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UMI
EVENT CASCADE ANALYSIS: IDENTIFYING PROXIMAL AND DISTAL HUMAN FACTORS IN PREVENTABLE MOTOR CARRIER ACCIDENTS

DISSERTATION

Presented in Partial Fulfillment of the Requirements for
the Degree Doctor of Philosophy in the Graduate School of The Ohio State University

By
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The Ohio State University
1998

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Graduate Program in Labor and Human Resources
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ABSTRACT

This study improves the accuracy and depth of knowledge regarding the link between preventable motor carrier accidents and the more remote factors that underlie them. Unlike most motor carrier accident research, this project used an inductive methodology termed event cascade analysis. Event cascade analysis is a qualitative technique that allows the researcher to identify remote factors residing in the distal environment that triggered preventable motor carrier accidents.

The data for this study consisted of 204 accident files obtained from the Oregon Department of Transportation. Discrete event cascades were developed for each accident sequence. Based on these event cascades, a conceptual model was formulated linking factors in the proximal environment to distal origins. Four proximal factors were routinely associated with preventable accidents: imprudent decision-making, failure to heed a directive, compromised physical condition, and failure to make an observation. These four proximal factors were traced to six distal factors: driver experience, training programs, trip scheduling, occupational socialization, task monotony, and government regulations. These findings are discussed in terms of the human factors literature, a widely accepted body of knowledge dealing with accident causation and prevention. The human factors perspective validates the qualitative approach used in this project as appropriate for
identifying obscure, contributory factors that otherwise might be overlooked in quantitative motor carrier accident research. These contextual factors are significant in the development of effective public policy designed to enhance the safety of motor carrier operations.
For Lyman
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Like most accomplishments in life, I alone cannot take credit for this document’s existence. Numerous people played critical roles in its creation. In fact, the document’s developmental history is itself illustrative of the quintessential event cascade. Had my sister, Lexie Kekoa, not given me Michael Crichton’s *Airframe*, I might never have embarked on this project. Crichton’s literary notion of an “event cascade” provided the intellectual trigger which launched this project. Thank you, Lexie.

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overlooked.

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VITA

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CHAPTER 1

INTRODUCTION

Statement of the Problem

Motor carrier safety has become an increasingly frequent topic of academic inquiry since deregulation of the trucking industry in 1980. Specifically, indicators of motor carrier safety such as accident rates have been used as the dependent variable in at least forty studies published between 1984 and the present. In the majority of this research, the designated unit of analysis is the firm, with the researcher attempting to explain accident rate variations as a function of public policy decisions like the deregulation of the industry itself or reductions in federal funding available to monitor motor carrier operations.

Despite this plethora of research, virtually no agreement exists regarding the effects that such policy changes have had on motor carrier safety. For example, the conclusions drawn by researchers regarding deregulation's impact on motor carrier safety run the spectrum from the claim that it actually enhanced safety (Alexander, 1992) to the assertion that it contributed to increasingly unsafe conditions (Kraas, 1993). Still others hold that the evidence fails to yield any conclusive findings (Phillips and McCutchen, 1991). Appendix A, Figure 15 provides an overview of this as well as other literature dealing with motor carrier safety issues.
The predominant methodological approach used in the motor carrier safety studies detailed in Appendix A is quantitative. The preference for that approach is understandable since an abundant body of numeric data compiled and maintained in machine-readable format by government agencies is accessible at a reasonable cost. Large data sets such as the MCS-32, MCS-50, and the MCMIS Accident Files, all compiled by the Federal Highway Administration, serve as the primary information bases for the majority of researchers engaged in assessing motor carrier safety. These data sets contain detailed information about motor carrier operations and accident histories. Additionally, motor carrier operating characteristics and extensive financial data are published annually by the American Trucking Association based on reports carriers are required to file with the U.S. Department of Transportation. These data are also readily available for purchase.

Interestingly, however, even researchers relying on uniform data sets provided by the same agency come to radically different conclusions depending upon the sample of carriers selected and the mix of independent variables included in the model. For example, Bruning (1989) analyzed motor carrier accident rates based on data from MCS-50T files in an attempt to tie firm profitability to safety performance. He included the presence of owner-operator drivers in his model because of an earlier finding by Corsi, Fanara, & Roberts (1984) statistically linking owner-operator drivers to a higher accident propensity. The Corsi, et al. study relied upon the MCS-50T just as Bruning had, yet Bruning found no significant relationship between the use of owner-operator drivers and higher accident rates.

Among other causes, failure to replicate statistical outcomes can occur when an quantitative model is expanded to include additional independent variables, and the
inclusion of these variables alters or obliterates the relationships that existed in the original model (Wimberley, 1988). To illustrate, consider research conducted by Hunter and Mangum (1995) that attempted to establish a link between motor carrier economic well-being and preventable accident rates. Their research drew from the MCS-50T data files just as the previously discussed Bruning and Corst, et al. studies had done. Agreeing with those researchers that owner-operator drivers likely contribute to higher accident rates, they included a continuous variable in their model to test that hypothesis. Their results were statistically insignificant. Based on some compelling arguments about owner-operator behavior at financially weakened carriers, they were convinced this statistical outcome was an anomaly. Isolating a sample containing only those firms that relied heavily on owner-operator drivers, they reanalyzed the data. Those results emphatically supported the hypothesis that owner-operators at financially distressed firms were statistically linked to higher accident rates.

The fact that the data sub-set containing exclusively owner-operator firms yielded significant findings is an indication that the original model failed to adequately specify the complexity of the relationship between owner-operator drivers and accident rates. Owner-operator drivers are not involved in accidents at a higher rate than are other types of drivers merely because they are owner-operators. Their accident propensity appears to increase significantly under very specific conditions, such as when their services are contracted by carriers experiencing financial difficulties.

Complexities of this sort create methodological challenges for quantitative researchers. In situations like the one just presented involving owner-operator drivers, the researcher must expand the model to include interaction terms in order to capture the
intricacy of the phenomenon being studied. Interaction terms are necessary when the influence of an independent variable $X_1$ (e.g. carrier reliance on owner-operator drivers) on a dependent variable $Y$ (e.g. carrier accident rates) is contingent on the status of a second independent variable $X_2$ (e.g. carrier operating ratios). To mathematically model such conditions, one must create an interaction term $X_1X_2$, the value of which is derived by calculating the product of $X_1$ and $X_2$ for each observation. Clearly this product is a linear combination of $X_1$ and $X_2$, and hence the interaction term $X_1X_2$ is highly correlated with the multipliers used to create it, which in this case are the two independent variables $X_1$ and $X_2$. When independent variables are highly correlated, the regression coefficients become extremely unstable due to the effects of multicollinearity (Wolfe, 1989). From a practical standpoint, statistical tests performed on regression models exhibiting unacceptable levels of multicollinearity may yield insignificant results when in fact the relationships being tested are significant. In the Bruning study previously mentioned, the author detected the presence of multicollinearity among several of the independent variables. Perhaps this mathematical "Achilles heel" explains the lack of statistical support Bruning found for his hypothesis that increased utilization of owner-operator drivers leads to higher accident rates.

Further problems arise when hypothesized relationships are predicated on little more than speculation. By definition, hypotheses testing is indicative of an *a priori* or deductive research approach (Vogt, 1993). Sound deductive research methodology requires that hypothesized relationships be derived from a well-established body of theoretical literature (Creswell, 1994). The body of research at issue here frequently failed to meet this accepted standard. In many studies, no reference to any established body of theory which
would have justified the hypotheses being advanced was offered (i.e. Moses and Savage, 1994; Moses and Savage, 1992; Stein and Jones, 1988; Corsi, Fanara, and Roberts, 1984). In others, theoretical references were mentioned but no effort was made to explicitly link their conceptual precepts to the empirical relationships being posited (i.e. Lin, Jovanis, and Yang, 1993; Alexander, 1992; Bedlock and Capelle, 1987).

Legitimate research questions can also be derived inductively through direct observation of the phenomena in question (Kidder, 1981). However, since the majority of academics conducting research in this area are experts in disciplines such as economics, industrial relations, sociology, and business administration, with little or no applied knowledge of the motor carrier industry, they could not fall back on inductive reasoning to formulate viable hypotheses. The result, then, is that hypotheses were all too often the product of “arm-chair theorizing” with no sound conceptual or experiential basis for their advancement.

Subsequent testing of ill-conceived hypotheses leads to research conclusions that are acutely vulnerable to challenge. Let us take, for example, a study conducted by Moses and Savage (1992) in which the researchers attempted to explain variations in firm accident rates using a model containing forty-nine independent variables, two of which pertained to the type of commodity sampled carriers hauled. The basic rationale for the inclusion of these two variables was the authors’ belief that the more valuable the cargo, the more sensitive shippers would be to safety. In a subsequent study published in 1994, Moses and Savage added two additional independent variables to the model presented in their 1992 article, for a revised total of fifty-one predictors. One of these new independent variables differentiated between for-hire and private carriers. The explanation offered for the
inclusion of this variable was the authors' opinion that private carriers would be more concerned with safety since these firms' own the cargoes that would be damaged were accidents to occur.

