, I and II", in A. Reinberg, N. Vieux and P. Andlauer, eds., *Night And Shiftwork: Biological and Social Aspects*, pp. 271-286, Pergamon, Oxford.

Price, W. and D.C. Holley (1981), "The last minutes of flight 2860: an analysis of crew shift work scheduling", in A. Reinberg, N. Vieux and P. Andlauer (eds.), *Night and Shift Work: Biological and Social Aspects*, Pergamon Press, Oxford.

Prokop, O. and L. Prokop (1955), "Ermüdung und Einschlafen am Steuer", *Zbl Verke hrsmed*, 1, pp. 19-30.

Queinnec, Y., G. De Terssac and M. Dorel (1984), "Temporal organization of activities in process control", in A. Wedderburn (ed.), *Psychological Approaches to Night and Shift Work*, Heriott-Watt University, Edinburgh.

Ranney, T. and V.J. Gawron (1987), "Driving performance as a function of time on the road", paper presented at the Human Factors Society 31st Annual Meeting.

Regina, E., G. Smith, C. Keiper and R. McKelvey (1974), "Effects of caffeine on alertness in simulated automobile driving", *Journal of Applied Psychology*, 59, pp. 483-489.

Reyner, L.A. and J.A. Horne (1998*a*), "Evaluation of "in-car" countermeasures to sleepiness: Cold air and radio", *Sleep*, 21, pp. 46-50.

Reyner, L.A. and J.A. Horne (1998*b*), "Falling asleep whilst driving: Are drivers aware of prior sleepiness?", *International Journal of Legal Medicine*.

Ribak, J., I.E. Ashkenzai, A. Klepfish *et al.* (1983), "Diurnal rhythmicity and airforce flight accidents due to pilot error", *Aviat Space Environ Med*, 54, pp. 1096-1099.

Road Safety Bureau (1993), *Problem definition and countermeasure summary: Fatigue*, Road Safety Bureau, New South Wales, Australia.

Roehrs, T., A. Zwyghuizen-Doorenbos and T. Roth (1993), "Sedative effects and plasma concentrations following single doses of triazolam, diphenhdramine, ethanol and placebo", *Sleep*, 16(4), pp. 301-305.

Roehrs, T., A. Zwyghuizen-Doorenbos, V. Timms, F. Zorck and T. Roth (1989), "Sleep extension, enhanced alertness and the sedating effects of ethanol", *Pharmacol Biochem Behav*, 34, pp. 321-324.

Rosa, R.R. and M.J. Colligan (1989), "Extended workdays: effects of 8-hour and 12-hour rotating shift schedules on performance, subjective alertness, sleep patterns and psychosocial variables", *Work and Stress*, 3, pp. 21-32.

Rosekind, M., P.H. Gander, D.L. Miller, R.M. Smith, J.V. Lebacqz *et al*. (1994*a*), "Fatigue in operational settings: examples from the aviation environment", *Hum Factors*, 36(2), pp. 327-338.

Rosekind, M.R., R.C. Graeber, D.F. Dinges, L.J. Connel, M.S. Rountree and K. Gillen (1995), "Crew factors in flight operations; IX: Effects of planned cockpit rest on crew performance and alertness in long-haul operations", NASA Technical Memorandum, Moffett Field, California.

Rosekind, M.R., D.L. Miller, K.B. Gregory and D.F. Dinges (1995), "Flight crew sleep in long haul aircraft bunk facilities: survey results", *Sleep Research*, 24, p. 112.

Rosekind, M.R., R.M. Smith, D.L. Miller, E.L. Co, K.B. Gregory, P.H. Gander and J.V. Lebacqz (1994*b*), "Naps and alertness management strategy", in T. Åkerstedt and G. Kecklund (eds.), *Work Hours, Sleepiness and Accidents*, IPM and Karolinska Institute, Stockholm.

Samel, A., A. Diedrich, B. Lorenz, G. Plath, M. Vejvoda and J. Wenzel (1997), "Langzeitmonitoring psychophysiologischer grössen in der Flugphysiologie", *Der Internist*, 38, pp. 755-769.

Samel, A., H.-M. Wegmann and M. Vejvoda (1997), "Aircrew fatigue in long-haul operations", *Accident Analysis and Prevention*, 29, pp. 439-452.

Sharpless, S. and H.H. Jasper (1956), "Habituation of the arousal reaction", *Brain*, 79, pp. 655-680.

Smith, A.P. and C. Miles (1986*a*), "The effects of lunch on cognitive vigilance tasks", *Ergonomics*, 29(10), pp. 1251-1261.

Smith, A.P. and C. Miles (1986*b*), "Effects of lunch on selective and sustained attention", *Neuropsychobiol*, 16, pp. 117-120.

Smith, L., S. Folkard and C.J.M. Poole (1994), "Increased injuries on night shift", *Lancet*, 344, pp. 1137-39.

Sokolov, E.N. (1963), "Higher nervous functions: the orienting reflex", *Annual Review of Physiology*, 25, pp. 545-580.

Summala, H. and T. Häkkinen (1994), "Fatal accidents among car and truck drivers: effects of fatigue, age and alcohol consumption", *Hum Factors*, 36(2), pp. 315-326.

Suvanto, S., M. Härmä, J. Ilmarinen and M. Partinen (1993), "Effects of 10h time zone changes on female flight attendants' circadian rhythms of body temperature, alertness and visual search", *Ergonomics*, 36(6), pp. 613-625.

Thorndike, E.L. (1926), *Mental Work and Fatigue and Individual Differences and Their Causes*, Columbia University Press, New York.

Tilley, A.J., R.T. Wilkinson and M. Drud (1981), "Night and day shifts compared in terms of the quality and quantity of sleep recorded in the home and performance measured at work: a pilot study", in A. Reinberg, N. Vieux and P. Andlauer (eds.), *Night and Shift Work: Biological and Social Aspects*), Pergamon Press, Oxford.

Torsvall, L. and T. Åkerstedt (1985), "Eye closure, sleepiness and EEG spectra", in W.P. Koella, E. Rüther and H. Schulz (eds.), *Sleep 1984*, Gustav Fischer Verlag, Stuttgart.

Torsvall, L. and T. Åkerstedt (1987), "Sleepiness on the job: continuously measured EEG changes in train drivers", *Electroencephalogr Clin Neurophysiol*, 66, pp. 502-511.

Torsvall, L. and T. Åkerstedt (1988), "Extreme sleepiness: quantification of EOG and spectral EEG parameters", *Int J Neurosci*, 38, pp. 435-441.

Torsvall, L., T. Åkerstedt, K. Gillander and A. Knutsson (1989), "Sleep on the night shift: 24-hour EEG monitoring of spontaneous sleep/wake behavior", *Psychophysiology*, 26(3), pp. 352-358.

Torsvall, L., T. Åkerstedt and M. Gillberg (1981), "Age, sleep and irregular work hours: a field study with EEG recording, catecholamine excretion and self-ratings", *Scand J Work Environ Health*, 7, pp. 196-203.

Totterdell, P. and S. Folkard (1990), "The effects of changing from a weekly rotating to a rapidly rotating shift schedule", in G. Costa, G. Cesena, K. Kogi and A. Wedderburn (eds.), *Shiftwork: Health, Sleep and Performance*, Verlag Peter Lang, Frankfurt.

US Department of Transportation (1995). *Safety is our Driving Force: 1995 Truck and Bus Safety Summit*, US Department of Transportation, Federal Highway Administration, Office of Motor Carriers.

Walsh, K.K., J.L. Sugerman and P.K. Schweitzer (1986), "Physiological sleep tendency during sleep/wake schedule inversion", *Sleep Res.*, 15, pp. 289.

Webb, W.B. (1978), "The forty-eight hour day", *Sleep*, 1(2), pp. 191-197.

Wever, R.A. (1979), "Influence of physical workload on freerunning circadian rhythms in man, *Pflügers Arch*, *381*, 119-126.

Wilkinson, R. (1969), "Some factors influencing the effect of environmental stressors upon performance", *Psychol Bull*, 72(4), pp. 260-272.

Wilkinson, R.T. (1964), "Effects of up to 60 hours sleep deprivation on different types of work", *Ergonomics*, 7, pp. 175-186.

Williams, H.L., A. Lubin and J.J. Goodnow (1959), "Impaired performance with acute sleep loss", *Psychol Mon*, 73, pp. 1-26.

Williamson, A.M., A.-M. Feyer and R. Friswell (1996), "The impact of work practices on fatigue in long distance truck drivers", *Accident Analysis and Prevention*, 28, pp. 709-719.

Williamson, A.M., C.G.I. Gower and B.C. Clarke (1994), "Changing the hours of shiftwork: a comparison of 8- and12-hour shift rosters in a group of computer operators", *Ergonomics*, 37(2), pp. 287-298.

Williamson, A.M. and J.W. Sanderson (1986), "Changing the speed of shift rotation: a field study", *Ergonomics*, 29, pp. 1085-1086.

Williamson, M., A.-M. Feyer, C. Coumarelos and A. Jenkins (1992), "Strategies to combat fatigue in the long distance road transport industry. Stage 1: The industry perspective" (CR108), Federal Office of Road Safety.

Wojtczak-Jaroszowa, J. and D. Jarosz (1987), "Time-related distribution of occupational accidents", *J Safety Res*, 18, pp. 33-41.

Wylie, C.D., T. Shultz, J.C. Miller, M.M. Mitler and R.R. Mackie (1996), "Commercial motor vehicle driver fatigue and alertness study: Project report", Technical Report No. FHWA-MC-97-002), Federal Highway Administration, Washington, DC.

REGULATING THE MANAGEMENT OF WORKING TIME IN ROAD TRANSPORT

Nick McDonald
Department of Psychology, Trinity College Dublin, Ireland

Introduction

It has often seemed that the commercial road transport industry may inherently not be amenable to effective regulation because of factors like the predominance of small economic units, the remoteness of the location of work, and the role of transport in the processes of production and exchange, which is essentially to maximise flexibility to accommodate rigidities in the rest of the system. Indeed, Hamelin (1987) has suggested that greater regularisation of work in other industrial branches increases the pressure on transport to be flexible. From the perspective of the European Community, there is a widespread view that, since Regulation 543/69, there have been almost 30 years (a generation of professional drivers) of regulations on drivers' hours which have not been grounded in the operational realities of the industry and have been ineffectively enforced and routinely flouted. From a scientific point of view, it has often seemed that the negotiations between the social partners leading to the framing of regulations have not given due weight to scientific evidence on fatigue and safety. Furthermore, the low level of investment in such research has compromised the possibility of developing a package of cost-effective regulation.

This report reviews aspects of the European regulations, changes in the size and characteristics of the commercial transport sector, and some broad safety trends in the sector. Evidence relating to the levels of accident risk associated with working hours of professional drivers will be outlined. It will be used to suggest a number of ways to exert a positive influence on the relationship between hours of work and safety. An alternative framework for regulating drivers' hours will be proposed, based on the fundamental obligations of those who control the working hours of professional drivers and how these obligations should be fulfilled.

Industrial trends, regulation and safety

The failure of regulation

The most succinct overview is offered by the following comment: "Lack of enforcement of regulations is perhaps the single greatest problem facing the sector" (Bayliss and Coleman, 1994). Surveys have consistently shown that regulations on drivers' hours are routinely flouted. Van Ouwerkerk (1989) found that 84 per cent of a sample of 650 international truck drivers from various European countries were in violation of these regulations, in particular those on driving time, length of daily rest, and daily work time. Tachographs (automatic recording devices) are also routinely falsified. Germain (1988) describes how systematic violation commonly arises. The first level of response to unplanned delays is to increase working time and to decrease the time taken for daily rest and meal breaks. When this level

of flexibility is exhausted, the pattern of driving changes, with increased speed and shorter following distances. There is often little expectation that work can routinely be done within the regulatory limits.

