EQUIPEMENT RELATED TO ACCIDENTS INVOLVING HEAVY TRUCK DRIVERS IN QUEBEC WHILE CARRYING OUT JOBS BOTH ON AND OFF THE ROAD

Authors: France Ruest, research professor
Claude Pageon, research assistant
Université du Québec à Rimouski
300, allée des Ursulines
Rimouski (Québec)
418-724-1723

Research title: An analysis of the risk factors involved for long-and-short-haul truck drivers when carrying out off-the-road activities and some suggestions on preventive measures.

Requested by: Association sectorielle transport et entreposage (ASTE)

Organizations that provide subsidies: Ministère des transport du Québec,
ASTE,
Université du Québec.

Research title: The role of mechanical factors in heavy truck accidents in Quebec and elements of prevention.

Organizations that provide subsidies: Fond pour la formation des chercheurs et l'avancement de la recherche. (FCAR)

CONTEXT

The Quebec transportation companies are presently going through their final stage in a process of dereglementation implemented by the federal government: partial elimination of transportation licences pertaining to specific goods and territory. Added to this change is the beginning of free trade with the United States (January, 1989).

We all know that Canadian dereglementation finds its roots in American dereglementation. Concerned about evaluating the results of such a change, a group of Quebec experts (personnel from the Quebec Ministry of Transport, members of the "Association du camionnage du Quebec" carrying out an assignment in the United States in 1986, noticed the following facts:

- the gradual drop in transportation prices;
- the decrease in the role of tarrif office;
- the decrease in vehicule maintenance;
- the drop in truckers' wages;
- the increase in the number of truck owners;
- the increase in the number of bankruptcies;
- the increase in the number of accidents due to poor maintenance,
- inexperience of new drivers and too many hours on the road.

With the aim of preventing such consequences, the provincial government has been putting into effect a set of safety rules since January of 1988. These rules define, particularly, the professional truckers' and transporters' responsibilities concerning maintenance, mechanical repairs and inspection of vehicules; the safety and stowing of loads; the measuring of vehicules; the conditions necessary for the transporting of dangerous goods; the limitations on working hours and driver's licences.

There are three important factorial categories that intervene in all working accidents: 1) technical factors related to equipment, climatic conditions and human factors related to working procedures, training... These accidents can happen to the driver when he is driving, when he is getting into his truck or trailer and other parts of the vehicule; 2) inspection of the vehicule and its load before departing, on the road, and once having reached its destination; moving about and parking the vehicule along wharves and in parking areas; the handling of packages when unloading; 3) the completion of administrative works concerning the custommer and the business...

According to the data from the C.S.S.T (Commission de la santé et de la sécurité du travail du Quebec) an average of one worker out of five, working in the transportation and warehouse sector, suffer annually due to a working accident that can be compensated for by the C.S.S.T. The subsector worker in general local or long haul transportation is the victim of such accidents at a ratio of one to five.

A recent assessment of safety for Quebec truckers (Cloutier,E., Levy.M, 1986), based on existing statistical data, emphasizes 1)the relatively large number of accidents involving truckers,2) the fact that this group has a higher average length of compensation time than that of all ten prime sectors combined,3) and that jobs carried out apart from driving hours are most critical in terms of safety. These accidents total more than 90% of all injuries.

The present document will border on accidents involving truckers and, more precisely, the role of varied mechanical equipment therein. Breaks and defects in mechanical parts can intervene at various levels when road accidents occur. The parts involved are among others: brakes, tires, steering, fifth wheel. A tool or vehicule part may also intervene at various levels at times of accidents involving off-the-road activities.They include the following: running boards, ladders, cab and trailer doors...

The presentation will be given in two parts:

THE ROLE OF THE VEHICULE AND EQUIPMENT IN ACCIDENTS CONCERNING OFF-THE-ROAD ACTIVITIES

THE ROLE OF MECHANICAL FACTORS IN ROAD ACCIDENTS

A short presentation of the problem, the methodology and the principal results will be given for each of these parts.

OBJECTIVES

The research study in progress analyzes the risk factors involved in off-the-road activities. It must allow one to:

- specify the technical and ergonomical problems related to these trucking activities (long and short haul), taking into account the main types of trucks used in Quebec.