With regard to both of these hypothesized relationships, one must ask if such reasoning makes substantive sense given the context in which motor carrier operations take place. In reality, drivers are the only persons truly capable of preventing or contributing to a truck-at-fault accident, excluding those collisions attributable to mechanical defects unknown to them. As such, any hypothesized linkages between firms' characteristics and accident rates must be explained in terms of the influence those factors had on driver behavior. In their article, Moses and Savage assume that because carriers or shippers are concerned about damage to costly cargo, drivers who haul those loads are equally concerned, and moreover, that these drivers exercise more care when transporting high-priced commodities, which in turn results in fewer accidents. To support this claim, one would need evidence that drivers behave more cautiously under such conditions than when hauling less valuable cargo. These authors fail to provide us with that evidence.

In truth, several equally plausible explanations could be constructed that conceptually link accident rates to commodity type. For example, based on a study commissioned by the National Highway Traffic Safety Administration (1993) which noted that a load's center of gravity plays a major role in truck accidents, one could hypothetically tie accident rates to commodities hauled using the following logic: all commodities have unique physical characteristics and those characteristics dictate the way in which freight is loaded. Some commodities, such as U.S. coinage, are very dense. Hence, to remain in compliance with legally mandated highway weight limitations, those
products are stacked directly on the trailer floor to a depth of less than two feet. As such, the center of gravity for semi-truck combinations transporting coins is much lower than would be the case for a semi-truck combination transporting a load of swinging meat suspended from rails affixed to the ceiling, over thirteen feet from the ground in a refrigerated trailer. In this example, the conceptual linkage is readily verifiable. One can merely ask truck drivers about their experiences with high versus low center of gravity loads and discover whether or not they clearly understand the safety implications. High center of gravity loads force drivers to reduce speeds on curvy highways or run the risk of tipping vehicles on their sides.

Another likely explanation for the embryonic hypotheses evident in this literature is that the researchers' primary objective was not to explain accident rates per se, but rather to use variations in those rates as denoting the success or failure of public policy. Any erosion in motor carrier safety that could be statistically linked to operational changes triggered by deregulation, for example, would call into question the wisdom of the policy decision itself. Conversely, the lack of such linkage would imply the policy's soundness.

Regardless of the position taken, the quantitative models researchers developed expressly sought to explain accident rates in terms of *distal* factors such as carrier profitability or financial distress, influences far removed from the accident occurrences themselves, rather than in terms of *proximal* factors such as driver experience or road conditions. Although the conceptual rationale for including proximal factors in an accident prediction model is fairly obvious, the logic tying distal ones to accident rates requires a thorough understanding of the context in which accidents ultimately result before these linkages can be articulated cogently (Achen, 1982). Apart from speculation, the way in
which the independent variables specified in these studies influence truck driver behavior
to the extent that carrier accident rates are affected remains conceptually unspecified
despite that established theories from economics, industrial relations, political science,
sociology, and social psychology would provide sound theoretical frameworks for these
relationships.

It is the researcher's job to justify why such relationships are being hypothesized in
the first place. Failure to base these justifications on judicious reasoning leads to
meaningless quantitative outcomes. Illustrative of this point is the way in which the
commonly-used dependent variable, motor carrier accident rates, is typically
operationalized. Of over forty publications attempting to explain variations in motor
carrier accident rates or safety records, only four differentiated between a carrier's total
accident rate and a rate based only upon those accidents which a carrier's employees or
agents could have prevented (Chow, 1989; Kraas, 1993; Traynor and McCarthy, 1993;
Hunter and Mangum, 1995). The distinction between a carrier's preventable accident rate
and its overall accident rate is fundamental when one is asserting that changes in these
rates are a function of carrier attributes such as financial well-being or driver recruitment
policies. Actually, numerous motor carrier accidents occur irrespective of firm solvency,
policies, or decisions made by its employees or agents, including those made by the truck
driver at the time of the collision. For example, a carrier's vehicle could be struck at a blind
intersection where a passenger vehicle failed to yield the right-of-way. This accident is not
preventable because it is not foreseeable. In fact, it can be viewed as a random occurrence
that just as easily could have involved a different carrier's vehicle traversing the same

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stretch of highway. As such, one logically cannot expect to predict or explain such accidents on the basis of many models generated in the research being discussed here.

**RESEARCH OBJECTIVES**

Given the cornucopia of both conceptual and methodological weaknesses exhibited in this body of literature, we appear to know very little about what distal factors legitimately can be linked to motor carrier accident rates. This study seeks to improve the accuracy and depth of our knowledge regarding the link between preventable motor carrier accidents and the more remote factors that underlie them. Linking proximal and distal factors is a fundamental part of the research process when one is attempting to analyze complex system failure (Reason, 1990). I intend to formulate and utilize a qualitative research methodology which I refer to henceforth as event cascade analysis. This methodology is a hybrid approach combining elements of Glaser and Strauss' (1967) grounded theory, Strauss and Corbin’s (1990) conditional matrix, and Yin’s (1994) case study methodology. Event cascade analysis is essentially designed to connect a micro-level event to increasingly macro-level explanations.

While other methodologies with similarities to event cascade analysis have been developed (See Woods, Johanneson, Cook, and Sarter, 1994; Cook, Woods, and Miller, 1998), most advocate data collection through field observations of practitioners, rather than through archival data, as is the strategy in this project. Nevertheless, the underlying logic shared by these methodologies, including event cascade analysis, is that the researcher must understand proximal events in terms of the distal environment in which
they transpired. Reason (1990) articulates this notion by referring to the proximal environment as a complex system's *sharp end.* The sharp end identifies where the consequences of system failures manifest themselves. The distal environment in Reason's conceptualization is referred to as the *blunt end.* The system's blunt end encompasses managers, designers, policies, technological choices, and so forth. The significant parallel between Reason's model and event cascade analysis is that both advocate the necessity of understanding practitioner behavior in the context of constraints and resources imposed by a broader system.

Event cascade analysis begins with the identification of all factors in the proximal environment that directly contribute to a particular event. Proximal factors in preventable motor carrier accidents include elements such as driver fatigue, excessive vehicle speed, or mechanical defects. Through an iterative process, the researcher systematically links verifiable proximal factors to underlying distal factors. Distal factors are those conditions not evident at the accident scene, but that nonetheless play a significant role in creating the environment in which the accident results.

For instance, let us suppose an investigation determined that the proximal factor triggering a particular accident was driver fatigue. The search for distal factors would be initiated by asking why was the driver fatigued. Suppose further that the accident report indicated the driver was cited for non-compliance with the federal hours-of-service regulations. The researcher would then ask why the driver was out of compliance with those regulations. Through further investigation and contingent on data availability, the researcher might determine that the carrier's own policies or practices contributed to the
driver's decision to violate the hours-of-service regulations. This line of inquiry would continue until no additional linkages to macro elements could be established.

To assist with the accurate development of these event cascades, I intend to rely heavily upon eleven years of personal involvement in the motor carrier industry, nine and a half of those spent driving semi-truck combinations in long-haul operations. I began working in the trucking industry in 1974 for a less-than-truckload carrier based in North Salt Lake, Utah. This firm provided scheduled service to southern California, operating double and triple trailer combinations. Between 1975 and 1977, I was employed by two different family-owned trucking firms based in Utah, one a flat-bed and dry van operation serving eleven western states, the other a forty-eight state refrigerated carrier. In 1977, I purchased the first of two semi-tractors and two refrigerated semi-trailers, entering the owner-operator ranks where I remained until 1983. During my years as an owner-operator, I leased my equipment to for-hire carriers domiciled in Utah, Wisconsin, and Washington. Subsequently, I operated independently, brokering my own loads. Finally, I spent a year and a half serving as a fuel tax and licensing administrator for two trucking firms in Washington State while I was earning my undergraduate degree. My years of industry experience include over-the-road as well as administrative duties, encompass virtually all vehicle configurations, involve the transportation of a wide range of commodities, and reflect operations conducted in a variety of employee and agent relationships including union, non-union, and owner-operator, both leased and independent.

Researcher expertise is recognized as an invaluable tool among scholars who use qualitative methods (Strauss and Corbin, 1990; Creswell, 1994). Mernam (1988) notes that
the researcher is the primary instrument for data collection and analysis. Indeed, complete familiarity with the subtle nuances of the topic to be investigated is usually considered a strength, not a detriment (Locke, Spirduso, and Silverman, 1987). Based on such encouraging endorsements, I will utilize my experiential knowledge about the motor carrier industry to construct accurate event cascades by analyzing archived investigative accident reports filed by law enforcement officers. In those instances where archival data is incomplete or insufficient, my practical experience at the trucking industry's sharp end will be drawn upon to infer linkages between the proximal and distal environment. Event cascades will further be verified by colleagues familiar with transportation issues and by practitioners working in the motor carrier industry. As idiosyncrasies in a carrier's event cascade aggregation emerge, they will reveal factors in the distal environment that can defensibly be included in explanatory models. Through this process, the inconsistencies in previously-investigated relationships will be clarified, modified or eliminated. Furthermore, new linkages will be revealed that can enhance the explanatory power of quantitative models formulated in the future.