The level of inspection is reported to be very low. Hamelin (1989) estimated the risk of a control inspection of work time to be of the order of nine per thousand working days (and the risk of sanction two per ten thousand days). As of 1988, the European Council introduced minimum requirements on monitoring compliance (checks must cover at least 1 per cent of days worked per year, not less than 15 per cent of the days checked at the roadside and not less than 25 per cent at the workplace). However, the impact of this requirement on the industry is by no means clear. A joint study by the Committee of Transport Workers' Unions in the European Community and the International Road Transport Union failed to elicit any significant information about enforcement of regulations from 30 trade union and 36 employer organisations (O'Brien *et al.*, 1995). Furthermore, enforcement of Regulation 3820/85/EEC has been hampered by legal challenges to its interpretation (European Court of Justice, 1992).

There is no consistent enforcement strategy across the Community. The agencies responsible for enforcement vary in different countries. In all jurisdictions, the police are the competent authorities in the matter of road safety (including driving hours). However, the enforcement of regulations on road transport may be the responsibility of inspectors of specialist ministries or departments of transport or it may fall to the general labour inspectorate, the police, or another body. The level of sanctions also varies considerably (Gugenheim, 1989).

Accountability is a further issue. Who should be held liable for violations? Regulation 3820/85/EEC places an obligation on transport firms to organise drivers' work so that they are able to comply with the relevant provisions, to check compliance periodically and to prevent repetition of any breaches found. It is not clear how this provision has been interpreted or applied. Certainly there is little evidence in Europe of the kind of "safety review" audits undertaken by the US Federal Highway Administration since the 1984 Motor Carrier Safety Act (Moses and Savage, 1994). Contractual relationships between firms are not covered in the EU regulations. Nevertheless, freight forwarders and prime contractors are frequently blamed for setting targets which require subcontractors to operate illegally (Bayliss and Coleman, 1994).

In conclusion, enforcement is commonly held to depend on the ability to detect and to deter infractions through high probability of detection and adequate penalties. European regulations manifestly fail to meet this criterion. Furthermore, there is no systematic approach to accountability and liability and to institutional mechanisms of ensuring compliance. Regulations should seek to ensure accountability (and liability) at the level at which there is the greatest control or influence over the possibility of infractions. This implies developing procedures for auditing firms' rostering and dispatching practices and their contractual relationships. Bayliss and Coleman (1994) recommend that the relationship between shippers/freight forwarders/prime contractors and subcontractors should be regulated through the adoption of obligatory contracts that allow verification of compliance with labour laws and operator and traffic regulations.

Some of the possibilities for and constraints on effective regulation of working time in road transport can be made clearer by reviewing ways in which the sector has evolved and some safety-related trends and characteristics.

Evolution of the commercial road transport industry

The European commercial road transport sector has undergone considerable structural change over the last few decades. Bayliss and Coleman (1994), in their report to the European Commission, have reviewed some of these changes. The most obvious is an increase in capacity, as tonne/kilometres more than doubled in the EU between 1970 and 1990. Associated with this is an increase in the number and size of road haulage firms. The great majority are small firms, predominantly, but by no means exclusively, servicing local markets. At the same time, there is considerable concentration of the haulage fleet in large enterprises (for example, in the United Kingdom, one-tenth of haulage companies operate six-tenths of the total vehicle fleet). The increase in the size of haulage companies implies a greater use of logistics in operations, which in turn permits greater routinisation of transport operations. Accompanying these changes is a move by professional haulage companies from "own account" to contracting out. This has led to new patterns of relationships between companies (haulage companies, shippers, forwarders and their clients). In particular, there has been a growth both in strategic alliances between enterprises with complementary roles and in subcontracting (in France, one-third of road hauliers subcontract at least 10 per cent of their business and are responsible for over 90 per cent of all subcontracting in the sector). Formal and more long-term contracts are more and more common. Within such arrangements, there is usually a hierarchical pecking order, with subcontractors taking the least profitable and the least regular business.

One factor that has stimulated such changes has been the growth of JIT (just-in-time) production systems. In 1990, 28 per cent of all shipments in the United States and the European Union were on a JIT basis, a share that was projected to rise to one-third by 1995 (Bayliss, 1993). The growth in JIT production has led to greater outsourcing of transport and to greater flexibility and efficiency in transport. Only the larger operators can assure shippers of the flexible service they require, operate over large networks with high capacity utilisation levels, and take advantage of sophisticated IT and telematics systems.

Working conditions for drivers vary markedly among the different parts of the industry. Hamelin (1987) has extensively investigated differences between the transport "for hire or reward" sector and the "own-account" sector in France in the 1980s. Drivers in the former have worse working conditions than their colleagues in the latter. Their average working time is longer, they are more frequently away from home for several days at a time, and they have longer working hours when they are away from home. Most drivers who are away for two days or more have average work spans of at least twelve hours, with short sleep times. Irregularity is the critical feature of working hours in the transport sector. Working hours depend on the client's requirements. The more regular these requirements are (in terms of journeys, products, kind of loading or rest times), the greater the decrease in the average weekly working hours. A good example of this is given by Germain and Nierat (1989) who describe the greater efficiency, shorter working hours and increased night work for operating "navettes" for long distance transport (a shuttle service between depots where trailers are exchanged). However, in Hamelin's sample, size of enterprise does not appear to be associated with the greater rationalisation of working time – working times are as long in large firms as in small. In contrast, in "own-account" transport, size of enterprise is translated into shorter weekly working hours. In terms of drivers' careers, there appears to be a progression from more demanding to less rigorous operations with increasing age and seniority.

There are some indications that these structural changes in the transportation sector are not always matched by ability of management to deliver an efficient service (P-E International, 1993). Thus, among haulage contractors in the United Kingdom, contractor weaknesses are blamed for a high level of non-renewal of contracts (almost 60 per cent changed contractor in the previous three years and over 70 per cent would consider changing contractors when the current contract expires). Service

failures are the most common reason for companies to change their haulage contractor, followed by cost, flexibility, management problems and management information.

A number of conclusions can be drawn from this brief review:

- There is a tendency towards greater concentration and integration of road transport, through growth of larger firms and development of strategic alliances and subcontracting between firms. Traditional modes of operation predominate in local short-distance transport; in the long distance market, integrated logistic operations are commanding a greater share.
- There are pronounced differences in working conditions in different parts of the road transport sector, in particular between own-account and for-hire operations. In the latter, long working hours and irregularity are the norm, though new logistical systems (*e.g.* navettes) permit greater efficiency with shorter working hours.
- Service failures and management weaknesses are perceived as common problems leading to non-renewal of haulage contracts.

Trends in safety

Depending on the index chosen, safety trends for the commercial road transport sector look very different. The critical issues here are safety of the professional driver (occupational safety) and safety of other road users involved in accidents with commercial vehicles (public safety).

Rates of involvement in accidents per distance travelled have consistently and substantially improved over the last few decades. Using figures for Great Britain, rates of involvement of heavy goods vehicles (HGV) in fatal accidents per distance travelled more than halved in the 15 years between 1981 and 1996. However, the rate is still substantially higher than that of other motor vehicles (Table 1).

Table 1. Involvement rate in accidents per hundred million vehicle kilometres (Great Britain)

	Severity of accidents					
	Fatal		Fatal or serious		All severities	
	1981	1996	1981	1996	1981	1996
Heavy goods vehicles >1.5 tons	4.0	1.9	25	10	70	44
All motor vehicles	3.1	1.2	41	14	148	91

Source: Department of the Environment, Transport and the Regions, 1997.

The fatality rate for HGV drivers themselves in traffic accidents has dropped from an average of 0.6 per hundred million vehicle-kilometres in the five years between 1965 and 1969, to an average of 0.42 between 1975 and 1979, and to an average of 0.18 between 1992 and 1996 (Department of Transport, 1971, 1977, 1980; Department of the Environment, Transport and the Regions, 1997). However, from the point of view of occupational safety, the important denominator is the duration of exposure of drivers rather than miles driven. It is not so easy to calculate this figure because of the considerable increase in the average mileage of these vehicles over this period and changing patterns of vehicle use (vehicle distance travelled is not the same as driver distance travelled). A more appropriate trend can be compiled from occupational mortality statistics which give the death rates for different occupations from a variety of causes standardised against population norms. Table 2

summarises the standard mortality ratios for goods vehicle drivers in Great Britain between 1949 and 1982 (the most recent figures available).

Table 2. Standard mortality ratios for goods vehicle drivers in Great Britain

	All causes of death	Deaths in motor vehicle accidents
1949-53	91	191
1959-63	101	154
1970-72	111	194
1980-82	113	178

Source: General Register Office, 1958, 1971; Office of Population Censuses and Surveys, 1978, 1988.

It is by no means clear that the impressive improvement in the accident rate per distance travelled has been translated into improved occupational safety (*i.e.* less relative chance of dying in road accidents) for commercial goods vehicle drivers. This analysis is supported by figures given by Viscusi (1989) showing that the trend in lost workday occupational injury rates for the US trucking industry has not declined during a period which saw a huge decline in accident rates per distance travelled.

From the point of view of public safety, the critical issue is the number of other road users killed and injured in accidents involving commercial road vehicles. The factor which, more than anything else, determines the relative fatality rate of different vehicle occupants in multi-vehicle collisions is the mass-ratio of the vehicles involved. McDonald (1984) summarised a number of studies demonstrating that heavy goods vehicles have higher rates of involvement in fatal accidents than other road vehicles (see also Table 1). In fatal accidents involving heavy trucks, the number of fatalities among other road users is typically ten times or more the number of fatalities of truck drivers, and the heaviest trucks account for the highest rates of fatalities per vehicle mile.

Given the segmentation of the commercial road transport industry outlined above, a relationship might be expected between the characteristics of different transport operators and their accident rates. Evidence from the United States suggests that accident rates are lower for larger truck operators: "Firms that operate half a million miles a year, which is to say firms in the ninth decile, have an accident rate about half that of smaller firms. The very largest firms have an accident rate about half that of the smallest firms." (Moses and Savage, 1994, p. 177) Furthermore, the accident rate of private (own-account) carriers appears to be about 20 per cent lower than that of comparable for-hire carriers. According to the same study, some safety management practices also had significant associations with accident rates; among the most important of which was the filing of accident reports with the government and the disciplining of drivers involved in "preventable" accidents. Thus, the 11 per cent of firms that are deficient in reporting accidents have accident records that are nine times worse than firms that do report, even on the records of accidents found during the audit carried out in the course of the study. Compliance with regulations on hours of service also discriminates between firms' accident rates. The 30 per cent of firms that are unfamiliar with rules on drivers' hours of service and do not keep records of the duty status of individual drivers have accident rates 30 per cent higher than those that do comply. An earlier study by Corsi and Fanara (1989) found similar patterns.

Hamelin (1987) describes the general safety levels of the transportation branch compared to other branches. In his survey, the transportation branch represented 53 per cent of drivers involved in accidents, yet accounted for 38 per cent of the population of drivers and 41 per cent of exposure related to number of hours worked. As calculated by Hamelin, the risk rate for the transportation branch is about twice that of other branches.