- check the significance, for Quebec, of technical specifications stemming from foreign projects (U.S.A., Europe) pertaining to safe access to various parts of both the tractor and trailer.

- propose some divices, equipment, and concrete safety measures to make these activities easier and to test their applicability in real-life working situations, taking into account the factors characteristic of the work setup (type of load, frequency and length of activities) and climatic conditions.

The research study is being carried out on the general transportation sector that is greatly touched (1 worker out of 3) by accidents, as well as on the transportation of bulk forest products such as wood shavings.

METHODOLOGY

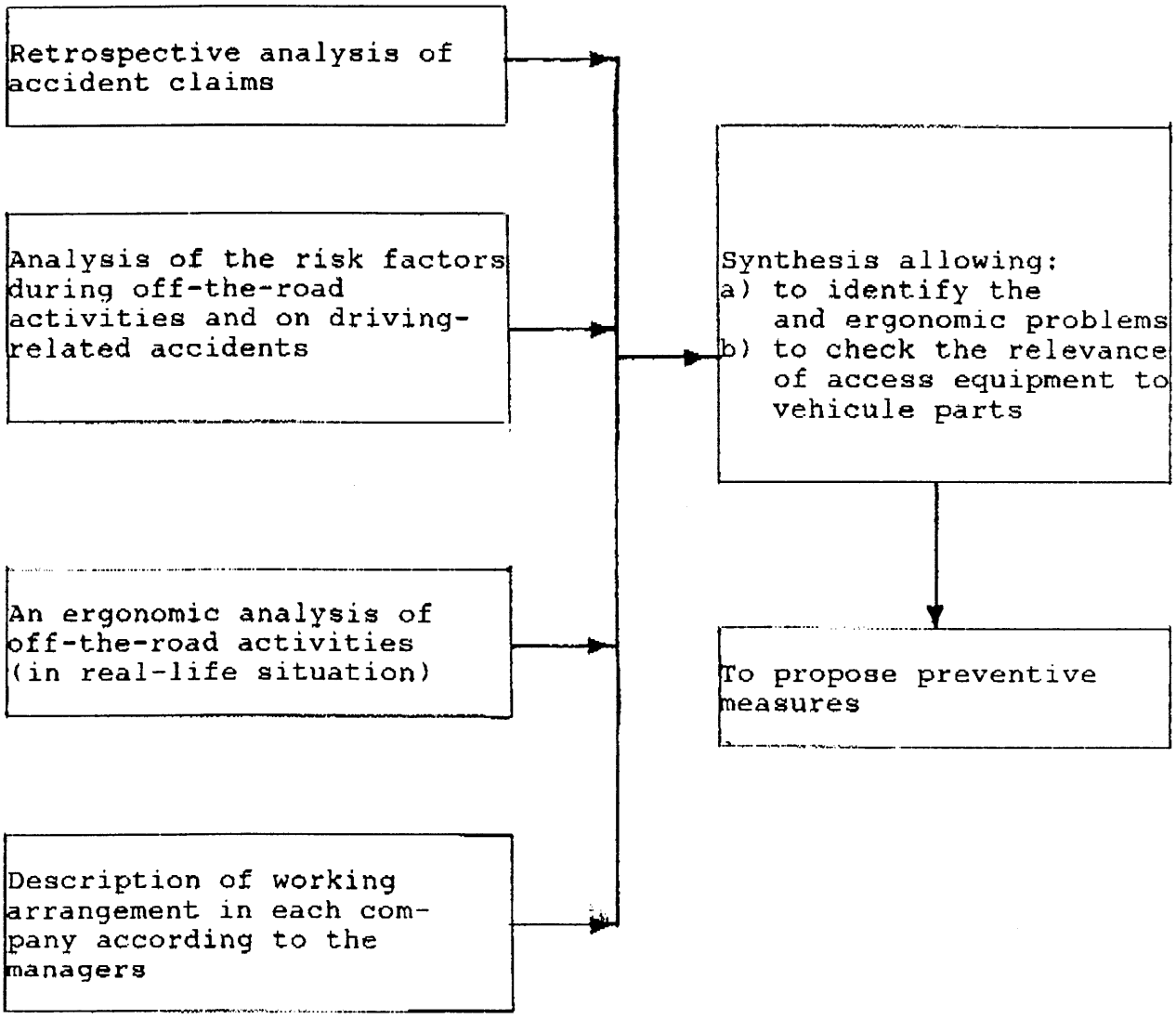
The research should serve to check the hypothesis that the frequency and nature of risks varies in relation to the 4 following parameters:

- kind of run done by a certain type of identified vehicule (tractor trailer - truck - trailer)
- kind of product
- type of delivery (terminal/terminal; terminal/custommer; terminal/several custommers)
- length of runs (short hauls in city areas and long hauls)

The research put forward (see table 1) combines three methods that analyze the risk factors involved in related activities: a retrospective analysis phase of accident claims from 4 companies (2 from the general sector and 2 from the bulk sector); on the other hand, an analysis (using questionnaires and interviews) of examples representative of injured and uninjured drivers from

Table 1

Outline of the Methodology



each company; and finally, an analysis of drivers at work, taking into account each type of truck and trailer as well as the season concerned (the same drivers being observed both winter and summer).

The activities of each driver are observed successively and analyzed according to the criteria used to make an ergonomic analysis of work (posture, exerted efforts, use of visual information, length and frequency of each activity, etc...) and according to principal places where these activities are carried out (departures and arrivals at transportation terminals; during the run).

To integrate the results of these 3 methods used for analyzing risk factors, it is important to have a description of the work setup in each of these companies to know: 1) the schedule systems used to determine the driver's job, the loading plans and the driver's assignments on the road; 2) the types of goods transported and the tools and equipment used by the driver when carrying out his off-the-road tasks; 3) the types of equipment used when arranging and putting signals on loading and unloading places; 4) working methods and procedures prescribed by the company; and 5) training received, remuneration policies, etc...

The study will be extended over a 2-year period, as of June 88, for reasons concerning methods, and in the light of obtaining practical results.

PRELIMINARY RESULTS

The present document is basically concerned with general transportation carried out on short and long hauls by tractor trailers and trucks (i.e. sector-based data) . The data have been obtained from two companies voluntarily participating in this study that is now in progress since May of 88 and is to resume for more than another year. The results will be presented in percentages in order to assure anonymity for the companies involved. However, the analysis of accidents is concerned with nearly 200 accident claims. The forms used were mainly those filled out by both the drivers and the company when making out claims for compensation to the "Commission de la sante et de la securite du travail du Quebec. It therefore entails accidents that have been, or might be, compensated for by the C.S.S.T. The other sources of information allow one to specify the diagnosis, the length of time absent from work or the circumstances that brought about the accident.

In order to allow for a comparison within the profile of accidents, table 2 presents the age span of all workers from both participating companies.

Table 3 shows the frequency of each of the following characteristics of working accidents:

length of time absent
activity at the time of the accident
site where the accident took place
equipment or material involved
injured part of the body
type of accident
nature of the injury.

We have observed that these accidents result in an average of 1 to 10 days of time absent from work in 45.5% of all cases, and an average of 11 to 20 days in 13.2% of the cases.

These accidents happen when the trucks are being loaded or unloaded, or in the handling of packages and objects (48.1%). Operations involving the vehicule (hitching up, unhitching, maintenance, getting in and out of the vehicule, opening and closing doors) cause 31.2% of these working accidents.

The accident happens mainly on the custommer's premisses (51.8%), in his yard (14.8%), or on the wharf (14.8%). The object being handled (17.5%) becomes the causing agent of injury. The vehicule and equipment being used by the driver (32.1%) represents the other agents.

The main parts of the body affected are, in order of importance; the back (28.6%), the legs (21.2%), the trunk (12.7%) and the fingers and toes (7.4%). They are affected during an overexerted physical effort (30%), falls (10.1%) and slips (11.1%) or by being struck by the object (21.7%). The part of the body that suffers a sprain (16.9%), a bruise (11.6%) or a serious pain (23.8%).