SIGNIFICANCE OF THE RESEARCH

The cost of motor carrier accidents, both in terms of human pain and suffering as well as property damage loss, is substantial. According to a report published by the National Highway Traffic Safety Administration (1994), during the 1992 calendar year, heavy trucks were involved in 4,028 fatal accidents, 95,000 injury crashes, and 277,000 property-damage only incidents. Of the 4,028 fatal heavy truck accidents tabulated, 584
truck drivers and 2,806 persons occupying passenger vehicles involved in those collisions were killed. In comparison, major commercial airline accidents in the United States during that same year accounted for the loss of twenty-seven lives in a single incident involving a USAir Fokker F28 at LaGuardia Airport in New York City (Denham, 1996). Yet, an extensive investigation by the National Transportation Safety Board was initiated to identify the causes of that accident so that recommendations could be made to the Federal Aviation Administration to reduce the likelihood of a repeat occurrence. No such scrutiny is directed toward the investigation of heavy truck accidents despite the obvious disparity between the number of lives lost in such accidents compared to the number of lives lost in commercial aviation accidents.

Given the absence of such in-depth case-by-case investigations, policy-making entities engaged in regulating motor carrier safety must rely on research conducted by third parties who typically utilize data sets compiled by yet other third parties. The voluminous statistical findings generated, as previously mentioned, often conflict with one another, producing contradictory public policy recommendations. Policy makers thus face extreme difficulty drafting viable strategies for the protection of the public’s safety on the nation’s roadways insofar as this safety is affected by the motor carrier industry. The approach introduced in this study seeks to improve the quality of data available, which in turn could lead to more effective public policy decisions.
In traditional dissertation format, the reader expects an extensive review of the literature to follow the introductory chapter. The literature review typically serves to place the research problem in a theoretical framework (Creswell, 1994) and to provide a theoretical rationale for subsequent hypothesis generation (Labovitz and Hagedorn, 1971). The structure of this document is markedly different, however, since the existing literature fails to provide sound linkages to the appropriate theoretical foundations. That is not to claim that existing theoretical frameworks would not be applicable here, only that thus far, the rationale for applying them to this research problem has not been adequately developed. This study seeks to address that weakness through the formulation of a conceptual model derived through an inductive methodology created specifically to address this research problem. That methodology is event cascade analysis.

Chapter 2 introduces event cascade analysis, a tool expressly developed by the author to identify factors that directly and indirectly contribute to truck-at-fault, or preventable, collisions (see Appendix B). The chapter opens by describing the conceptual development of event cascade analysis in terms of the human factors literature, a widely accepted body of knowledge dealing with accident causation and prevention in the airline industry (Shinar, 1978; Wiener and Nagel, 1988; Beaty, 1995). Next, the inductive process by which event cascade analyses generates a conceptual model is explained through parallels with techniques advanced in the grounded theory literature (Glaser and Strauss, 1967; Strauss and Corbin, 1990). Additionally, the strategy used to select specific accidents
for analysis is detailed, the sources from which accident data were obtained are identified, and the depositories from which supplementary archival information was collected are revealed.

Once the procedure and rationale for the event cascade methodology are established, Chapter 3 delivers the results generated through the analysis process. Stage one focuses on the development of event cascades for discrete accidents. These results include the identification of proximal and distal factors that contributed to each accident analyzed. Each event cascade is traced backward from the accident's proximal contributors to encompass increasingly remote distal contributors. Thus, an explanatory chain of factors is forged, one element the temporal antecedent of the next. In stage two, event cascades for a specific carrier's discrete accidents are analyzed in aggregation. The objective is to identify recurrent elements in the carrier's event cascade aggregation and then to infer a distal explanation for their repeated appearance. Those explanations provide the foundation for the formulation of a defensible conceptual model that links carriers' organizational traits to their preventable accident history.

Chapter 4 offers an analysis of the results generated in Chapter 3 and discusses them in terms of the human factors literature introduced in Chapter 2. A conceptual model linking discrete accidents to their distal origins is proposed along with a discussion of the data resources necessary to quantitatively test the model. Finally, Chapter 5 provides recommendations for improving the quality of public policy decisions in the area of motor carrier safety based on the findings generated in this study.
CHAPTER 2

METHODOLOGY

A major weakness associated with conventional motor-carrier-accident investigation is that, once a direct cause has been identified, accident investigators devote little or no effort to uncovering the indirect factors which may have influenced the behavior that ultimately led to the crash (Morton, 1998; Schwartz, 1998). An awareness of these underlying or distal factors is crucial if we hope to reduce the number of future accidents. This realization has already expanded the scope of post-crash investigations conducted in an allied industry — aviation.

The National Transportation Safety Board first alluded to the role of indirect factors in commercial aviation accidents in its report NTSB-AAR-80-7 (1980) detailing the elements, both proximal and distal, that contributed to the crash of Downeast Airlines Flight 46 on May 30, 1979 (Nance, 1986). Prior to this report's release, the Board had restricted comments regarding aviation accident causality exclusively to the identification of those elements that could be directly tied to the adverse event through physical evidence collected at the disaster scene.
In the post-crash investigation of Flight 46, fourteen former Downeast pilots and several other employees provided written statements and sworn testimony regarding management practices and policies that encouraged, and even coerced, personnel to violate federal regulations pertaining to operational safety (NTSB-AR-80-5). The National Transportation Safety Board’s willingness to acknowledge heretofore ignored distal factors as contributing to the Downeast accident greatly enhanced the accuracy of its final report by explicitly linking those remote factors to the erroneous decision-making the crew exhibited at the time of the accident. Previously, such an accident would have been solely attributed to pilot error, a gross oversimplification of the circumstances that in actuality contributed to this catastrophe (Nance, 1986).

By 1983, the Board had formally enumerated six human performance factor categories. These six categories included behavioral (e.g., pilot life habit patterns, 72 hour pre-accident history), medical (e.g., drug and alcohol ingestion, fatigue), operational (e.g., company policies, training programs), task (e.g., workload, time constraints), equipment design (e.g., instrument panel design, seat configuration), and environmental (e.g., weather, noise, vibration, illumination) factors (Miller, 1988). The Board recommended that the influence of these factors be thoroughly evaluated as part of any post-crash investigation.

While the effort to link human performance to increasingly distal factors has become an accepted component of airline accident inquiry, it is still virtually disregarded in the investigation of motor carrier accidents. Unlike the National Transportation Safety Board’s investigators who routinely evaluate the influence of distal factors as part of post-airline-crash inquiries, most motor carrier accident investigations terminate with the identification of direct contributors. That distal factors are generally ignored in motor
carrier accident investigations should not be taken to imply that they failed to exert any influence on the driver's behavior at the time of the crash; it simply means that the link connecting distal influences to that behavior was not investigated and hence remains undocumented. Developing such links is a major objective of this research project. Doing so after the fact, however, requires a technique expressly designed to unveil the influences of these indirect factors using whatever documentation is available. I have formulated event cascade analysis specifically to perform this function.

**EVENT CASCADE ANALYSIS**

**Conceptual Description of the Event Cascade Analysis Process**

An event cascade is the chain of actions and interactions that precede a preventable accident episode. A well-constructed event cascade describes how distal factors influenced the evolution of the accident. Reason (1990) emphasizes the necessity of linking proximal outcomes to distal origins in order to fully understand complex system failure.

Event cascade analysis is a methodology expressly designed to analyze errors resulting from motor carrier operations. The event cascade notion is predicated on the view that truck-at-fault accidents are foreseeable once one fully understands the context in which they evolve. The goal of event cascade analysis is to construct a conceptual picture of that context through evaluation of actual accident files, and then to articulate the
process by which that context contributes to driver behavior at the time of preventable accidents. In other words, this approach yields a middle-range explanation that links proximal outcomes to distal influences.

I developed the event cascade analysis methodology because I recognized the need for a middle-range theory capable of explaining the influence distal factors exert in the proximal environment where preventable accidents actually occur. Other researchers have similarly acknowledged this gap in knowledge. Bruning, for example, (1989) notes "the factors that cause truck accidents are not very well known. At best, we have tentative measures of association." While many researchers have formulated distal factor models designed to predict and explain motor carrier accidents (See Appendix A), none have explicitly detailed the process by which those factors influence driver behavior. Without such understanding, the chance of interrupting event cascades in preventable accident episodes is very slim.

The term event cascade itself was adopted from Michael Crichton's novel, *Airframe* (1996). He used it to describe the complex sequence of events that precede any airline crash. Given the similarities that exist between the aviation and motor carrier industries, I felt the concept applied equally well to both environments. It captures the notion that one cannot hope to predict or explain outcomes without considering the contexts in which they evolve. Crichton illustrates his event cascade notion through the discussion of an actual airline disaster involving an American Airlines DC-10 that occurred during May, 1979 in Chicago, Illinois. The accident was triggered when an engine broke off the wing due to improper maintenance procedures that had resulted in structural damage. He points out that the crash could have been avoided entirely if the event cascade preceding it had
been disrupted. For example, Continental Airlines knew from its own experiences that the failure to follow the manufacturer's prescribed maintenance procedures resulted in cracked engine pylons. Yet, Continental chose not to convey the information to other operators of DC-10 fleets.