What then of the social costs and liabilities of such accidents? Morris (1996) describes the development of a model for estimating the extent to which the external costs of road freight transport accidents are a significant factor in overall truck freight efficiency. The external costs are those borne by society, rather than the truck operator. He estimates that in 1989 in the United States, the total cost of traffic accidents involving for-hire, cargo-carrying trucks was $14.1 billion, of which external costs represented 59 per cent. Modelling various case studies demonstrated that the marginal external cost of accidents could be as high as $0.21 per loaded mile. This is the expected increase in the total costs of accidents on the route as a result of adding one truck trip, less the truck operator's own expected accident costs. The figures in this study vary according to assumptions about routes, loading, and the relationship between truck and other vehicle traffic volumes and accident rates. Nevertheless, they do demonstrate that the social cost of road freight accidents represents a significant social subsidy of the freight transport industry.

The following conclusions can be drawn:

- The consistent improvement over the last few decades in the HGV accident rate with respect to distance travelled is not matched by equivalent improvement in the occupational exposure of drivers to risk.
- Heavy goods vehicles are involved in higher rates of fatal accidents (per distance travelled) than other road vehicles, and at least ten times as many other road users as HGV drivers are likely to be killed if involved in an accident involving a heavy goods vehicle.
- It is possible to break down the rate of involvement in accidents for different types of trucking company, according to the size of the enterprise and by comparing "own-account" with for-hire transportation. Management response to preventable accidents and firms' policy on compliance with regulations on hours also have a relation to the safety levels of firms. Studies carried out indicate the value of undertaking safety audits of firms.

The total cost of commercial transport accidents can be divided into internal and external costs, and their impact on road freight efficiency can be modelled. Such studies suggest that external costs represent a significant social subsidy of commercial road transport.

Implications for regulation

European legislation has apparently been ineffective in ensuring compliance with prescribed working and driving hours. One possible inference is that placing regulatory emphasis on the point of production – the actual driving process – is not the most cost-effective way of ensuring compliance. While EU legislation does place obligations on transport operators as well as drivers to comply with driving hours, it is not clear to what extent these obligations are enforced. It has been recommended that the contractual process should be made subject to transparent compliance with hours requirements. The commercial road transport sector has become increasingly integrated and rationalised through concentration into larger firms and subcontracting relationships between larger and smaller firms. This suggests that it would be a sensible regulatory strategy to focus efforts to ensure accountability on the level at which the greatest control is exercised over working conditions - that of the firm and inter-firm relationships. General service and management weaknesses in satisfying industry clients and specific safety management weaknesses (particularly compliance with hours regulations and response to involvement in accidents) suggest that the industry would benefit from regulatory and other initiatives which would enhance the competence of management.

Broad divisions within the industry do allow differentiation according to working hours (short vs. long distance and the for-hire transport sector vs. own-account transport) and safety levels (for-hire transport versus other branches, size of transport operation). Clearly, the sector is segmented horizontally as well as vertically. One crude segmentation is between long- and short-distance operations, with small operators predominating in the latter and large operators in the former. There are also divisions according to the type of goods or produce carried (for example, fresh fish), which can be very important in terms of the demands (time, distance) on transport operators. Increasing specialisation may follow the development of longer-term alliances between hauliers, shippers, freight forwarders and industry partners. Together with the development of better transport logistics, this can sometimes lead to greater routinisation of transport operations.

If these trends are in fact common to the sector, it may be desirable to develop a more flexible approach to regulation by setting a general regulatory norm, which would be mandatory for most operations and in most circumstances. The norm would be quite restrictive, in that it would promote the highest possible level of safety for most normal transport operations. However, exceptions could be permitted for operations which could not be effectively carried out under this norm. For example, such exceptions might only be permitted under the following conditions:

- The operation should be justified in terms of technical or operational necessity (it cannot be carried out effectively otherwise), rather than simply as a matter of saving labour costs. Such conditions might include logistical problems over great distances or a need for extreme flexibility.
- The operation should be regarded as having a lower safety level so that compensatory measures need to be taken in rostering and safety management to ensure that the risk is managed in an optimal manner.
- The operation should attract greater regulatory oversight as befits the higher level of risk.

Overall, incentives built into the regulatory system should encourage compliance with the regulatory norm, insofar as exceptions require more managerial control and more stringent regulatory oversight. This approach would be quite consistent with the higher external safety costs that would be expected to be associated with operating outside the regulatory norm. Current practice appears to demonstrate that operators have strong incentives to violate the regulatory norm. There are few incentives to comply and the travelling public and taxpayers incur the additional external costs.

One jurisdiction has taken a different approach to the regulation of drivers' hours in response to extreme geographical dispersion of the population (Poore, 1998). The Transport Department of Western Australia has proposed a draft code of practice for fatigue management for commercial vehicle drivers, operators, shippers and contractors. Derived from the general obligations for occupational safety and health legislation, the code specifies a standard of good practice for work and rest. The mechanism for ensuring that this standard of practice is attained is a management system (in this case a fatigue management system) which outlines the various management practices deemed essential to ensure that the highest practicable standards of safety are met. The code permits flexibility where required by operational constraints, in which case a number of additional control measures have to be taken. While the limits chosen in this code reflect the extreme circumstances of road transport in Western Australia (and are not generally applicable), the management system framework and the duties incorporated in this approach are applicable elsewhere.

Hours of work and risk of accident

Much has been written about fatigue over the last 80 years, including fatigue and driving since the beginning of motorised commercial road transport. McDonald (1984) attempted to synthesise the available evidence. The evidence on fatigue and alertness during driving is closely related to research on working hours and sleep in many other industries, including aviation, where there are requirements for hours of service (flight time limitations) and regulations equivalent to those in road transport. It is possible to generalise from this broad body of evidence the main aspects of a psycho-physiological model of the rhythms of sleep, activity and nutrition. This section presents some general propositions of this model and compares them with studies which have specifically looked at accident risk in commercial road transport, in order to demonstrate the extent to which the pattern of accident risk is influenced by these psycho-physiological processes.

The following factors would be expected to affect the performance of drivers and hence the safety of commercial vehicle operations (the list is not exhaustive):

- The time of day during which driving or work occurs. Work during the early hours of the morning, sometimes called the "window of circadian low" of physiological activation, is particularly vulnerable to performance failure. The window of circadian low is subject to partial adaptation during continuous shift work but is strongly affected by customary uses of time.
- The duration of work or other activity. There is an expectation, not always seen in the literature, that prolonged continuous work will increasingly be subject to error as time progresses. The type of work is relevant here, and work requiring sustained attention, complex judgements, or involving monotony, time pressure or unexpected demands will be particularly vulnerable.
- Rest periods and meal breaks that interrupt periods of continuous work will help to prevent decreased performance associated with continuous activity, not only because of the break in performance, but also because of the importance of regular and reasonably frequent nutrition for maintaining alertness. Short naps may also delay the onset of decreased performance.
- There may be an increase in drowsiness and a decline in performance in the early afternoon (the so-called "post-lunch dip").
- Whatever the waking activity, the length of time since awakening may also affect the level of attention and performance.
- The quality of sleep prior to a work shift will also affect the quality of performance during that shift. Sleep periods that do not include the window of circadian low will be less restorative. Early starts to work shifts, which necessitate arising during the window of circadian low, may also impair performance in that work shift.
- Any cumulative sleep debt over several days will also adversely affect performance. Such a sleep debt needs to be dissipated over successive nights of good sleep, including the window of circadian low.
- Repeated days of prolonged work activity may be associated with a cumulative decrease in performance, although evidence for this is less substantial.

How do these broad fatigue and performance parameters relate to quantifiable changes in risk of accident for professional drivers? Studies comparing the incidence of accidents in a sample with a quantification of exposure to risk (Harris *et al*., 1972; Hamelin, 1987; Lin *et al*., 1994) have been crucial to demonstrating the relationship. Different types of exposure data are appropriate to the different parameters of working time. For time of day, appropriate exposure data concern the amount

of traffic of different types in the traffic population or a matched sample on the road at any one time. For duration of work or driving, accidents after different lengths of time need to be compared with numbers of work shifts or driving periods of varying length, in which there was no accident (ideally, this should take into account the fact that when an accident occurs, it curtails a trip which would otherwise have been longer). For age or experience, the numbers in the age or experience category in the accident sample are compared to an equivalent non-accident sample.

Some types of exposure are difficult to control for. In principle, one should be able to control for multiple exposures that can affect the accident rate simultaneously, such as trip duration, time of day, traffic density, road type, and number of stops for loading and unloading. In practice, this is very difficult. Some of these factors also interact with accident type. It is likely, for example, that trips of relatively short duration, or involving a number of stops for loading and unloading or changing trailers, will involve a smaller proportion of time on large multilane inter-city highways than on smaller, more congested highways with fewer lanes. This will affect the risk of different types of accident. In the latter case, one would expect the risk of accidents involving only relatively minor property damage to be higher. Moses and Savage (1994) suggest that most of the accidents of large, predominantly less-than-truckload, general freight firms are minor in nature and incurred in the urban pick-up and delivery operations that characterise this business. Thus, it is critically important to be clear about what definition or measure of accident is being adopted.

Cumulative effects (the effects of previous rest, previous work days and accumulated sleep debt) are also difficult to control for. Harris *et al*.'s (1972) psycho-physiological studies suggest the importance of cumulative effects, as the drivers' status in the fourth or fifth day of prolonged driving was significantly worse than in the first two or three days. This factor is very important from the point of view of regulations on hours of work in terms of how to balance short-term daily restrictions against longer-term restrictions over a week or more. In terms of the evidence summarised below, these limitations on accident risk studies need to be borne in mind.

Circadian variation of accident risk

Folkard (1997) performed a macro-analysis of six studies, which had reported data on accidents at different times of the day. These studies had either corrected for exposure (Hamelin, 1987) or for traffic density (Langlois *et al*., 1985) or concentrated on particular types of accident, such as single vehicle or sleep-related accidents (Lavie, 1991). The analysis showed a highly significant time-of-day effect, with the risk of accident clearly highest in the early hours of the morning (about two standard deviations higher than the overall 24-hour mean). The mean Z scores for all hours between 23.00 hrs and 06.00 hrs were higher than the overall mean. There was also a relatively minor secondary peak in risk in the early afternoon.

The results of Lin *et al*. (1994) are less clear-cut, although significant relationships with time of day were found. The lowest accident risk was between 10.00 hrs and 12.00 hrs; the risk between 16.00 hrs and 18.00 hrs was 60 per cent higher than the low and the risk between 00.00 hrs and 02.00 hrs, 06.00 hrs and 08.00 hrs, and 20.00 hrs and 22.00 hrs was about 40 per cent higher than the 10.00-12.00 hrs baseline. Other times did not differ from the baseline. Time of day interacted strongly with driving time. Why did this study not find a more pronounced circadian pattern? It is not possible to know with certainty, but some suggestions might be made. The company whose data was used for the study was a national "less-than-truckload" carrier, operating a coast-to-coast "pony express" operation, which apparently adhered reasonably conscientiously to US Department of Transportation hours of service regulations. All accidents, including minor "fender bender" incidents, were included in the analysis. Both the nature of the transport operation and the definition of accident adopted may

have skewed the distribution of accidents towards minor property damage accidents occurring in and around depots or in urban environments at periods of high traffic density. The more serious accidents that are more closely associated with circadian factors (*e.g.* falling asleep) may have been less numerically represented.