It is obviously the crossed analysis of various characteristics in accidents that provides the richest source of information. This analysis has been put under way. Table 4 shows some of its interesting results. The parts of the vehicule that are responsible for falls and slips are the cab and trailer doors, the tank, the trailer and cab as such (10.8%). Those hitting or bumping into the driver are the tank, the dollies (5.2%).The tools and equipment used by the driver that cause falls and slips

Table 2

Demographic data (in percentage)

Age span	Recurrence
18 to 25	1
26 to 35	20
36 to 45	37
46 to 55	30
56 to 65	11
unknown	1
Total	100

Table 3

A study on accidents during off-the-road activities
(percentages, recurrence)

Time absent	
1 to 10 days	45.5
11 to 20 days	13.2
21 to 30 days	2.6
31 to 40 days	2.1
41 to 50 days	1.6
50 days	2.6
Unknown	11.2
0 days	21.2

Activity at the time of the accident	
Driving	4.2
Loading	11.6
Unloading	22.8
Handling	13.7
Hitching and unhitching	4.7
Getting in and out of vehicule	15.3
Maintenance	1.2
Opening and closing of doors	10.1
Unknown	16.4

Place of accident	
Client's yard	14.8
Client's wharf	14.8
On the road	7.4
At the company	20.6
At the client's place	22.2
Unknown	20.2

Equipment or material agent	
Box + package/furniture	17.5
Trailer/truck	26
Fifth wheel/door	6.4
Equipment used by the driver	44.8
Unknown	5.3
Others	

Body part injured	
Head	4.8
Trunk	12.7
Arm	9.5
Leg	21.2
Fingers and toes	7.4
Back	28.6
Unknown	23.2

Type of accident	
Fall	10.1
Slip	11.1
Bump into an object	5.3
Struck by	16.4
Jammed in/by/under	6.9
Fall while getting in vehicule	6.3
Getting up/lifting/ carrying	7.9
Body movement	20.6
Unknown	15.4

Nature of injury	
Sprain	16.9
Cut	1.7
Bruise	11.6
Tear	4.2
Crushing	3.2
Pull	3.2
Fracture	3.1
Hernia	
Lumbago	4.2
Pain/hurt	23.8
Unknown	28.1

are (2.5%) carts, hand trucks, and forklifts. He can be hurt by mechanical or electric motors operated by somebody else(1%), or by the loading plate (1%).

Our researchers have accompanied truck drivers for the entire run on several occasions since July of 1988. The objectives were the following:

- to calculate the time it takes for the driver to carry out his various tasks;
- to take note of the driver's jobs, their variations and the factors that may have an effect on their progress;
- to analyze precisely the activities leading to a potential accident;
- to analyze the risk factors involved in these activities.

Several observational instruments have been divised and checked; a portable computer is used to estimate the time it takes to carry out each activity, a camera is used for taking pictures, and charts are set up to record each operation.The preliminary analysis is in progress.

A series of photographs were taken during this research with the aim of gathering information about the equipment used by the driver (custommer or company), and of determining the risk factors and working postures. These photographs were arranged in the following order:

- mechanical inspection before departure;
- getting in and out of the cab and trailer;
- the parking;
- the handling of packages;
- the equipment used by the driver, particularly the loading plate;
- the hitching and unhitching of double road trains.

The following pictures illustrate some pertinant situations.

Table 4
Equipment and tools involved and type of accident
(in percentage and total)

Type of accident	Equipment and tool TRUCK	CART	DOLLIES	MOTOR (mech./ele.)
Fall		.5	.5	
Slip	2.2			
Collision	.5		2.2	.5
Struck by object			.5	
Jammed in/between/under				.5
Body movement			.5	
Getting out of vehicule	2.8			
Getting up/lifting/carrying			.5	
Total	3.5	.5	4.2	1.