I relied on Crichton's literary concept as the foundation for development of the event cascade analysis methodology. In this study, event cascade analysis is defined as a two-stage process that yields a grounded explanation for a particular carrier's preventable accident profile. In stage one, individual event cascades describing discrete preventable accidents are formulated. In stage two, preventable accident aggregations are compiled for a specific carrier from which a comprehensive summary is developed. This summary identifies those distal factors that have been systematically linked to the carrier's preventable accident history. Figure 1 details the steps associated with both stages of the analysis process.

Data generated through these procedures are organized into the human performance factor categories specified by the National Transportation Safety Board as having significance in aviation accident investigations. An adaptation of this schema to the motor carrier industry is justified by the clear parallels between the work environments of pilots and truck drivers. Both occupations are subject to irregular work schedules in terms of variations in day-to-day work hours, days of the week worked, and extensive off-duty periods spent away from home. Such erratic scheduling produces fatigue and stress (Graeber, 1988; NTSB, 1995). Both occupations also require lengthy periods of monotonous activity — pilots on long flights when primary duties involve passively monitoring instruments and truck drivers traversing mile after mile of desolate interstate.
Stage One Objective
Formulate an event cascade for a discrete preventable accident

Step One ➔ Transcribe relevant information from the preventable accident file to the appropriate event cascade grid cells (See Figure 2)

Step Two ➔ Infer conditional paths
➔ Transcribe findings to the event cascade grid

Step Three ➔ Compare documents in accident file for inconsistencies
➔ Transcribe findings to the event cascade grid

Stage Two Objective
Formulate an event cascade aggregation summary for a specific motor carrier

➔ Identify recurring critical proximal elements from aggregated event cascade grids

➔ Infer distal influences responsible for the recurring proximal elements

➔ Compile evidence & rationale for inferred distal explanations

➔ Transcribe findings to event cascade aggregation worksheet (See Figure 3)

➔ Develop carrier event cascade aggregation summary

Figure 1: The Event Cascade Analysis Process
<table>
<thead>
<tr>
<th>HUMAN FACTOR CATEGORY</th>
<th>PROXIMAL</th>
<th>CONDITIONAL PATH LINKAGES</th>
<th>DISTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Behavioral</td>
<td>Driver Judgments</td>
<td>DMV Abstract</td>
<td>Medical History</td>
</tr>
<tr>
<td></td>
<td>Driver Statements</td>
<td>Life Events</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Driver Actions</td>
<td>Occupational Socialization</td>
<td></td>
</tr>
<tr>
<td>Medical</td>
<td>Physical Condition</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mental Condition</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operational</td>
<td>Solo / Team Operation</td>
<td>Carrier Safety Policies</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Trip Origin / Destination</td>
<td>Recruitment Guidelines</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Commodity</td>
<td>Maintenance Policies</td>
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<tr>
<td></td>
<td>Equipment Ownership</td>
<td>Training Programs</td>
<td></td>
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<td></td>
<td></td>
<td>Compensation System</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Communication Technology</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Carrier Culture</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Trip Scheduling</td>
<td></td>
</tr>
<tr>
<td>Task</td>
<td>Attention to Task</td>
<td>Driver Experience</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Time Engaged in Task</td>
<td>Route Familiarity</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Nature of Task</td>
<td></td>
</tr>
<tr>
<td>Equipment Design</td>
<td>Vehicle Configuration</td>
<td>Vehicle Recalls</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Vehicle Weight</td>
<td>Part Recalls</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Vehicle Safety Features</td>
<td>Component Failures</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Equipment Condition</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Auxiliary Safety Equipment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Environmental</td>
<td>Weather Conditions</td>
<td>Posted Cautionary Signs</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Road Surface Conditions</td>
<td>Road Condition Advisories</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Time of Day</td>
<td>Government Regulations</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Road Configuration</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Terrain</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Distractions</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Traffic Volume</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 2: Event Cascade Grid with Proximal and Distal Data Examples
<table>
<thead>
<tr>
<th>HUMAN FACTOR CATEGORY</th>
<th>RECURRENT ELEMENT</th>
<th>INFERRED DISTAL CONTRIBUTOR</th>
<th>EVIDENCE &amp; RATIONALE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Behavioral</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Medical</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operational</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Task</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Equipment Design</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Environmental</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 3: Worksheet Template for the Carrier Event Cascade Aggregation Summary
frequently during hours of darkness. Task tediousness exacerbates fatigue and stress
(Weiner, 1988; Loeb, Talley, and Zlatoper, 1994). And finally, the occupational cultures of
both pilots and truck drivers share the common characteristic of *machismo* which breeds an
attitude of self-sufficiency, independence, and invulnerability that can lead to accidents
(Beaty, 1995; Ouellet, 1994). These shared occupational idiosyncrasies have already been
linked to preventable accident episodes in the airline industry. Through the event cascade
analysis process, their influence can be studied in motor carrier preventable accident
sequences.

**Applied Description of the Event Cascade Analysis Process**

Stage one of event cascade analysis is accomplished through a three-step
procedure. Its objective is the formulation of an event cascade for a discrete preventable
accident. Step one is initiated with a systematic evaluation of all documents contained in a
specific accident file. Proximal and distal factors explicitly identified in such documents are
transcribed to the appropriate cells of an event cascade grid. A separate grid is completed
for each discrete accident file. The event cascade grid itself (depicted in Figure 2) contains
four columns. Column one enumerates the National Transportation Safety Board’s six
human performance factor categories. Columns two and four provide proximal and distal
examples for each category as they apply to the motor carrier industry. Column three is
used to trace the conditional paths that will be formulated in the stage one, step two
procedure. It is important to note that conditional paths can and do cross categorical
boundaries. Hence, a proximal factor located in one human factor category may have
distal origins situated in a different category. For example, suppose an accident was
triggered because a driver became distracted by the on-board telecommunications equipment provided by the carrier. The proximal contributor to this accident is inattention while driving. It is recorded in the task category of the event cascade grid. The distal origins of this distraction, however, lie in the operational category since the carrier installed the technology and management should have foreseen the consequences of placing it where the driver would have access to it while simultaneously operating the vehicle.

**Stage One - Step One**

In stage one, step one, all proximal and distal factors in a file's documentation are transcribed to the appropriate cells on an event cascade grid. Only data explicitly noted in the accident file is transcribed during step one. The objective is to form a rudimentary picture based on a factual account about the way in which that particular preventable accident episode unfolded. With the completion of step one, the proximal factor column of the grid will be rich with data while the distal factor column will be comparatively empty. An accident file with inadequate data to meet step one objectives is eliminated from consideration at this time. Such files are not useful since they lack sufficient information to identify even the proximal origins of these accidents.

**Stage One - Step Two**

In step two, conditional paths are formulated. The conditional path concept was developed by Strauss and Corbin (1990) who hold that micro-level situations are the consequence of macro-level influences. The purpose of conditional path formation is to
link the micro action occurring at the time of an accident to increasingly remote macro influences. Tracing such paths begins by identifying the action of interest, which in this study is truck-at-fault accidents. Next, an analysis of the interactions with other people (or lack thereof) that immediately preceded the accident is conducted. Parties with whom interaction occurred, or with whom it reasonably should have occurred, are identified, and their involvement with the action of interest is clarified. In this research, such a person might be a relief driver or a dispatcher.

Such interaction, or its conspicuous absence, unveils distal influences that played a contributory role in a preventable accident sequence. The decision to voice pre-accident concerns, or alternatively to say nothing, is influenced by factors far removed from the proximal work environment. To illustrate, suppose that a post-crash inquiry revealed that the driver had fallen asleep at the wheel while a relief-driver was resting in the sleeper berth. Obviously, an interaction should have taken place in which the driver’s state of fatigue was communicated to the relief-driver. The team then could have developed an action plan to solve the problem, thus avoiding that particular accident episode. That such interaction failed to occur indicates a communication breakdown in the proximal work environment. We are interested in discovering what led to the breakdown. Based on the evidence at hand, explanatory paths are traced. We may discover that the team had agreed upon rotating eight-hour shifts and that the driver felt duty-bound to fulfill that commitment despite extreme fatigue. Tracing the path further still, we may find that the driver’s sense of duty stems from values internalized during the occupational socialization process in which mentors conveyed that one’s worth to the industry is very much tied to
the ability to complete a task (i.e. one's driving shift). The internalization of such value judgments is a process clearly initiated in the distal environment, yet it is plainly having an influence on behavior enacted in the proximal.

Once conditional paths have been identified, they are transcribed to the event cascade grid, along with a brief notation providing the rationale for the link being established. Defensible conditional path formation relies on detailed accident documentation, a resource not always available to the researcher. Consequently, in the absence of adequate documentation, step two may yield no findings. That shortfall, however, does not cause the accident file to be removed from consideration, as was the case in step one, because it may still yield data using step three analysis procedures.