Duration of work

While a number of studies have shown a significant relationship between accidents and duration of driving or working time of professional drivers, the precise pattern of the relationship varies. In Lin *et al*.'s 1994 study, driving time had the strongest direct effect on accident risk. The first four hours consistently had the lowest risk of accident. Accident risk increases significantly after the fourth hour up to the seventh hour by some 50 per cent or more. The eighth and ninth hours show a further increase, at approximately 80 and 130 per cent higher than the first hour. These results are broadly compatible with the results of Harris *et al*. (1972), who found a pattern of increasing rates of accident from the seventh to the tenth hour for a larger trucking company. For two smaller companies, there was an increasing risk of accident with time driven only for older drivers and night driving. Mackie and Miller (1978), using a larger sample, found risk increasing after the fifth or sixth hour of driving but tending to return to expected levels during the ninth and tenth hours. Hamelin (1987) studied risk rates in relation to working time (driving plus other activities); while the risk rate was relatively high for the first four hours of work (1.2, when the average is 1.0), it subsequently decreases before strongly increasing for work lasting over 12 hours (a risk rate of approximately 2).

Why are there such differences in the temporal pattern of accident rates? There are often methodological problems for obtaining unbiased data on duration of driving for accident-involved or reference samples. Hamelin, for example, suggests that the work durations in his accident sample may often have been durations since the last legal break (which could be one hour) rather than the last daily rest period. This would increase the apparent accident risk of short work durations and reduce that of long durations. However a number of other factors have been shown to modify the pattern of the accident rate associated with duration of work or driving.

Interactions between duration and time of day

There may be different patterns in accident risk associated with different times of the day. This is suggested by Pokorny *et al.* (1981) in a study of urban bus drivers in one company who worked one of two shifts, an early shift (beginning between 05.30 hrs and 10.00 hrs) and the late shift (beginning between 13.00 hrs and 17.00 hrs). Maximum working hours were eight hours. They found that the early shift had a higher proportion of accidents (corrected for mileage covered) than the late shift; within each shift earlier starting times were associated with higher accident rates, and the two shifts differed quite markedly in terms of the relationship between hours of driving and the 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. Lin *et al*.'s (1994) study also suggests a strong interaction between time-of-day and duration-dependent effects, and Harris *et al*. (1972) also found such interaction in one company. Hamelin's data demonstrates this interaction very clearly. Table 3 shows the risk rates for different times of day and working durations. While the risk rate is higher both for work periods that exceed 11 hours and those that occur during night-time hours, the relative impact of long working hours is less at night. Nevertheless, the risk rate for long durations at night is over three times that of short durations during the day.

Table 3. Risk rate as a function of time of day and work duration

	20.00-07.00 hrs	08.00-19.00 hrs
Work time < 11 hours	1.85	0.74
Work time > 11 hours	2.37	1.35

Source: Hamelin, 1987.

Rest and meal breaks

Rest breaks have been shown to significantly modify the relationship between duration of driving and accident risk. Lin *et al*.'s data (1994) show that rest breaks taken between the second and the sixth hour of driving significantly lower the risk of accident. Rest breaks taken later have no effect.

Cumulative effects

There is very little conclusive evidence concerning cumulative effects of fatigue over several days. Linklater (1980) found that, among a number of variables, average weekly driving hours, as reported by the driver, presented the best discriminator of probable involvement in an accident. The best discrimination between those who had had no crashes over the previous two years and those who had had at least one came at 55 hours per week. When exposure to risk (in terms of working hours) was taken into account, the accident peak came in working weeks of over 55 hours and up to 74 hours, but fell to a surprisingly low level thereafter.

Age and experience

Several studies have identified either age or experience as moderating the accident risk. Lin *et al.* (1994) found that drivers with more than ten years' driving experience have a consistently low accident risk; while all other categories of experience have a significantly higher risk (between 1.7 and 2.2 times higher). Age *per se* had no significant effect. Hamelin (1987) used age as an index of experience, having shown a relationship between age and seniority in a large sample of the trucking industry. Drivers under 30 years of age had consistently higher accident rates than those over 30. Interestingly, however, although their overall rate was lower, older drivers showed consistently greater differences between accident rates at different times of day and between longer and shorter working hours than younger drivers. Thus, while older drivers have overall a lower risk of accident, they appear to be more susceptible to fatigue. Harris *et al*. (1972) also found an increasing risk of accident following prolonged night driving among older drivers.

Different transport operations

Of particular interest here are Hamelin's (1987) findings comparing risk rates associated with night driving and prolonged driving in the different branches. Overall, the risk rate for the transportation branch is over double that for other branches. However, within this pattern, the difference in risk rates between long and short working hours (more or less than 11 hours) is less marked in the transportation branch than in others. What is more surprising, in the transportation branch, the risk rate for longer hours (over 11) during night-time hours (20.00 hrs to 07.00 hrs) is lower than that for shorter working hours at night, while this combination shows by far the highest risk rate for drivers in other branches.

Hamelin accounts for these findings in terms of the experience and "know-how" of these drivers in dealing with adverse conditions, *i.e.* a greater capacity to manage fatigue.

Conclusions

Studies of risk of accident in relation to hours of driving and work have largely confirmed the psycho-physiological model. Night work and prolonged work are both associated with increased risk; they also interact. Regulations to control hours of work should be more restrictive for night work than for day work, and should control working time as well as driving time. Rest breaks reduce the risk associated with prolonged driving if they are taken early enough. There is not a great deal of evidence concerning risk and cumulative effects over several days, but the evidence which does exist suggests that cumulative effects are an important factor. This points to the importance of including adequate periods of recovery into the provisions for weekly rest in regulations. The findings on age and experience indicate that occupational selection and mobility need to be considered as important areas for intervention, particularly in the parts of the for-hire transport branch with the greatest demand for prolonged work at night. This strongly suggests that a regulatory approach to fatigue and safety might need to develop a differentiated approach to different parts of the industry and to seek to influence the management of fatigue through the profession's culture and "know-how".

Any discussion of measures to mitigate the impact of driver fatigue on commercial road transport safety must acknowledge that they go beyond measures that simply limit the number of hours of work, driving or rest. No single set of figures can do justice to the complexities of rostering work in transport in real operational situations. If the management of rostering and dispatching is to prevent fatigue effectively, it has to be sensitive to more general criteria for ensuring that, within the limits set, the pattern of work permits adequate recuperation from work in terms of normal psycho-physiological rhythms of sleep, activity and nutrition and provides some flexibility for individual needs. Education about fatigue and management of alertness at both individual and corporate level then becomes an important ancillary. Because individuals differ in their susceptibility to fatigue and sleep disruption and because their susceptibility may change over time, it is important to monitor the health and well-being of those who have non-standard working times. Beyond this, it is important to develop career possibilities in management for those who find adaptation to such work rhythms difficult. Because none of these interventions can entirely prevent fatigue, it is also important to monitor incidents and accidents so as to identify any continuing contribution of fatigue to safety failures.

Possibilities for intervention

Table 4 summarises some of the main factors to be taken into account when considering the kinds of interventions that can influence the relationship between the working hours of drivers and the safety of the travelling public.

The left-hand column contains what may be called fundamental factors; these are outside the equation for intervention in the name of fatigue and safety. This is not to say that no safety issues need to be addressed at this level. The road, vehicle and traffic environment is basic to the relationship between fatigue and safety, both from the point of view of the time-distance equation for any transport operation, but also in terms of the range of factors that influence accident survivability. However, for present purposes, this level of analysis is taken as a given. Within the market structure of road transport, working time and the cost of labour are fundamental factors in the manner in which the demand for road transport is realised. Ultimately, such factors will determine the cost effectiveness of legislation, regulations, or other measures, but this is beyond the scope of this paper. The age and

experience of the current workforce (drivers, dispatchers, managers, shippers, forwarders, etc.) also constrain what can be achieved through various types of intervention. Perhaps most basic are the biological rhythms which govern sleep and waking, activity and nutrition and which ultimately set limits upon safe performance. Pharmacological interventions, which seek to modify these patterns, are not considered here.

Table 4. Possibilities for regulatory intervention

Fundamental factors	People and institutions	Requirement for transport	On-going management	Outcomes
Psycho-physiological rhythms	Professional culture, "know-how"	Operational requirements for road transport	Inter-firm contracts	Risk of accident
Age and experience of workforce	Occupational selection and mobility		Intra-firm management of working time and personnel	Internal costs of accidents
Market structure of road transport Road, vehicle and traffic infrastructure	Commercial road transport firms	Geographical constraints, *e.g.* distance to home base	Individual management of constraints	External costs of accidents
Possibilities for intervention	Accountability, code of practice and competence	Infrastructure and logistics	Audits and inspections	Monitoring and measurement

The second column gives some of the specific ways in which the fundamental factors become manifest in specific institutions, social processes and cultures. Here there are some clear possibilities for intervention: building a system of accountability for those organisational and contractual factors that affect safety, developing clear standards of good management practice, and fostering the competence of those within the commercial road transport industry to meet those standards.

Among commercial road transport firms, weaknesses have been identified in the system of contracting transport; management failings (with respect to compliance with hours regulations and accident reporting) have been associated with lower levels of safety. Current European regulations do identify some obligations at the level of the management of transport operations, but not within a systematic framework for establishing and enforcing accountability. Much contemporary safety legislation is built upon codifying the obligations of management within an enterprise and of contractual relationships between enterprises. In Europe, this is true of the general framework directive for occupational safety and health; it is also true of transport safety regulation, for example the Joint Aviation Requirements (JAR) for civil aviation. The legislative approach is often accompanied by a more elaborate code of practice or documentation on acceptable means of compliance which provides a detailed exposition of the management activities that are necessary, not only in order to ensure compliance with regulations, but also to manage safety effectively as a goal in itself (for example, British Standards Institute, 1995).

Occupational selection and mobility are important at the level of both management and driver. Effective safety management requires competent managers. Demonstrating competence in managing fatigue and rostering systems could appropriately be built into existing entry requirements for road transport operators. This might also be the subject of continuing training. For the driver, the impact of work stresses, particularly those associated with working time, has long been known to affect the

driver's career (Hollowell, 1968 Hamelin, 1989). Managing fatigue and safety throughout a career in road transport demands a high degree of occupational mobility. These are at least two areas of potentially useful intervention. Licensing and initial professional formation of drivers should address the importance of and mechanisms for managing fatigue and alertness. Both enterprises and state training agencies should give attention to career planning and occupational mobility in order to provide enough flexibility to ensure that drivers do not become trapped in an occupational niche where they are unable to cope adequately with the demands.

The third site for potential intervention is more diffuse but no less important. Occupational culture, and more specifically safety culture, has come to be recognised as a critical component of the safety system of any industry that depends upon a high degree of reliability in the performance standards of its operators. Truck drivers have a strong professional culture, which places value on autonomy and resilience in the face of hardship and extreme demands. More specifically, Hamelin points to a distinctive subculture among drivers in the transportation branch who are faced with the greatest need for flexibility in their working pattern. This he calls "know-how", the ability to manage one's resources to ensure that the work gets done as required. The constraints under which this "know-how" is exercised and the active role of the driver in managing the process is described by Germain (1988). This professional culture may be in some respects highly persistent, despite the routinisation or "industrialisation" of the driver's work process. On the other hand, it may be amenable to influence in critical aspects related to the management of fatigue. Here, there is a potential role for a common code of good professional practice endorsed by the drivers' professional and industrial organisations. Such a code should complement the code of good safety management, which should guide managers of road transport operations.

Table 4, col. 3 addresses what might be called the overall requirements for transport. On the one hand, there are the operational demands, such as the amount of freight to be moved from one location to another. This is a particularly important area for the development of logistics (OECD, 1992; Germain and Nierat, 1989), which have the potential to alter radically the organisation of driving. It is important for logistical systems to pay attention to human constraints and limitations. For example, the use of "navettes" described by Germain and Nierat was associated with shorter working hours but more night work. Therefore, the rostering arrangements for such a system should explicitly address the human factors that would minimise the risks involved in night work. While better logistics may be a way to change the relation between working hours and safety, geography is often less amenable. The need to spend days and nights away from home makes the provision of an adequate infrastructure for ensuring good rest, hygiene and nourishment crucially important for preventing the accumulation of fatigue. The development of such infrastructure and logistics may not be amenable to direct regulatory intervention but should be fostered through public policy.