Type of accident	Equipment and tool HAND TRUCK	DOOR (CAB)	PLATE	DOOR (trailer)	TRAILER
Fall	.5			2.2	.5
Slip	.5	.5		2.2	2.2
Collision			.5		.5
Struck by object			.5		
Jammed in/between/under			.5	.5	
Body movement			.5	1.6	1.6
Getting out of vehicule					
Getting up/lifting/carrying					
Total	1.	.5	2.	6.5	4.8

Type of accident	Equipment and tool TANK	FIFTH WHEEL	FORKLIFT
Fall	.5		.5
Slip	.5		
Collision			
Struck by object	2.2	.5	
Jammed in/between/under			
Body movement		.5	2.2
Getting out of vehicule			
Getting up/lifting/carrying			
Total	3.2	1.	2.7

THE ROLE MECHANICAL FACTORS PLAY IN ROAD ACCIDENTS

The mechanical working order of a vehicule at the time of an accident is the result of a series of decisions in relation to management rules of the vehicule owner together with events encountered on the highway.

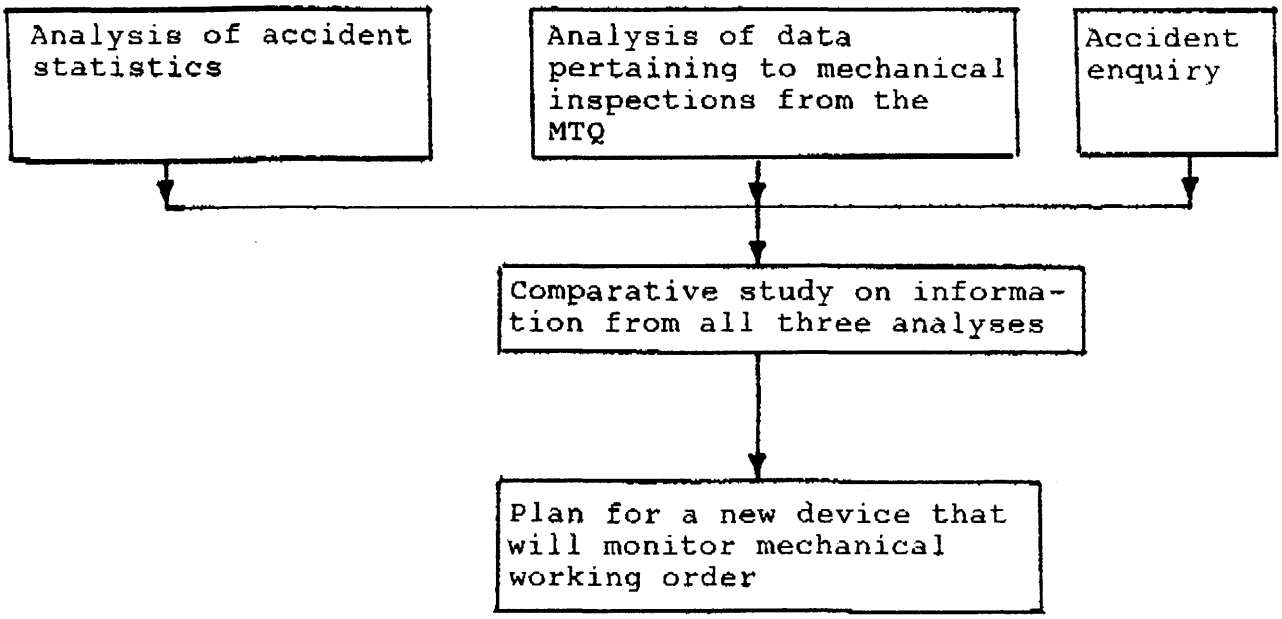
The study completed and published in 1987 aims to verify the following hypotheses:

- a relatively significant proportion of the fleet is in poor working order.
- older vehicules are in worse shape than newer ones;
- faulty mechanical systems play a predominant role in accidents;
- mechanical systems that are most likely to be faulty can easily be checked by the driver or another company employee at the time of routine inspections;
- the mechanical working order accounts for a relatively significant propotion of all trucking accidents;
- older vehicules are more often damaged than newer ones.

The use of several sources of data together with various approaches in the field of safety and in the particular context of highway transportation is of utmost importance in discovering the root causes of all accidents pertaining to transportation. To avoid being bias in our findings we have used three sources of information. Table 5 shows the methodology used by the employee.