**Stage One — Step Three**

In step three, a comparative content analysis of all documents contained in a particular accident file is undertaken. The objective is to identify any content inconsistencies noted in the file's documents. Such inconsistencies may include discrepancies between the statements of various parties at the accident scene, or they may be evident in incongruous accident narratives authored by different people. The significance of any inconsistencies detected must be analyzed. Such discrepancies may denote nothing more than oversight or confusion. However, if the evidence implies an intent to mislead, the motivation for such behavior must be carefully evaluated and traced to its distal origins. For example, suppose that the police report describing a single-vehicle accident notes that the truck driver admitted drifting off the pavement when he or she fell asleep. Yet, the narrative contained in the MCS-50T carrier self-report states that the
driver was forced off the highway by another vehicle. The legitimacy of the carrier's narrative is suspect since no reference to another vehicle's involvement was alleged in the police report. That such key information had been overlooked at the accident scene when it would have been fresh in the driver's mind is difficult to accept. The motivation for the invention of a "phantom" vehicle must be analyzed.

Step three results are then transcribed to the appropriate distal column grid cells. Step three yields no findings if document inconsistencies are nonexistent. As was true with step two, this shortfall does not eliminate the accident file from inclusion in the study since the information gleaned in step one and step two is still useful.

Stage Two

In stage two analysis, focus shifts from the development of discrete event cascades to the formation of a specific carrier's event cascade aggregation. Obviously, this phase of the analysis cannot be conducted unless the carrier exhibits a multiple-preventable-accident history. The primary goal of stage two analysis is distal factor identification. But rather than developing conditional paths and evaluating the disparities among documents as was the strategy with discrete accidents, distal factor influence at this level is inferred through the presence of recurring elements in a carrier's event cascade aggregation. The repeated appearance of any factor indicates that something beyond isolated errors in truck drivers' judgments is contributing to the carrier's preventable accident history.

The Downeast Airlines case mentioned previously illustrates this point. At the National Transportation Safety Board post-crash inquiry, evidence confirmed that management had established unwritten company policies requiring flight crews to violate
Federal Aviation Administration safety regulations on a routine basis. Witness testimony further indicated that Downeast's owner had humiliated, ridiculed, and threatened to terminate pilots who refused to comply with these dangerous expectations (NTSB-AAR-80-5). These coercive management practices indirectly contributed to several near disasters, and ultimately to the crash of Downeast Flight 46 (Nance, 1986). As recurring elements are identified, they are transcribed to a carrier event cascade aggregation worksheet. The template for the worksheet is reproduced in Figure 3. The recurrent elements are placed in the appropriate human factor category. Then, distal explanations for each element's presence are inferred, along with evidence and rationale to support them. Finally, an event cascade aggregation summary is developed. This summary details the distal contributors routinely linked to that carrier's preventable accident history.

RESEARCH DESIGN

An embedded, multiple-case design is appropriate when the researcher is dealing with more than one unit of analysis and is evaluating more than a single case (Yin, 1994). In this study, event cascades are formulated from individual accident files. In the first stage, the unit of analysis is the individual accident and the main objective is proximal and distal factor identification. The second stage of the process involves the aggregation of event cascades associated with a specific carrier. That compilation shifts the unit of analysis to the level of the organization. This multilevel research design enables the development of links connecting micro level outcomes to macro level influences, a fundamental research objective of this research project.
DATA SOURCES

Accident data is available from the Oregon Department of Transportation (ODOT), Motor Carrier Transportation Branch. The State of Oregon was selected for three basic reasons: first, ease of record accessibility is ensured through an "open records" statute (ORS 192.420); second, fatal accident reports are extremely well documented and technically detailed, largely attributable to Oregon State Police personnel who have received extensive training in accident reconstruction analysis (Morton, 1998); and third, accident files are conveniently archived in a single repository location.

From a researcher's perspective, few states compare to Oregon's exceptional system of accident data management. All motor carrier accident reports are forwarded to ODOT's offices in Salem by the law enforcement agencies completing the reports. Once a specific report arrives in Salem, the motor carrier accident analyst matches that document with any other relevant materials. File contents vary substantially, but include one or more of the following documents: the official report compiled by the investigating law enforcement personnel, an accident reconstruction report, a self-report by the motor carrier involved (MCS-50T), and/or supplementary investigation up-dates. The crash sequence is then reviewed by the analyst to determine whether the accident was truck-at-fault (Shepard, 1998). Appendix B contains a reproduction of the preventability algorithm used by the ODOT accident analyst to determine truck-at-fault accidents.

Accident data for this project cover three calendar years: 1992, 1993, and 1994. The accident files archived for these years are sufficiently mature to contain all pertinent documents, yet not so antiquated that the event cascades formulated from them would
lack relevance to today's industry operating conditions. Moreover, the three year time span increases the pool of carriers with multiple truck-at-fault accident histories, a critical attribute when identifying distal influences during stage two of the analysis process.

The level of detail reflected in these accident files is directly proportional to the seriousness of the accident. Hence, fatal accidents command substantial documentation while mere “fender-benders” often warrant nothing more than the MCS-50T carrier report. From the standpoint of event cascade development, the more voluminous the documentation, the less likely a critical proximal or distal factor will be overlooked. From the standpoint of research design, voluminous accident files are also preferable, albeit for a different reason. They contain multiple documents describing the same accident, but originating from different sources. Such replications are most advantageous since they strengthen the study's construct validity through data triangulation, a qualitative research technique in which facts are corroborated through several accounts of the same event (Yin, 1994).

DATA SELECTION PROCESS

The data selection process was designed to meet three primary objectives: first, preventable accident files were chosen such that a broad array of motor carrier operations is represented; second, carriers with multiple preventable accident histories were selected to ensure that stage two event cascade analyses can be performed; and third, carriers whose vehicles were involved in preventable accident episodes resulting in fatalities were targeted to guarantee that the accident files containing the greatest detail are evaluated.
The accident selection process began with a request to Jack Shepard, the ODOT motor carrier accident analyst, for a master file listing all preventable motor carrier accidents that had occurred in Oregon for the years 1992 through 1994. The master file included only those accidents involving vehicles with gross weight ratings of 80,000 pounds or greater, thereby excluding local delivery truck operations. Each master file entry included the carrier name, city and state of domicile, the accident date, location, commodity transported, and severity in terms of property damage, injuries, or fatalities.

To meet the three objectives noted above, it was necessary to request 213 truck-at-fault accident files from the master file: 73 from 1992, 72 from 1993, and 68 from 1994. The 213 preventable accident files selected involve fifty-five motor carriers. Table 3 in Appendix C identifies these carriers, using the legal names under which they file required fuel tax returns with the state of Oregon. The city and state in which each carrier is domiciled and the number of preventable accident files obtained per year for each is also indicated.

Careful consideration was given to the decision to explicitly identify carriers by name. While aliases could have been assigned, Yin (1994) recommends against this practice on two grounds. First, the use of authentic identities enables others to verify data and evaluate the accuracy of the study’s findings. Second, it facilitates the ease with which others wishing to build on these findings can do so. Yin further notes that one can choose to disclose true identities at one level of analysis, but maintain anonymity at another. Such is the case with this study. While accurate carrier identities are revealed, names of specific individuals involved in the accidents themselves are not disclosed.
**VALIDITY AND RELIABILITY**

General agreement exists in the qualitative methods literature that four specific issues should be addressed to ensure the accuracy and consistency of research findings. These areas of concern are construct validity, internal validity, external validity, and reliability. (Creswell, 1994; Strauss and Corbin, 1990; and Yin, 1994). Construct validity has been addressed previously in the section entitled *Data Sources*; hence, it is not revisited here.

External validity refers to whether a study’s findings are relevant to subjects and settings beyond those specified in the study (Vogt, 1993). Random sampling is a necessary condition for establishing external validity if a researcher intends to generalize statistical research findings to the wider population from which the subjects were drawn (Campbell and Stanley, 1966). This study does not seek to generalize statistical findings to a broader population, but rather to specify the conditions under which specific phenomena evolve for the purpose of grounded theory development (Strauss and Corbin, 1990). External validity in this situation refers to the domain to which the theory can be applied. The breadth of that domain is established through replication (Yin, 1994). The embedded, multiple-case research design employed in this project facilitates such replication.

Internal validity concerns must also be addressed in qualitative research projects. Merram (1988) defines internal validity as the accuracy of the information and its correlation with reality. The primary internal validity threat in this study arises when inferences are made. Yin (1994) suggests that the researcher pose questions that compel him or her to consider rival explanations and possibilities. Given my years of industry
experience, I thoroughly understand the context in which preventable motor carrier accidents occur. Hence, I can develop realistic rival explanations and alternative scenarios. Yin further suggests that the convergence of multiple sources of evidence help ward off internal validity threats. As mentioned previously, the majority of accident files requested for this study contain multiple accounts of the same event. During stage one, step three analysis, the seriousness of any deviation detected in these accounts is evaluated.

Creswell (1994) refers to reliability as the likelihood the same study could be replicated by another researcher. He indicates that reliability can be enhanced through explicit statements regarding the methodology used, including the strategies for selecting cases, the procedures for organizing data, and the steps taken to draw conclusions. He also suggests that the researcher detail any personal experiences that likely played a crucial role in the research process. Earlier sections of this document provide the recommended information.
CHAPTER 3

RESULTS

Of the 213 accident files initially received, 6 were deleted as a result of insufficient data to meet stage one, step one objectives. Three other files described accidents involving multiple motor carriers, with the carrier of interest vehicles not being the at-fault units: these files were also removed from consideration. The remaining 204 accident files are listed in Table 4, Appendix D.