A system of accountability for safety management should be subject to audit, and the results should be subject to inspection. Such audits and inspections would appropriately be at three levels: the contractual relationships between firms, the management system within the enterprise, and the actual work and driving assignments of each driver (Table 4, col. 4).

Finally (Table 4, col. 5), in the evolution of regulations on drivers' hours and safety, there is a potential area for intervention which has been relatively neglected. Such regulations should, in principle, be based on a clear understanding of the risks involved, and measures should take account of the costs and benefits likely to accrue. Quantification of the main parameters of risk in relation to working hours in road transport has progressed in a slow and piecemeal fashion over a number of decades. This is an industry where the opportunities for quantifying risk are good. In contrast to the aviation industry, for example, accident frequency is high, and in all European countries considerable administrative effort goes into reporting and investigating them. On the other hand, an enormous

amount of information about driving and working times (although not always accurate) must, by law, be collected. Yet, for some reason, there have been very few serious investigations linking one to the other. A new regulation could give the opportunity to monitor the link between factors that are controlled (working and driving hours and their management) and outcomes that may be affected (accidents) on a routine or recurrent basis. Such monitoring would provide the basis for quantifying the cost and benefit of such regulation and justify a range of measures that might further improve the safety of commercial road transport.

A regulatory model for managing working time

This section offers a model for how a regulatory scheme for drivers' hours of work could operate. It should be taken as illustrative of basic principles. This approach is not new but is fully in conformity with the principles of European safety legislation. It:

- outlines a framework of duties for those concerned, how they are to be fulfilled and assessed;
- is based on a set of safety limits, with a mechanism for managing exceptions and the criteria, decision procedures and compensatory measures to be implemented in the case of exceptions;
- is designed both to set a clear safety standard based on the best scientific evidence and to permit flexibility where technical or social criteria make this unavoidable.

Basic obligations of the parties to a regulatory scheme

Ultimately, any satisfactory scheme to regulate the working hours of commercial drivers has to be built on mutual obligations or requirements:

- the drivers' duty to manage their own sleep and alertness in order to ensure their own fitness for duty;
- the operator's duty to manage rostering and dispatching to comply with human needs so as to ensure that drivers can fulfil (1);
- the obligation on those who contract commercial transport services to ensure that these contractual arrangements are compatible with (1) and (2);
- the regulator's duty to ensure that (1), (2) and (3) are complied with according to the prescribed standards.

Any regulatory scheme should encompass the duties outlined in 1, 2, 3 and 4 above, but should also describe how these are to be achieved and set the standard by which compliance will be judged. Thus, the system for regulating a driver's working hours should specify three things:

- the duties of the major actors of the system – the drivers, the operator, those who contract transport services, the national authority, and the European authority – which are complementary and reciprocal;
- the means of compliance, *i.e.* how these duties are to be fulfilled;
- the standard of safety and how compliance is to be assessed.

Drivers

A driver's basic duty is to report for duty in a fit state and not to undertake driving duty when unfit. A second duty is to co-operate with the operator and the authority in operating a safe scheme for managing drivers' working hours.

The means of compliance is the way to make this duty operational. A code of practice for individual sleep and fatigue management should be endorsed and promoted by drivers' professional associations and by the relevant operator and national authority.

The standard of safety is the criterion by which to judge compliance. Professional and industrial associations should monitor the code of practice and if necessary enforce it by disciplinary sanction.

Operators

The operator's duties are to operate a rostering system according to the working hours rules, to endorse and promote a professional code of practice for the management of working time, and to collaborate with the authorities in ensuring compliance.

The means of compliance for the operator would include having a system for rostering and dispatching in conformity with the regulation and code of practice, being able to demonstrate that the plan is put into practice and how deviations are dealt with, having a health monitoring system, and reporting, monitoring and investigating accidents and safety incidents.

The standard of safety for the operator would involve the following activities:

- demonstrating compliance with the regulatory scheme and code of practice, both in planning and in practice;
- monitoring levels of health and well-being, identifying any problems potentially associated with rostering, drawing up and implementing a set of measures to anticipate and prevent any adverse health consequences of rostering;
- monitoring and reporting accidents and incidents, drawing up and implementing a set of measures to anticipate and prevent any potential incidents associated with rostering.

Contracting of haulage services

Those who contract haulage services have a duty to ensure that the contracts are compatible with having the haulage contractor fulfil his regulatory obligations. The means of compliance with this obligation must involve becoming aware of how these contracts are carried out in practice. The standard of safety would involve having such contracts available for regulatory scrutiny.

Regulatory authority

The role of the regulatory authority could be differentiated, as appropriate, between national authorities and authorities at European level. The obligation on the regulatory authority can be expressed as promulgating, implementing and enforcing the working hours regulation in order to achieve the highest possible level of safety. The regulatory authority should also endorse and promote a code of practice for fatigue management in commercial road transport. Such a code of practice would provide a framework for the codes of practice for drivers and operators.

The means of compliance would include the following:

- inspection, monitoring and auditing operation of schemes;
- prosecuting infringements;
- assessing, approving and reviewing exemptions;
- commissioning research to identify more clearly the risks associated with the scheduling of driving duty, and ways of ameliorating these risks;
- amending the regulatory scheme according to the best available scientific evidence.

The standard of safety for the regulator would include collation of audits and monitoring, assessment, and review of the implementation of the regulation. It would also encompass fulfilling the regulator's mandate to co-ordinate or stimulate a range of initiatives designed to improve safety, including the promotion of the code of practice, and measures to foster and enhance management training, occupational mobility, and improved logistics and infrastructure.

The framework of limits for regulating drivers' hours

This would set specific limitations on drivers' working hours and would be the equivalent of the drivers' hours limitations in current regulations. The constraints of this contribution do not permit a detailed justification of any specific optimal set of limits. However, two aspects of the limits in current European regulations need to be addressed if such regulations are to take account of the evidence. There should be specific limitations on night working in order to curtail the duration of work at night relative to day and to ensure adequate sleep at appropriate times on a daily and weekly basis. Second, it is important to control working time as well as driving time. A consensus document was drawn up under the auspices of NASA in 1996 based on scientific recommendations for flight time limitations in commercial aviation (Dinges *et al*., 1996). It would seem entirely appropriate for an equivalent document to be drawn up for commercial road transport.

A code of practice for managing driving times and rosters

Because of the complexity of rostering in commercial road transport, it is recognised that no single set of figures can satisfactorily encompass every eventuality. Good roster management means accepting that, with a 24-hour requirement for service, some fatigue and sleep loss is inevitable, but mitigating this as far as possible by balancing different requirements. The limits on drivers' hours which are codified in regulations should be set so that this compensation and balancing can occur without causing serious safety concerns. However, it is also important to stress the importance of education and roster management. Some principles of good roster management fall under the following headings (offered as a rough approximation for purposes of illustration); however, where it is not possible to abide by the principles, compensatory measures are needed to allow the human system to readjust to its normal patterns:

- where possible, preserve the opportunity for regular sleep, including the circadian low;
- limit the duration of work to prevent build-up of fatigue;
- preserve regularity in the 24-hour cycle;
- allow for regular nutrition and hygiene requirements (*e.g.* rest breaks);
- provide weekly rest to prevent the accumulation of fatigue;
- prefer short-term to long-term compensation to prevent accumulation of fatigue and sleep loss;

- provide notice and predictability in roster patterns;
- provide flexibility to meet individual requirements.

In addition to these general principles it is also suggested that good rostering practice in an industry where safety is at a premium should adopt the following additional measures:

- monitor the health and well-being of those subject to rostering, individually and collectively;
- provide an appropriate career structure and career management (including counselling) to prevent long-term problems of adaptation to the roster system;
- provide advice and training in personal sleep and fatigue management;
- undertake systematic monitoring of incidents and accidents;
- provide a mechanism, including consultation, for the continuous improvement of the roster system to fulfil and reconcile technical, operational and individual needs.

These or some equivalent set of principles should be expanded and promulgated by the regulator as an advisory code of good practice.

The need for flexibility

Flexibility may be needed if it can be shown that some operations are technically or socially necessary but cannot be accomplished with the regulatory limits. In such cases, the starting point should be that the operation falls short of the recommended standard for safe practice, so that at least two conditions would need to be satisfied:

- The operator should have to demonstrate, against criteria set by the regulator, that such operations are technically or socially necessary and that no practicable alternative exists.
- In order to minimise the risk associated with operating outside the prescribed standard, a set of stringent procedures would become mandatory. These would include:
  - specific compensatory measures to minimise the impact on sleep loss and fatigue, while requiring all other aspects of the roster system to meet the explicit requirements of the core regulatory limits;
  - standby arrangements that ensure no pressure to drive if less than fully fit;
  - specific individual training on sleep and fatigue management;
  - a career management system to prevent long-term effects;
  - frequent monitoring of health and well-being, both individually and collectively;
  - close monitoring and auditing of these schemes by the regulator;
  - availability of these schemes to scientific research in order to establish the risk parameters;
  - time limitation on the operation of these schemes, with continuation depending on renewed justification.

The main principle in managing exemptions should be to isolate duties which have been the subject of exemption from any other requirement that could contribute to fatigue, sleep loss or sleep disruption. Thus, for example, if the exemption was to permit extended daily duties, the following provisions might apply:

- no invasion of daily rest, regular sleep/waking pattern at home base;
- minimisation of fatigue through good workload management;
- no cumulative fatigue, with a duty-free period before extended duty;
- duty-free recovery period following, with curtailment of amount of duty in a seven-day period.

Applying the model to road transport

The problem confronting regulators of commercial road transport in the matter of hours and conditions of work has often seemed to stem from the difficulty of exerting regulatory control over an industry characterised by a predominance of small firms and owner-operators, and where the driver's place of work is physically remote from the transport operations home base. On the other hand, the evidence suggests that the industry is changing in ways which may make it more amenable to regulation. Two tendencies are apparent. On the one hand, there is a process of rationalisation and routinisation of transport operations through increasing scale and the adoption of logistics. On the other, there are increasing pressures for flexibility in relation to very short-term changes in demand.

The approach adopted here is designed to address both of these tendencies, which make quite different demands on regulation. It may well remain the case that the most difficult parts of the commercial road transport sector to regulate will be small enterprises, which have little control over their position in the market and must compete by operating closer to the margin of safety in terms of hours and conditions of work. If that is the case, the strategy with the greatest chance of success is one which takes a systematic approach to the industry as a whole in a manner similar to that outlined here. The extent to which such an approach will be able to deliver tangible improvements in safety (hopefully in less than another three decades) will very likely depend on three factors:

- establishing clear accountability and legal liability up the chain of managing and commissioning of transport operations;
- developing the competence to manage working hours in road transport more effectively among all those involved and the willingness to put that competence into practice;
- developing transparency in relation to both the internal and external costs and benefits of improved safety.

REFERENCES

Bayliss, B.T. (1993), "Industry, Industrial Location and the Role of Transport in a Single European Market", in J. Polak and A. Heertje, eds., *European Transport Economics*, Blackwell, Oxford.

Bayliss, B.T. and R.J. Coleman, co-chairmen (1994), Report of the Committee of Enquiry, *Road Freight Transport in the Single European Market,* European Commission Directorate-General of Transport, Brussels, July.

British Standards Institute (1995), *BS 8800: Guide to Health and Safety Management Systems,* BSI, London.