Table 5

Methodology outline



The statistics concerning analyzed accidents (1,163 accidents) are based on data gathered by the " Regie de l'assurance Automobile du Quebec ". They refer to accidents, involving heavy trucks, that occurred in 1985 and were taken from police records. Data related to mechanical inspections (887 double road trailers and heavy trucks were gathered from various inspection procedures led by mechanics and inspectors working for the "Regie". The data were compiled in 1986 during "heavy truck" programs, "blitz" programs, "double road train" programs, and "old wreck" programs. There were 13 accidents involving heavy trucks that were all carefully inspected by expert mechanics.

The principal mechanical systems known as accident factors are: brakes, headlights and signal lights, tires and fifth wheels. These are also the systems that are most often found to be faulty at times of diverse inspections, with very few exceptions. The suspension also proves to be a faulty system once a mechanical inspection has been carried out. The relative significance of this system as regards accidents has not been founded due to the limited nature of police reports. The results of an analysis of various sources of information concerning mechanical systems are shown in table 6.

The mechanical breakdowns are not the result of a defect present at the time the vehicule was purchased, but seem to be mostly due to the wearing down of mechanical parts after extended usage.

It is impossible to state clearly the number of mechanical defects involved in accidents in Quebec. In fact, it is easier demonstrate to the effect of the mechanical state when a part is found to be the direct cause of an accident. The connection is not so obvious when the defect is a contributing factor. Our analases focus on the role the mechanical working order of the vehicule plays in accidents.

Until recently, the amount of surveillance with regard to the working order of heavy trucks has, on the whole, been rather minimum. Various arrangements have been made by the government of Quebec to reinforce inspections on heavy vehicules. It includes without doubt pertinant and indespensible measures concerning highway safety. However, these arrangements will have to be included in a movement involving all intervening agents concerning the transportation industry. It is now important to incite a mentality that lies beyond all coercive regulations. Truck drivers must be considered as having an important role to play in this effort to reduce the risk of accidents involving heavy vehicules and with regard to other road users.

Table 6: Comparaison between mechanical systems responsible for accidents ans systems declared nonstandard after mechanical inspections.

Order of importance	1	2	3	4
Systems identified as factors in accidents	Brakes	Headlights/ signal lights	Tires	Trailer hitches
Main systems classed nonstandard on vehicules that passed the inspection				
Tractor trailers and trucks	Lights and signals	Brakes	Accessories and electrical	Tires/ wheels/ dollies, suspension
Trailers and semi-trailers	Tires/ wheels/ dollies, brakes	Suspen- sion	Body	
Converter dollies	Suspen- sion	Brakes		
Main systems that are nonstandard on vehicules considered hazardous				
Tractor trailers and trucks	Brakes	Lights and signals	Accessories and electrical	Suspen- sion
Trailers and semi-trailers	Brakes	Tires/ wheels/ dollies	Suspen- sion	

BIBLIOGRAPHIE

CLOUTIER, E., LEVY, M., Les problèmes de sécurité des camionneurs de sécurité des camionneurs, Rapport de recherche IRSST, Montréal, 1986, 70 pages et annexes.

RUEST, F., CHAUMEL, J.-L., LEBEL, D., LAFRANCE, L.. Le rôle des facteurs mécaniques dans les accidents de camions lourds au Québec et éléments de prévention. Rapport de recherche, Université du Québec, Rimouski, 1987. 257 pages.

SESSION 4 – VEHICLE/PAVEMENT INTERACTION 1

Chairman: John Woodrooffe, National Research Council

Speakers

1. **Axle Group Spacing: Influence on Infrastructure Damage**
   J.J. Hajek, A.C. Agarwal, Ministry of Transportation, Ontario

2. **Dynamic Pavement Loads Measured for a Variety of Truck Suspensions**
   C.G.B. Mitchell, L. Gyenes, Transport Road Research Laboratory, England

3. **The Effect of Alternative Heavy Truck Suspension on Flexible Pavement Response**
   J.K. Hedrick, K. Yi, University of California, Berkeley

4. **Suitability of Alternative Pavement Roughness Statistics to Describe Dynamic Axle Loads of Heavy Trucks**
   A.T. Papagianakis, Memorial University; J.H.F. Woodrooffe, P.A. LeBlanc, National Research Council

5. **High Priority National Program Area Overview**
   W. Kennis, Federal Highway Administration