Two other modifications to this list differentiate it from the one presented in Table 3, Appendix C. First, the carrier identified as B C T Inc. in Table is, in fact, Boise Cascade Corporation. Hence, the B C T Inc. row was deleted in Table 4, and the single accident contained in it was added to the appropriate Boise Cascade Corporation cell. Second, T N T Reddaway Truck Line and T N T United Truck Lines Inc. are managed by the same parent firm. Their operations serve the same market segment and adhere to the same corporate rules and policies. As such, their data were merged as shown in Table 4.

EVENT CASCADE ANALYSIS FINDINGS

Stage one of event cascade analysis yielded event cascade grids for 204 preventable accidents. These grids served two purposes. First, grids were sorted according to the
critical proximal element that triggered each accident. The critical proximal element is the most immediate antecedent factor responsible for initiating a particular accident sequence. Without the presence of the critical proximal element, a specific accident would not occur. Sorting grids on the basis of such criteria allows us to identify recurrent trends associated with a particular accident sequence. This process facilitates the grouping of event cascades so that we can conceptually describe how general categories of preventable accidents evolve.

Discrete event cascade grids served a second function. They were aggregated by carrier to conduct stage two analyses for those firms exhibiting multiple preventable accident histories. Stage two findings are reported in a subsequent section of this chapter entitled “Carrier Event Cascade Aggregation Summaries.”

**DISCRETE EVENT CASCADE GRIDS**

Stage One — Step One Findings

The 204 event cascade grids formulated in this study were sorted according to their critical proximal elements. Table 1 identifies the fourteen critical proximal elements that emerged as a result of that sorting process. It further delineates the total number of accidents, injuries, and fatalities associated with each critical proximal element. The remainder of this section details the accidents associated with each critical proximal element as specified in Table 1.

Of the 204 accidents evaluated, 54 were triggered by loss of control during inclement winter weather (Element C). Of these 54 weather-related incidents, 50 resulted
<table>
<thead>
<tr>
<th>CRITICAL PROXIMAL ELEMENT</th>
<th>TOTAL ACCIDENTS</th>
<th>TOTAL INJURIES</th>
<th>TOTAL FATALITIES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loss of control on icy / snowy road (Element C)</td>
<td>54</td>
<td>36</td>
<td>8</td>
</tr>
<tr>
<td>Failure to remain attentive / alert / awake (Element D)</td>
<td>36</td>
<td>23</td>
<td>13</td>
</tr>
<tr>
<td>Speed excessive for maneuver attempted (curve, exit ramp, downgrade, stopping) (Element H)</td>
<td>25</td>
<td>12</td>
<td>6</td>
</tr>
<tr>
<td>Failure to avoid rear-end collision with another vehicle (Element B)</td>
<td>18</td>
<td>21</td>
<td>7</td>
</tr>
<tr>
<td>Failure to avoid a stationary object while executing a turn (Element F)</td>
<td>17</td>
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<td>0</td>
</tr>
<tr>
<td>Failure to yield the right-of-way at an intersection (Element M)</td>
<td>12</td>
<td>7</td>
<td>4</td>
</tr>
<tr>
<td>Failure to detect vehicle traveling in an adjacent lane prior to merging (Element L)</td>
<td>11</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Failure to conduct required equipment inspections (Element J)</td>
<td>10</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Failure to properly secure load (Element R)</td>
<td>9</td>
<td>8</td>
<td>1</td>
</tr>
<tr>
<td>Failure to avoid a vehicle or stationary object while executing backing maneuver (Element Q)</td>
<td>6</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Failure to observe a pedestrian (Element I)</td>
<td>2</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Failure to control whipping unit in multiple trailer combination (Element O)</td>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Failure to detect overhead obstruction (Element K)</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Failure to remain in moving vehicle (Element A)</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
</tbody>
</table>

Table 1: Critical Proximal Elements Initiating 204 Preventable Motor Carrier Accidents
because truck drivers were driving too fast for the road conditions. Of the remaining 4 accidents, 1 resulted when the driver encountered an unexpected patch of ice on an otherwise dry road. The second resulted when the driver's vehicle lost traction on an upgrade, slid backwards, and left the paved surface. The third was triggered because the driver failed to obey a posted "Traction Devices Required" regulatory sign. The unchained vehicle went out of control on a downgrade, striking another vehicle in the opposing traffic lane. The fourth crash resulted when the driver used a secondary highway not recommended for trucks. The driver made this decision upon discovering that primary routes had been closed by ODOT officials due to snowy conditions. This vehicle failed to negotiate a 14% downgrade on the unplowed two-lane road and careened over an embankment.

Thirty-six of the 204 preventable accidents analyzed were initiated by inattention to task (Element D), defined as any activity that distracts the driver from the primary duty of operating the vehicle. Such activities include reaching for a thermos bottle, using a cellular telephone, reading a map, or falling asleep at the wheel. In 16 of these 36 accidents, police investigations conclusively established that the driver had fallen asleep at the wheel. In 14 others, investigators strongly suspected the driver had fallen asleep at the wheel, but they lacked sufficient physical evidence to confirm that suspicion. The remaining 6 accidents resulted when drivers allowed their attention to be diverted. Four of these 6 incidents involved drifting off the paved surface while rounding a curve in the highway. The other two occurred on straight and level highways. In one instance, the driver was re-entering the interstate from a rest area when he realized his wallet was missing. He began frantically searching for it while simultaneously trying to drive. During
this search, he steered the vehicle off the paved surface. In the remaining accident, the
driver attempted to retrieve his thermos bottle from across the cab. While his attention
was focused on his thermos, he steered the vehicle off the paved surface.

Twenty-five out of 204 accidents resulted when drivers attempted to execute
maneuvers such as negotiating a curve or taking evasive action at unsafe speeds Element
H). All of these incidents took place on road surfaces that were free of snow and ice.
Twelve of the 25 took place on curvy sections of highways posted with warning signs
advising drivers of safe speeds for the given conditions. The drivers of these 12 vehicles
exceeded the recommended limits, which led to loss of control. Another 8 accidents
resulted when drivers executed evasive maneuvers to avoid rear end collisions with other
vehicles. Had these drivers been traveling at safe speeds, such evasive actions probably
would have been unnecessary and the subsequent accidents avoided. Three accidents
occurred when drivers used interstate highway exit ramps at speeds too fast to maintain
control of their vehicles. In another accident involving excessive speed, the driver
overturned his vehicle while executing a turn to enter an interstate highway on-ramp. The
last of these twenty-five accidents was triggered when the driver attempted to pass another
vehicle at an unsafe speed during a heavy rain storm. The unit’s semi-trailer began
whipping, striking the vehicle being passed.

Failure to avoid rear-end collisions with other vehicles (Element B) attributed for 18
of the 204 total accidents analyzed. Ten of these episodes occurred on the interstate
highway system. Of these 10, 2 involved failure to avoid rear-end collisions with vehicles
merging onto interstate highways from rest areas. Two others involved drivers who failed
to avoid rear-end collisions with slower moving vehicles on interstate exit ramps. Another
occurred when a disabled vehicle parked on the shoulder was struck from the rear because
the at-fault truck driver allowed his vehicle to drift across the fog line. In the other 5, the
at-fault drivers failed to avoid rear-end collisions with vehicles that were traveling at legal
highway speeds, but at rates slower than the trucks. Of the remaining 8 collisions, 4
occurred on city streets when the at-fault truck drivers failed to detect slower moving or
stopped traffic ahead of them. Three others occurred when drivers slammed into lines of
vehicles stopped by road crews in legally posted construction zones. The last of these 18
accidents involved a truck that skidded into the rear of a horse drawn wagon traveling on a
rural, uncontrolled-access state highway.

Seventeen of the 204 accidents evaluated resulted because drivers failed to avoid
stationary objects such as light poles or street signs while executing right-hand turns in
confined spaces (Element F). During a right-hand turn, as the angle between a semi-
tractor and semi-trailer approaches 90 degrees, the image reflected in the passenger side
mirror reveals less and less of the rear portion of the trailer. These conditions are
graphically depicted in Figure 4. Hence, when executing such turns, a driver must rely
upon another person to monitor the trailer's tracking so that stationary objects will not be
struck. The drivers involved in these seventeen episodes failed to take that precaution.

Of the 204 total accidents analyzed, 12 occurred when drivers did not yield to
vehicles legally entitled to the right-of-way (Element M). Six of these incidents took place
when drivers failed to obey red lights. Another occurred when a driver failed to obey a
stop sign. The remaining 5 accidents occurred when truck drivers executed left turns
directly in the paths of vehicles having the right-of-way. In 1 of these instances, the driver
Figure 4: Illustration of Obscured Visibility Contributing to Element F Accident Sequences
Figure 5: Illustration of Obscured Visibility Contributing to Element L Accident Sequences
had inhaled cocaine just before the accident. Investigators held that the drug's influence had impaired the driver's judgment, contributing to his decision to execute the unsafe left turn.