Corsi, T.M. and P. Fanara, Jr. (1989), "Effects of New Entrants on Motor Carrier Safety", in L.N. Moses and I. Savage, eds., *Transportation Safety in an Age of Deregulation,* pp. 241-257, Oxford University Press, New York.

Department of Environment, Transport and the Regions (1997), *Road Accidents Great Britain 1996: The Casualty Report,* The Stationery Office, London.

Department of Transport (1971, 1976, 1980), *Road Accidents Great Britain, 1969,1975, 1978,* HMSO, London.

Dinges, D.F., R.C. Graeber, M.R. Rosekind, A. Samel and H.M. Wegmann (1996), "Principles and Guidelines for Duty and Rest Scheduling in Commercial Aviation", National Aeronautics and Space Administration, Ames Research Center, Moffett Field, California.

European Court of Justice (1992), *Criminal Proceedings against Kevin Albert Charlton and Others,* C116/92.

Folkard, S. (1997), "Black Times: Temporal Determinants of Transport Safety", *Accident Analysis and Prevention,* Vol. 29, No. 4, pp. 417-430.

General Register Office (1958, 1971), *Decennial Supplement: Occupational Mortality,* HMSO, London.

Germain, C. (1988), "Le Conducteur routier gestionnaire de contraintes", Conservatoire National des Arts et Métiers, Unpublished doctoral thesis, Paris.

Germain, C. and P. Nierat (1989), "Traction routière en longue distance : les navettes, une organisation particulière de travail, paper presented at the conference "Professions et réglementations des transports dans la perspective européenne 1993", Paris.

Gugenheim, J.M. (1989), "Nécessité et enjeux de l'harmonisation européenne de la réglementation du travail des conducteurs routiers", paper presented at the conference "Professions et réglementations des transports dans la perspective européenne 1993", Paris.

Hamelin, P. (1987), "Lorry driver's time habits in work and their involvement in traffic accidents", paper presented at the Second CEC Workshop on Irregular and Abnormal Hours of Work, Brighton.

Hamelin, P. (1989), "Les contradictions d'un système de production sur site public : le camionnage", paper presented at the conference "Professions et réglementations des transports dans la perspective européenne 1993", Paris.

Harris, W., R.R. Mackie, C. Abrams, D.N. Buckner, A. Harabedin, J.F. O'Hanlon and J.R. Starks (1972), "A Study of the Relationships among Fatigue, Hours of Service and Safety of Operations of Truck and Bus Drivers", Report 1727-2. PB213.963, Human Factors Research Incorporated, Santa Barbara Research Park, Goleta, California.

Hollowell, P.G. (1968), *The Lorry Driver*, Routledge and Kegan Paul, London.

Langlois, P.H., M.H. Smolensky, P. Bartholomew, B.P. Hsi, and F.W. Weir (1985), "Temporal Patterns of Reported Single-Vehicle Car and Truck Accidents in Texas, U.S.A. during 1980-1983", *Chronobiology International*, Vol. 2, No. 2, pp. 131-146.

Lavie, P. (1991), "The 24-hour Sleep Propensity Function (SPF): Practical and Theoretical Implications", in T.H. Monk, ed., *Sleep, Sleepiness and Performance*, pp. 65-93, John Wiley & Sons, Chichester.

Lin, T.-D., P. Jovanis and C.-Z. Yang (1994), "Time of Day Models of Motor Carrier Accident Risk", *Transportation Research Record* (1467), pp. 1-8.

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

Mackie, R.R. and J.C. Miller (1978), "Effects of Hours of Service, Regularity of Schedules and Cargo Loading on Truck and Bus Driver Fatigue", Technical Report 1765-F, Human Factors Research Incorporated, Santa Barbara Research Park, Goleta, California.

McDonald, N. (1984), *Fatigue, Safety and the Truck Driver*, Taylor and Francis, London.

Morris, J.R. (1996), "External Accident Costs and Freight Transportation Efficiency", in F. Saccomanno and John Shortreed, eds., *Truck Safety: Perceptions and Reality*, Institute for Risk Research, Waterloo, Ontario.

Moses, L.N. and I. Savage (1994), "The Effect of Firm Characteristics on Truck Accidents", *Accident Analysis and Prevention*, Vol. 26, No. 2, pp. 173-179.

O'Brien P. *et al.* (1995), *Final Report: Road Transport in the European Union: Aspects of the Organization and Enforcement of Working and Driving Time Regulations*, a study jointly undertaken by the Committee of Transport Workers' Unions in the European Community and the International Road Transport Union, December

OECD (1992), "Advanced logistics and road freight transport", report prepared by an OECD Scientific Expert Group, Paris.

Office of Population Censuses and Surveys (1978), *Decennial Supplement: Occupational Mortality 1970-1972* , HMSO, London.

Office of Population Censuses and Surveys (1988), *Decennial Supplement: Occupational Mortality 1979-80, 1982-83* , HMSO, London.

P-E International (1993), "Contracting Out or Selling Out", Survey into the current research issues concerning the outsourcing of distribution, P-E International, Surrey.

Pokorny, M.L.I., D.H.J. Blom and P. van Leeuwen (1981), "Analysis of traffic accident data (from busdrivers): an alternative approach, I and II", in A. Reinberg, N. Vieux and P. Andlauer, eds., *Night And Shiftwork: Biological and Social Aspects,* pp. 271-286, Pergamon, Oxford.

Poore, L. (1998), *Fatigue Management for Commercial Vehicle Drivers and Operating Standards for Work and Rest in the Western Australian Road Transport Industry,* Transport, Regional Policy Section, Perth, Western Australia.

Van Ouwerkerk, F. (1989), "La durée du travail des conducteurs routiers à longue distance : une question toujours d'actualité", paper presented at the conference "Professions et réglementations des transports dans la perspective européenne 1993", Paris.

Viscusi, W.K. (1989), "The Effect of Transportation Deregulation on Worker Safety", in L. N. Moses and I. Savage, eds., *Transportation Safety in an Age of Deregulation*, pp. 70-89, Oxford University Press, New York.

THE INTRODUCTION OF ON-BOARD COMPUTERS IN TRUCKS IN RELATION TO SOCIAL ASPECTS OF THE ROAD TRANSPORT INDUSTRY

F. Van Ouwerkerk
Stichting Vewo, Rotterdam, Netherlands

Introduction

This report describes a transport company in the Netherlands, which is one of the first companies to start an on-board computer system operation. The driver working in local distribution will be referred to as the "A driver".

The decision to implement the on-board computer system was originally due to a requirement of one of the company's clients and the Dutch Law on Food Hygiene. The company later saw that, in the future, the system would give the company an advantage through faster planning and calculating of truck loads. Paying drivers' salaries and producing invoices for clients would also be handled faster. The ultimate result should be more work with fewer people.

A new concept, the roll-on roll-off (RoRo) trailer, is also presented. It reduces loading and unloading time by half. In addition, the truck driver's physical labour is reduced, as it is easier to work at ground level.

Finally some results are presented on the working week and average working day of a truck driver in local distribution and a container driver working international long distance.

There are few data available, because this is the start of a new project and it has not been possible to generate a random sample of drivers. This should be borne in mind when interpreting the data. The conclusions drawn concern the operations of a particular company, and it would be inappropriate to generalise to transport (companies) as a whole.

The on-board computer in trucks

This section explains the functioning and components of the on-board computer in operation at a Dutch transport company. The need to use computers in the trucks of this company arose from a requirement of a client of the company. This company is, in part, a transporter for a large supermarket chain. This chain, here called A, is the leading food distributor in the Netherlands, with almost 30 per cent of consumer food products sold by supermarkets.

A Dutch law known as HACCP (Hazard Analysis Critical Control Point) forces A to ensure that the products delivered to the consumer meet legal requirements at time of sale. The law, which entered into force on 12 December 1994, is designed to protect against microbiological, chemical and physical hazards in the food industry. It means, for example, that products that should be stored at under 2 °C

must be transported under the same conditions, and records must be kept of the fact that these consumer goods are stored and transported under these conditions. The law obliges the industry to collect data and keep records proving that it meets legal requirements.

For this reason, the transport company started a project of placing computers on board. Information technology facilitates the collection and retrieval of data. Moreover, the company is a modern one that operates in different parts of the transport market. The company management recognises that, if it is to continue operation the near future, it has to adapt to new technologies in an ever-changing market. The company's office is already highly automated whereas operations were not.

The on-board computer project

Initially, a pilot project with six trucks began in July 1997. First, an on-board computer was placed in the trucks. Three trucks were mounted with a computer and a GSM-SMS telephone for data transfer, and three were mounted with a computer and a Mobitex//Mobidem data transfer system in order to compare the performance of the two different means of data transfer.

The pilot project showed that the difference between these two systems was that GSM-SMS operates throughout most of the world and especially in Europe, while the Mobitex system operates perfectly in the Netherlands and Belgium but only partly in Germany and not in other European countries. In France, for example, no companies use the Mobitex system. It is not possible to send and receive messages in countries that are not connected to the Mobitex system.

This test was the basis for a decision to use the Mobitex system for domestic distribution, as data transfer is less costly, while trucks operating throughout Europe and the United Kingdom will mostly be equipped with GSM-SMS telephones for data transfer, which can also be used for communicating by telephone. The Mobitex system can only communicate through the on-board computer.

In December 1997, at the end of the pilot project, management decided to extend the project and ordered 20 trucks to be equipped with the on-board computer system and the ICS RITTS system for the trailer.

At the end of this phase of the project, the company's overall performance was much better than that of its direct competitor, and management decided to equip the whole fleet of over 160 trucks with the on-board computer. On 15 October 1998, the fiftieth on-board computer was delivered with a new truck.

All trucks will gradually be equipped with the on-board computer, first for the container and fresh fruit and vegetables department, then those that operate for the dairy company, and finally those delivering bread and bread-related products.

The on-board computer and the RITTS system

This section explains, in general terms, the different parts of the system chosen by this particular company. In the Netherlands, more and more transport companies are mounting on-board computer systems in their trucks. These are expected eventually to replace the traditional tachograph and have the advantage of recording more aspects of work-related activities in the road industry.

The data collected by means of the on-board computer can be used for:

- salary administration;
- information for management on the performance of vehicles and personnel as input for continuous improvement;
- billing/invoicing;
- on-line data communication, which allows company planners to see on screen when a truck is loaded or unloaded;
- exact registration of delivery times per outlet and/or client;
- registration of the temperature of the transported goods and registration of door openings or closings.

Annex 1 gives an overview of the components of the system. A SIMAC logiq MDA on-board computer is mounted in the truck. For interchange and compatibility of data, the on-board computer is attached to a specially built SIMAC interface. The interface is also connected to the transmitter and receiver, which can be either a GSM-SMS telephone or a Mobitex/Mobidem system. The trailer is built with ICS components and consists of:

- A tempbox, a small box which displays and records the data generated by two or three temperature sensors which are evenly distributed throughout the trailer.
- Door sensors, which record whether the door is open or closed.
- The button reader, a case constructed of plastic on the right-hand rear side of the trailer, which records when a button (an intelligent key) is passed over the reader. The intelligent key has a code, which is registered by the system. Three lamps, white, red and green, are on the side of this box and also on the ATI box (see below). The meaning and operation of the red, green and white light will be explained below.
- An ATI interface, which is also a translating medium between the different components of the truck and trailer.

The ATI interface, a component of the ICS system on the trailer, translates the data between the ICS RITTS system and the ICS on-board computer. However, the company described here chose a different on-board computer and, for this reason, the ATI interface is connected to the SIMAC interface. Otherwise, the two systems would not be able to communicate with each other.