Of the 204 preventable accidents evaluated, 11 resulted when drivers merged into vehicles occupying an adjacent lane (Element L). As illustrated in Figure 5, the driver of a semi-truck combination has a restricted view of vehicles traveling directly beside his or her equipment in the adjacent lanes. Areas of blocked visibility are commonly referred to as blind spots. If a vehicle moves into a blind spot undetected by the truck driver, the obscured vehicle can easily be struck when the unaware driver executes a lane change. Such was the pattern in nine of these eleven accidents. The remaining two occurred on city streets when drivers not executing lane changes allowed their trailers to drift into adjacent lanes occupied by other vehicles.

Ten of the 204 preventable accidents analyzed resulted from the failure to detect mechanical defects (Element J) when conducting equipment inspections required by Parts 392.7 and 396.3 of the Federal Motor Carrier Safety Regulations (1998). Four of these accidents were traced to steering or suspension failures. Two were triggered by improperly adjusted or maintained air brake systems. Two others occurred when drivers improperly coupled their trailers. These trailers later separated from the towing units while the combinations were under way. Of the two remaining accidents, one occurred when a vehicle's front axle cracked and the other resulted when an accelerator stuck to the floor.

Nine of the 204 preventable accidents evaluated were triggered when improperly secured loads shifted (Element R). Eight of these 9 episodes involved flatbed trailers, which lack the added side wall support that van-type trailers offer. As such, loads on these
trailers are insecure if they have not been properly secured with chains or straps explicitly designed for this use. The drivers involved in these 8 accidents failed to adequately secure their loads. The loads subsequently shifted, initiating accidents. In the single remaining accident, particle board was loaded in a container destined for placement on a seagoing vessel. The container was being transported from the shipper’s facility to the pier by truck. The entire container shifted as the truck was exiting the shipper’s property, causing the units to overturn. Had the driver verified that the container was properly attached to the chassis prior to departure, this incident would not have occurred.

Out of the 204 accidents analyzed, 6 resulted when drivers backed into occupied vehicles or stationary objects (Element C). In 3 of these episodes, drivers backed up at intersections to clear pedestrian crosswalks, striking the vehicles directly behind them. The remaining 3 accidents occurred when drivers backed into stationary objects: a stone fence, a parked car, and a parked semi-truck. All 6 of these incidents could have been avoided had the drivers asked someone to act as a lookout while these backing maneuvers were being executed.

The remaining 6 of the 204 accidents reviewed fell into four varied categories. Two occurred when drivers operating in urban areas failed to observe pedestrians crossing their paths (Element I). Both pedestrians were struck and killed. Two other accidents were triggered when the rear unit in a set of multiple trailers began whipping (Element O). The drivers of these combinations failed to correct the problem before the whipping units propelled them off the highway. Of the two remaining accidents, one occurred when the operator attempted to drive a vehicle requiring 13 feet, 6 inches of vertical clearance under a railroad trestle 11 feet, 4 inches high (Element K). A low clearance warning had been
clearly posted. The final accident was triggered when a driver decided to jump out of his truck as it was traveling 45 miles per hour down a 6% grade (Element A). The unattended moving vehicle left the highway and struck a house at the bottom of an embankment. The driver was killed upon impact with the pavement. The reason for the driver's behavior was not determined.

Stage One – Step Two Inferences

According to the methodology advanced in Chapter 2, the function of a conditional path is to link proximal contributors to their distal origins through an analysis of interactions. In other words, we are interested in tracing the origins of those communications likely to have motivated the pre-crash behavior that triggered the accident. Conditional paths were formulated in those few instances where sufficient data permitted. By definition, a conditional path begins with an evaluation of the interaction (or lack thereof) that immediately preceded the action of interest. The actions of interest in this study are, of course, preventable accidents. Of the 204 accidents evaluated, 138 involved solo drivers. Consequently, the interactions immediately preceding these crashes were generally limited to the internal dialogue in which people who are alone engage. Thirty-two of the 204 accidents evaluated involved sleeper teams. In these circumstances, interaction with another person prior to the accident was an option. However, in no instance did relevant interaction take place. Of the remaining 34 incidents, accident documentation failed to indicate whether drivers were operating alone or as part of a team. Hence, it is impossible to know whether interactions with others were even a possibility.
Data limitations, then, compelled me to substitute my knowledge of motor carrier operations for the documentation I had hoped would be contained in archived records. In other words, the data obtained for this project were insufficient to complete stage one, step two procedures as they were described in Chapter 2. Hence, an alternative approach was necessary in order to formulate conditional paths. This approach is based wholly on my experiential knowledge of the motor carrier industry, and the conditional paths yielded through it approximate what I believe would have been found had external documentation been available.

In stage one, step one findings, the 14 critical proximal elements that initiated the 204 accidents analyzed in this study were identified. Ten of those 14 elements were selected as "actions of interest" from which the inferred conditional paths presented in Figure 6, 7, and 8 were traced. Inferred conditional paths were not traced for the remaining 4 critical proximal elements because these actions accounted for only 6 of the 204 accidents evaluated. Of these elements, failure to remain in moving vehicle (Element A), was an action sufficiently unique that only one preventable accident was associated with it. As such, inferring a conditional path for this particular action based on a solitary observation has limited value. Similarly, Element K, failure to detect overhead obstruction, accounted for only 1 preventable accident, again an inadequate number to formulate a meaningful conditional path. Element I, failure to observe a pedestrian, and Element K, failure to detect overhead obstruction, were associated with 2 preventable accidents each. These scant occurrences are likewise insufficient to formulate viable conditional paths for these actions.
Figure 6 contains the inferred conditional path for Element C, loss of control on an icy or snowy road. Based on stage one, step one findings, we know that 50 of these accidents were attributable to speeds excessive for the road conditions. The decision to drive at unsafe speeds is a driver judgment, a behavioral proximal contributor. The distal origins of such judgments can be logically tied to occupational socialization, driver experience, and carrier operational practices. Truck drivers learn their trade from other truck drivers, either overtly through truck driving schools or on-the-job training programs, or indirectly through their observations of other drivers in similar circumstances. Either way, values and attitudes are passed from one driver to the next. Regrettably, an ingrained attitude among many truck drivers is that regardless of road conditions, one should press on as if roads were dry and the day sunny. To behave otherwise is perceived as a weakness. Of course, the more years of winter trucking experience a driver has, the more likely he or she can accurately assess the amount of caution needed on a given highway. A carrier’s operational practices can further influence the decision to drive at unsafe speeds. When trip schedules fail to allocate the time necessary to accommodate inclement weather, drivers are given added incentive and justification to exceed prudent speeds. Carriers exacerbate these tendencies when bonuses or incentives are tied to achieving on-time deliveries.

The vocational training process, a function primarily overseen by other truck drivers, strongly influences behind-the-wheel judgments on which drivers act at critical times during their careers. During the training period, novice drivers are taught not only the technical skills required to operate the equipment, but the attitudes and behaviors that will allow them to be accepted by others in the occupation and in the industry.
<table>
<thead>
<tr>
<th>CRITICAL PROXIMAL ELEMENT</th>
<th>PROXIMAL CONTRIBUTORS</th>
<th>DISTAL ORIGINS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Human Factor Category</td>
<td>Factor Description</td>
</tr>
<tr>
<td>Loss of Control on Icy or Snowy Road (Element C)</td>
<td>Behavioral Task</td>
<td>Decision to drive at unsafe speed</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Failure to recognize conditions favorable for black ice formation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Failure to use traction control devices</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Failure to obey route restrictions</td>
</tr>
<tr>
<td>Failure to Remain Attentive / Alert / Awake (Element D)</td>
<td>Behavioral Medical Task</td>
<td>Decision not to focus full attention on driving duties</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Drowsiness and fatigue</td>
</tr>
<tr>
<td></td>
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<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Speed Excessive for Maneuver Attempted (Element H)</td>
<td>Behavioral</td>
<td>Decision to drive at an unsafe speed</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
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Figure 6: Inferred Conditional Paths for Critical Proximal Elements C, D, and H
<table>
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<tbody>
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<td>Human Factor Category</td>
<td>Factor Description</td>
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<tr>
<td>Failure to Avoid Rear-End Collisions (Element B)</td>
<td>Task</td>
<td>Failure to observe slower moving traffic ahead</td>
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<tr>
<td></td>
<td></td>
<td>Failure to slow in posted construction zone</td>
</tr>
<tr>
<td>Failure to Avoid Stationary Object While Executing Turn (Element F)</td>
<td>Behavioral</td>
<td>Decision not to obtain another person's assistance while executing turn</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Failure to Yield Right-of-Way at an Intersection (Element M)</td>
<td>Medical</td>
<td>Drug impaired</td>
</tr>
<tr>
<td></td>
<td>Task</td>
<td>Failure to obey traffic control device</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Failure to observe vehicle approaching in oncoming traffic lane when executing left turn</td>
</tr>
<tr>
<td>Failure to Detect Vehicle Traveling in Adjacent Lane Prior to Merging (Element L)</td>
<td>Task</td>
<td>Failure to monitor location of traffic traveling directly beside vehicle</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 7: Inferred Conditional Paths for Critical Proximal Elements B, F, M and L
<table>
<thead>
<tr>
<th>CRITICAL PROXIMAL ELEMENT</th>
<th>PROXIMAL CONTRIBUTORS</th>
<th>DISTAL ORIGINS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Human Factor Category</td>
<td>Factor Description</td>
</tr>
<tr>
<td>Failure to Conduct Required Equipment Inspections (Element J)</td>
<td>Behavioral</td>
<td>Decision not to inspect vehicle as required by Parts 392.7 &amp; 396.3 of the FHWA regulations</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Environmental</td>
</tr>
<tr>
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<td></td>
<td>Government regulations</td>
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<tr>
<td>Failure to Properly Secure Load (Element R)</td>
<td>Task</td>
<td>Failure to adequately strap or chain down load to flat bed trailer</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Task</td>
</tr>
<tr>
<td>Failure to Avoid Another Vehicle or Stationary Object While Executing Backing Maneuver (Element Q)</td>
<td>Behavioral</td>
<td>Decision not to obtain another person's assistance while executing backing maneuver</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Operational</td>
</tr>
</tbody>
</table>

Figure 8: Inferred Conditional Paths for Critical Proximal Elements J, R, and Q
Unfortunately, many of the attitudes formed during this occupational socialization process spawn the judgments that triggered the majority of accidents reviewed in this study. Occupational socialization was identified as a distal influence in six of the ten inferred conditional paths formulated. Such was the case whenever stage one, step one analyses established that a proximal contributor to the accident sequence was an erroneous driver judgment.