The lights on the side of the ATI box and button reader are used to inspect visually whether the door of the trailer has been opened by an official who is allowed to open the door – personnel of A's distribution centre or the official from the (client) supermarket who checks the arrival of the goods at the supermarket.

It is important to know, as stated earlier, that the goods are transported in a closed circuit. At the distribution centre, personnel of A and the managers of the supermarkets or their delegates where the products are delivered are in possession of the intelligent key referred to as "the button". When a truck and trailer leave the distribution centre, the button is passed over the button reader when the door is closed. The light on the trailer changes from red to green. On arriving at the supermarket, the manager of the supermarket or his delegate passes the button over the button reader. If the system is operated appropriately, the white light will not come on. Only the red and green light will show during normal operation. The red light means that the door is open and the green light means that the door is closed. When the green light and the white light are on simultaneously this means that the door is closed but has been opened unofficially. This means that the driver should be asked why this

has occurred and what happened during transport. The driver should be able to explain why this event occurred.

During normal operation, drivers that work for business unit A read their driver cards out every day. In the early evening, the data are converted on the server situated in the head office. When the data are converted and read into the database, it is easy to produce data files automatically. These files, in reality two files, are automatically uploaded to a mainframe computer of A in the village of P, which is the distribution centre. One file records the time of arrival at the supermarket. It identifies the driver, the truck and the time of arrival at a coded outlet. The second file produces data on the temperature of the transported goods. Every 15 minutes a sample is taken from the temperature recording box (the tempbox). An overview of the file data transfer is presented in Annex 2.

The client of the transport company

The transport company's client is interested not only in the temperature conditions of the transported consumer goods, but also wishes to have three other types of information:

- ***Just-in-time principle***: Trucks are allowed to arrive at the supermarket a quarter of an hour before arrival time and a quarter of an hour after the scheduled arrival time. The client uses a bonus system to reward the transport company when the truck arrives during that half-hour.
- ***Control of the "closed circuit":*** When goods are transported by a third party, the client is interested in the safe and complete arrival of the products. Nothing should be missing, as otherwise there is the question of theft on the part of the transport company, the driver or the personnel of A, such as distribution personnel or personnel employed by the supermarket. This is the reason for choosing a system that controls and records the opening and closing of the trailer door and whether it was done by an official who is allowed to do so.
- ***The temperature of the transported goods***: As explained earlier, the HACCP law obliges the distribution company as well as the transport company to have proof of the conditions under which products are maintained during storage and handling.

The implementation of the on-board computer system in the truck

Once the transport company has decided to change over to a new system of recording data of importance to the company and its clients, there is still a long way to go before all parts of the company use the system fully. The major implementation steps are:

- The management has to decide to change over to a new system.
- The management must show all personnel in the company that they are fully behind the idea and are willing to support the project team in their effort to make the system work.
- The drivers must co-operate to ensure that the data they enter into the computer are correct.
- The planners that guide the trucks and their drivers to their work must co-operate and work with the system. When major repairs need to be conducted on the system, they need to ensure that the truck is on the premises, especially when hired specialists are there to maintain the truck and its system.
- The administrative personnel must co-operate to ensure that the incoming data are used properly for payment of salaries and for preparing clients' invoices.

Thus, many different aspects must be co-ordinated to make the project work. However, this report focuses on the driver's co-operation and on how the on-board computer influences the driver's day-to-day practice.

The driver

During the course of the project, it was realised that there is no single type of driver. Within this one company, there are two kinds of drivers, and even this is a simplification. The drivers that work for client A are different from other drivers in the same company, such as those working for the container department. The differences have three origins:

- ***The working conditions***: The working conditions of the A drivers differ in many ways from those of drivers that work in long haul international goods transport. A driver who handles containers most of the time drives more kilometres than the A driver and does less physical work. The containers are handled with machines and the driver almost never has to load or unload the truck or container. The A drivers drive fewer kilometres and do far more physical labour. They have to load and unload the truck themselves. Therefore, their daily working hours are generally far longer than their driving hours. On average, unloading the goods and loading the empty carriers at an outlet take 45 minutes to an hour, and they average two to three stops per trip.
- ***The social aspect***: The drivers operating in the container section are the "original" drivers. The drivers working in the A department are "the others". (The parent company added the business unit that operates A in January 1997.) Also, the A drivers are local drivers and the drivers in the container department are divided among national and international drivers.
- ***The cultural aspect***: The drivers that operate in the container department are from a different region and are for this reason a different kind of people. Those who work for A were generally raised in a society where the church plays a major role. Those who work in the container department are more the "wild boys", as the international drivers that work throughout Europe are known.

Concerning the implementation of the on-board computer project, the drivers who work for A were more open and co-operative at the start of the project than the drivers who work in the container or fresh fruit and vegetables department. There were many reasons for the difference in co-operation, only some of which will be mentioned here.

First, the A drivers were the first drivers inn the company to operate the on-board computer system and were chosen to do so. Second, they see the need to change over to a new system more than other drivers do. They work in an environment (A) where computers are part of everyday life: company A uses computer technology to pick goods ordered and the outlets (supermarkets) have systems that automatically order every night the products needed for the following day. The drivers feel the need, therefore, for the transport company to adjust to "modern times". They realise that if they want to keep working for the rest of their lives for an important client of the transport company, their working conditions will change. This makes it easier for them to adjust to modernisation. Third, they have colleagues working in the same business unit for a dairy company who had already worked with on-board computers for two years. However, their system is an outdated, while the A drivers work with the latest "state of the art" equipment. Fourth, in daily life, the A drivers are generally more co-operative and are more used to social contact with other colleagues and personnel working for A, not only at the distribution centre but also in the supermarkets that receive and collect the transported goods.

The drivers in the container department are different from their colleagues in the A department. They see themselves as "the wild bunch". They drive international routes or work for the fresh fruit and vegetables department, driving to the United Kingdom and returning other goods to Holland. They view the introduction of the on-board computer system as something of an interference and do not understand the importance of the new system for their future and that of the transport company. They feel that the on-board computer is not for "their kind of work" because they have to be fast and are always in a hurry, so that they have no time to enter information into the on-board computer's database. For them, the telephone, not the computer, is the most important means of communication.

Another important factor is the "big brother is watching you" aspect of the on-board computer. Drivers generally fear that they will lose their relative freedom on board their truck. While this may be true of all drivers, in this company again it is even truer of drivers working in the container department than of those working for the A department. The latter are more accustomed to the constraints imposed on their working day by the need to deliver to A's outlets on the just-in-time principle and the scheduled loading times.

The change in drivers' everyday lives

There are two major changes in the working conditions of drivers working for the A department.

First, with the new distribution centre opened in September 1997, the company introduced a new type of trailer, the "RoRo trailer". This trailer works with a floor that is only 20 cm above ground level. With the modern suspension system, the trailer can be lowered to 10 cm above the road. This means that the time needed for lifting the loading and unloading board is minimised. The driver has simply to lower two boards at the rear of the trailer and can immediately start unloading almost at ground level. Also, the trailer has two side doors so that there are more ways to unload. This saves about half of the loading and unloading time: an activity that takes about an hour with a normal Euro trailer takes only 30 minutes with the RoRo trailer.

Second, there are three major changes in a driver's working day that are due to use of the on-board computer. They involve: the introductory phase, the overall operations of the company, and the logging of the driver's activities and payment of his salary.

When the on-board computer is introduced, there is an extra load on the drivers. During an initial phase, they have to answer the questions that are presented by the on-board computer on their activities and also write their normal daily and/or weekly activity reports, and the tachograph records their actions. This is because the personnel who work with the data produced by the on-board computer system need to become acquainted with this new system. The data and the analysis generated by the on-board computer must be compared with the data the drivers produce on their working day activities.

As mentioned above, the presence of the computer introduces a sense that "big brother is watching you". Although company planners know most of the time exactly where a driver is located and what his activity is at a certain moment, the driver feels watched. When planners can see on a screen what drivers are doing, the fact that they are being followed and watched is more explicit. This psychological aspect is not without meaning for the drivers.

The introduction of computerisation means that certain policies are being changed by the introduction of the on-board computer. For instance, drivers will now be paid according to the parameters of the computer software. This means that the computer programme has a module that calculates the driver's

salary, which uses parameters that have their origin in the Dutch law on working conditions in road transport, referred to as the CAO, a collective agreement between labour and industry.

Results and the driver's working week

This section presents some results based on on-board computer data.

An advantage of the computer system is the fact that data are readily available. The software that is delivered with the system has a report module which produces data from the original database. In addition, there is software for sale that makes it possible to access the database and manipulate the data. Such software allows the operator to answer questions that arise in the organisation and generate reports. However, the relevant data has to be collected previously and recorded in the database. For example, if management wants to know which drivers have a working week of over 90 hours, the answer can be obtained with this additional software.

Because the project is still in a preliminary stage, the full range of data is not yet available. The A drivers have worked the longest with the on-board computer system, and the results concern 30 drivers over a four-week period. Some have a six-day working week, which is "normal" for that category of drivers. Their working hours are presented in Table 1. New drivers are hired under a contract that limits them to a five-day week. Some older drivers have also chosen a five-day week, and their data are presented together with data for new drivers in Table 2. Because the sample is small and because it was not possible to create a random sample, the results must be interpreted with care. Tables 1 and 2 describe A drivers working in regional distribution.

The average working week of drivers who work six days a week is almost 70 hours, including the daily rest periods. Most time is spent loading and unloading the truck. About half their working week is spent on this activity, which involves physical activity, *i.e.* rolling special carriages holding the different products in and out of the truck. On average, an hour a day is spent on rest. The driver with the longest week worked almost 87 hours. The driver with the shortest worked 56 hours.

Table 1. The six-day working week of the A driver
Hours

Driver	Rest during working week	Other activities	Waiting hours	Loading and unloading	Driving hours	Working hours per week
1	7.02	6.07	0.22	20.53	21.29	55.54
2	9.49	8.53	0.00	19.40	25.01	63.23
3	6.01	4.01	0.30	27.40	27.35	65.47
4	3.35	2.24	024	33.04	27.54	67.21
5	4.05	3.36	0.26	35.04	28.53	72.04
6	2.33	4.13	5.59	44.08	29.51	86.43
7	6.15	5.34	0.30	21.06	28.06	61.30
8	5.15	1.52	0.22	33.31	24.55	65.55
9	10.50	3.39	0.50	29.44	29.30	74.33
10	3.50	2.28	0.22	47.53	31.28	86.01
Total	59.15	42.47	9.45	312.43	274.42	699.11
Average	5.55	4.16	0.58	31.16	27.28	69.55
Avg. per day	0.59	0.42	0.09	5.12	4.34	11.39

Nine out of ten drivers working a six-day week exceed the weekly working hours established by Regulation 3820/85/EEC. The drivers have no problem with the maximum daily driving hours because driving is only a small portion of their working day hours.

Table 2. The five-day working week of the A driver

Driver	Rest during working week	Other activities	Waiting hours	Loading and unloading	Driving hours	Working hours per week
1	3.28	2.15	11.45	27.05	22.16	66.48
2	7.48	6.53	0.00	19.24	22.07	56.11
3	5.23	2.57	0.45	24.32	22.17	56.33
4	4.27	3.20	0.22	30.17	22.28	60.54
5	10.07	2.26	0.57	27.36	22.16	63.22
6	5.43	4.32	2.36	30.09	23.08	66.09
7	5.30	4.28	0.58	20.14	22.44	53.53
8	3.22	7.59	0.28	21.11	21.31	54.32
9	5.35	2.56	0.14	28.21	18.04	55.10
10	5.46	5.25	5.30	29.07	26.08	71.51
11	3.49	2.46	3.26	29.30	20.02	59.32
12	5.02	3.28	3.20	28.11	25.12	65.12
13	8.07	2.53	0.23	26.11	25.38	63.12
14	5.49	5.30	0.26	21.37	26.39	60.00
15	7.28	6.32	0.10	18.23	21.19	53.51
16	3.41	1.55	1.19	26.56	27.06	60.56
17	5.35	5.30	0.09	29.19	23.13	63.45
18	5.06	3.00	0.42	32.00	23.05	63.52
19	4.54	1.57	0.28	33.58	24.25	65.41
20	7.27	3.32	1.25	27.46	26.14	66.23
Total	114.07	80.14	35.23	531.47	465.52	1 227.47
Average	5.42	4.00	1.46	26.35	23.17	61.23
Avg. per day	1.08	0.48	0.21	5.19	4.39	12.16

In general, the results in Table 2 show the same picture as those in Table 1, especially in terms of averages. Average waiting hours are a relatively small portion of the working week. The waiting time for these drivers is reduced because they work under a very tight schedule comparable to those in passenger transport, *e.g.* train schedules. The transport company's client obliges them to maintain a "just-in-time" delivery schedule. The driver with almost 12 waiting hours may have been held on "standby" because the planner foresaw problems for a particular day.

For the six-day driver, the average working week of 70 hours is longer than that of the five-day driver, which is 61 hours. The five-day driver with the longest week worked almost 72 hours, while the one with the shortest worked 54 hours. In contrast, the average working day of the six-day driver is shorter than that of the five-day driver. The six-day driver may have a longer working week because of the extra day, but works on average fewer hours per day than a five-day driver.

For comparison, Table 3 presents data on four working weeks of a single long-distance truck driver working in the container department of the same company.

Table 3. The working week of a container truck driver

Driver	Rest during working week	Other activities	Waiting hours	Loading and unloading	Driving hours	Working hours per week
1[1]	30.08	31.03	0.16	3.03	57.56	122.26
2[1]	20.54	25.11	8.21	21.38	45.22	122.10
3[2]	20.27	21.13	3.54	6.55	45.22	97.52
4[2]	18.08	19.35	5.30	5.43	46.31	95.26
Total	89.37	97.02	18.01	37.19	195.11	437.54
Average	22.24	24.15	4.30	9.19	48.47	109.28
Avg. per day	4.04	4.24	0.49	1.41	8.52	19.54

1. Six days.
2. Five days.

The long-distance container driver works an extremely long week, 109 hours on average including rest periods. Even when rest periods are deducted, the working week remains about 80-90 hours, with almost 50 hours spent driving. This driver takes rest periods either when needed or when obliged by the EEC regulation. Also, the container driver's working day is a 24-hour period, whereas the A driver has a working day of 10-14 hours. The A driver goes home every night, while the container driver described in Table 3 rests in the truck during the working week. On average, the container driver works almost 20 hours a day, including rest periods, and spends on average four hours both on rest and on "other activities". The four-hour rest period is within the 24-hour day. The container driver almost never loads or unloads the container (or truck) himself. The average driving hours are almost nine hours a day. This complies reasonably with the EEC rules on driving hours per day.

Conclusion

The introduction of IT and computer technology in a company changes the way the company works. It also puts an extra burden on the company's personnel, both office staff and drivers. As part of the changeover to a new system, drivers, planners and administrative personnel have to be trained. The system needs an operator to work with and maintain the system. The company has to change policies that are no longer possible with computerisation. The drivers have to become acquainted with the system, have to be trained to operate the on-board computer, and have go through a period of double reporting of their activities. The project management has to overcome countervailing pressures from drivers and planners who do not want to work with the new computer system. An introduction by stages is recommended because drivers and planners need attention from the project leader.

Together with the new on-board computer system, this company introduced the RoRo trailer which reduces loading and unloading time by half.

The data presented do not represent a random sample, and it is not possible to draw general conclusions. This report should only be read as a description of the operations of a particular transport company.

The working week of local distribution drivers who work under Dutch law is a long one of 60-70 hours, especially as physical activities such as loading and unloading the truck are a large portion of the working day. It is not unusual for the A driver to work 14 hours a day.

In general, the local distribution drivers comply with Regulation 3820/85/EEC except in terms of the working week. Driving hours are not a problem because these only represent about 40 per cent of their working day.

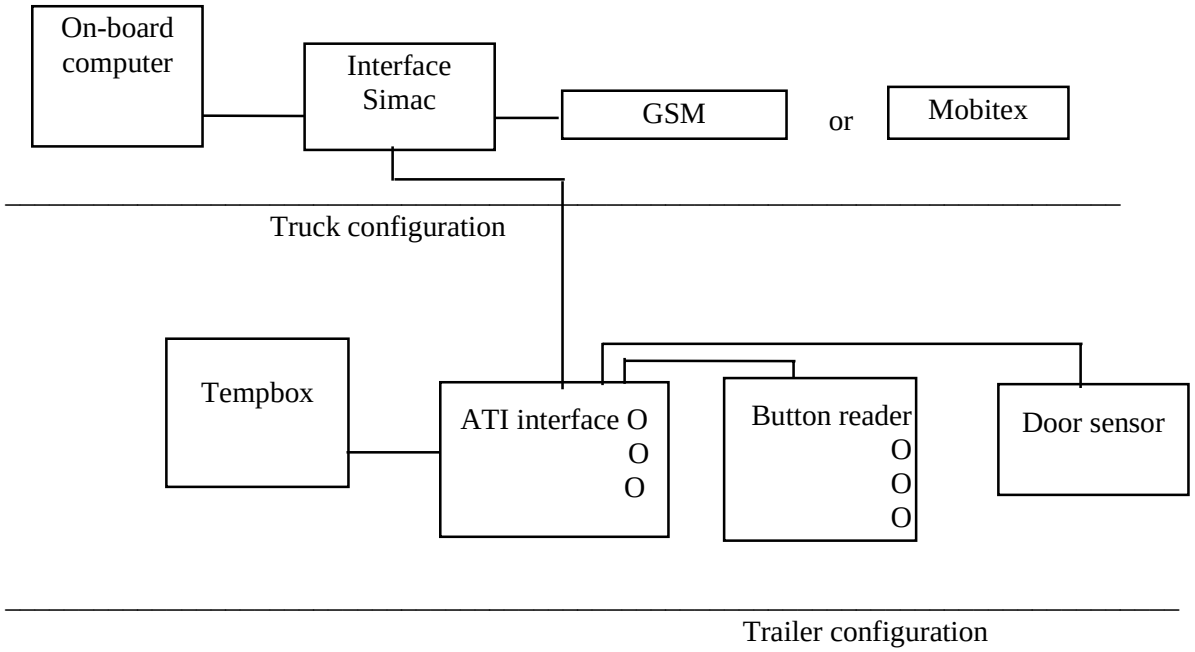
The local distribution driver spends less time driving than other drivers, and spends more time loading and unloading the truck than driving. Driving is in fact only a small part of his working day. At the extreme, the container driver doubles the number of working hours of the local distribution driver. It seems that the upper limits of Regulation 3820/85/EEC still allow the driver to extend his working day and week.

Local distribution driving and international container driving are two different professions. Cultural and work-related aspects add to the differences in these professions. This means that the EEC regulation, which is concerned with drivers in general, does not fit everyday reality. Further studies are needed on the differences in the work of different drivers.

Finally, other questions require answers. Will the on-board computer replace the tachograph? What will the effect be on working hours of drivers? Will the system be less vulnerable to manipulation than the tachograph?

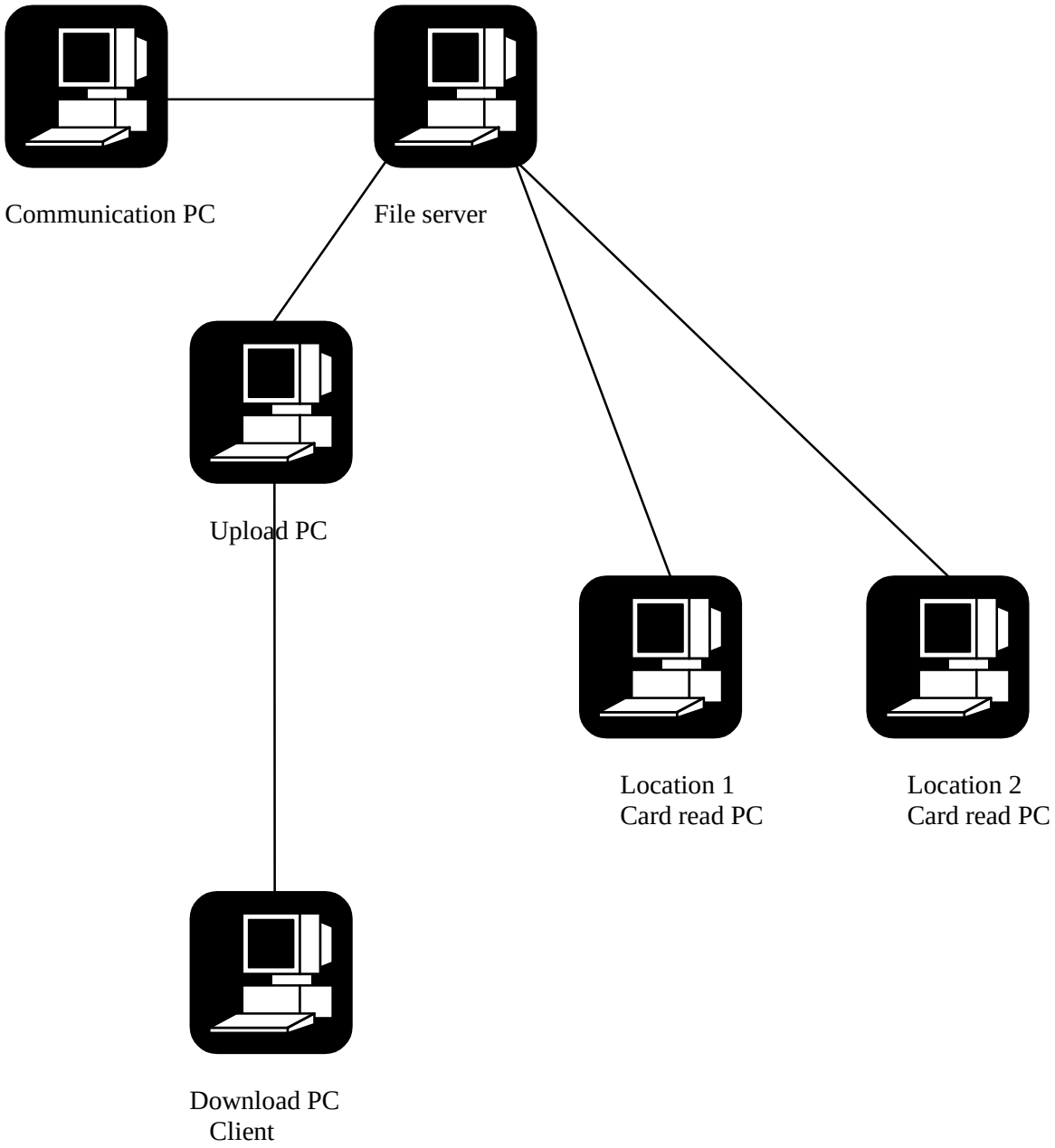
ANNEX 1

ON-BOARD COMPUTER AND RITTS SYSTEM



ANNEX 2

COMMUNICATIONS PC NETWORK



OECD PUBLICATIONS, 2, rue André-Pascal, 75775 PARIS CEDEX 16
PRINTED IN FRANCE
(75 1999 05 1 P) ISBN 92-821-1245-4 – No. 50595 1999