Figure 6 also presents the inferred conditional path for Element D, failure to remain attentive, alert, or awake. Drowsiness and fatigue, medical proximal contributors, can be linked to several distal origins including occupational socialization, trip scheduling, task monotony, and government regulations that allow drivers to work 70 hours in any 8 consecutive days. For many drivers, a gratifying sense of achievement is experienced when they manage to cover inordinate numbers of miles quickly. External validation for such behavior comes from shippers, receivers, and dispatchers who lavish drivers with praise for delivering critical loads on time. Drivers will go to great lengths to garner such approval, including driving while excessively drowsy. Further challenging these individuals’ efforts to remain alert is the fact that the driving task itself is often tediously monotonous.

Driver attitudes toward the federal hours of service regulations instilled during the occupational socialization process provide yet another incentive to drive while fatigued. A source of tremendous pride stems from the ability to concoct log book entries such that non-conforming trips appear to comply with the hours of service regulations articulated in Part 395 of the *Federal Motor Carrier Safety Regulations* (1998). For years, log books have been dubbed “lie books” or “comic books” quite simply because the information recorded in them is frequently false (Ouellet, 1994). Drivers learn very quickly that commitment to
maintaining an accurate log book is not valued by the industry. However, drafting entries
that appear legal is of utmost importance since both drivers and carriers can be held liable
when log books fail to comply with Parts 395.3 and 395.15(j) of the Federal Motor Carrier
Safety Regulations (1998). As a result of the irreverent attitudes held by truck drivers, as well
as other industry representatives, toward the federal hours of service regulations, these
rules, which were designed to protect drivers and the motoring public, are frequently
circumvented.

Driver oversight during task execution constituted a proximal contributor in the
inferred conditional paths for Element C, loss of control on icy or snowy road; Element
B, failure to avoid rear-end collisions; Element M, failure to yield the right-of-way at an
intersection; Element L, failure to detect a vehicle traveling in an adjacent lane prior to
merging; and Element R, failure to properly secure a load. Such oversights frequently
occur because the driver's vocational training failed to provide enough information about
important conditions which, when overlooked, can lead to catastrophe. The likelihood
significant information won't be conveyed is especially heightened when training is
conducted informally by other truck drivers rather than by professional instructors who
follow a structured curriculum. For example, consider the eight Element R accidents that
resulted when drivers pulling flatbed trailers failed to adequately secure their loads. The
majority of these accidents could have been avoided had drivers been required to attend
formal training sessions in which the proper procedures for strapping or chaining down
flatbed loads was explicitly conveyed.

Driver oversight during task execution can also be linked to lack of experience.
Seasoned drivers are more likely to recognize threats and respond appropriately to them
than are ones with little experience. For example, an Element C accident resulted when the driver failed to recognize patchy black ice on an otherwise dry road. Drivers familiar with winter conditions know that certain road configurations are subject to ice formation when temperatures fall below freezing. The pavement under overpasses, on bridges, and in areas shaded by trees during the day are common problem sites even when otherwise favorable meteorological conditions prevail.

In summary, the dominant proximal contributors for the ten inferred conditional paths traced in Figures 6, 7, and 8 fall into the behavioral, task, and medical human factor categories. The distal origins for these proximal contributors resided in the behavioral, operational, task, and environmental human factor categories. Occupational socialization, a behavioral factor, and trip scheduling and training, both operational factors, were most frequently linked to the proximal behaviors that resulted in preventable accidents.

Stage One – Step Three Findings

Inconsistencies and document omissions were evident in many of the accident files analyzed. As expected, accident file contents varied depending upon the seriousness of the accident. Ninety-seven of the 204 files analyzed contained only a single document. In 28 of these files, the MCS-50T carrier self-report provided the sole account of the episode. These 28 accidents were relatively insignificant and required no police involvement. In the remaining 69 accidents, the police report constituted the only document in the file. Of these 69 accidents, 20 were sufficiently serious that the carriers involved were legally required to file the MCS-50T self-report but failed to do so.
Accident file contents further varied as a consequence of revisions in the motor carrier accident reporting system, as set forth in Part 394 of the *Federal Motor Carrier Safety Regulations* (1998). Prior to March 4, 1993, carriers were required to submit MCS-50T self-reports of all accidents that resulted in fatality, bodily injury, or the necessity to tow any vehicle from the accident scene. The completed reports were forwarded by carriers directly to the Office of Motor Carrier Safety. Beginning March 4, 1993, the Federal Highway Administration implemented a new system in which law enforcement agencies were requested to electronically transmit motor carrier accident reports to the Office of Motor Carrier Safety, thus relieving motor carriers of this responsibility. Despite these changes at the federal level, the State of Oregon continued to maintain its requirement that carriers submit MCS-50T self-reports whenever accidents meeting the above criteria occurred. Nevertheless, twenty-one qualifying accident files failed to include the required MCS-50T self-reports. In total, 45 of the 204 files evaluated should have contained the MCS-50T carrier self-report, but failed to do so. This evidence reinforces concerns raised by Jovanis (1989) regarding the reliability and validity of the MCS-50T motor carrier accident database used in many of the quantitative studies described in Appendix A.

Aside from the omission of required documentation, accident file contents displayed material inconsistencies. The gravity of these discrepancies ranged from mere clerical oversights to outright attempts to alter material facts. Thirty-two of the 204 files analyzed exhibited relatively insignificant discrepancies. For example, in 37 files, the MCS-50T self-report differed from the police report on some minor point, such as misstating the driver’s age by a year or incorrectly identifying the vehicle’s direction of travel while
correctly identifying the mile marker at which the accident occurred. Errors of this sort were considered indicative of nothing more than simple clerical mistakes.

In 16 other files, however, the investigating officers’ narratives differed substantively from the narratives provided on carriers’ MCS-50T self-reports. These discrepancies cannot be attributed to clerical oversight. Nine of these 16 accidents involved fatalities. The MCS-50T narratives associated with these 9 accidents altered or embellished the facts so that the culpability of the at-fault carriers was mitigated. Two examples illustrate such efforts to shift responsibility. As the report reproduced in Appendix E details, the Oregon State Police accident reconstruction investigation revealed that the at-fault truck driver executed a left turn at night onto a two-lane state highway from a shipper’s facility without stopping to evaluate the traffic situation. A Ford Taurus traveling on the two-lane highway at a speed estimated between fifty-five and seventy miles per hour impacted the driver’s side of the semi-trailer killing both occupants of the car. The subsequent investigation disclosed that events likely unfolded so quickly that the Taurus’ driver never perceived the hazard in time to react to it. Given an average reaction time of 1.5 seconds, the accident reconstruction team estimated that the Taurus was approximately 120 to 150 feet from impact as the truck driver pulled across the highway directly in its path. In contrast, the MCS-50T report submitted by the carrier included a statement by the at-fault driver in which he claimed that he (1) had stopped before entering the two-lane highway, (2) had activated his four-way hazard lights, (3) had looked both ways, (4) had observed no on-coming traffic in either direction, (5) had began executing the left turn when his associate in another truck a quarter of a mile ahead of him radioed back that a car was approaching at an excessive rate of speed, and (6) was then
struck by the aforementioned vehicle. The Oregon State Police Accident Reconstruction
Team concluded that the physical evidence evaluated at the scene did not support this
version of the “facts.” Moreover, the carrier failed to note that its own driver was under
the influence of cocaine at the time of the accident, a fact established through post-crash
drug testing.

The accident report reproduced in Appendix F illustrates a similar discrepancy
between the narrative prepared by law enforcement officials and that of the carrier
representative. In this winter-weather-related incident, the driver of a relatively light weight
semi-combination traveling westbound on an extremely icy stretch of Interstate 84 at a
minimum of forty miles per hour lost control of his vehicle. According to the accident
reconstruction report, the vehicle entered the median where it came to a complete stop or
nearly a complete stop. The driver then drove the vehicle westbound out of the median
across the eastbound travel lanes on to the south shoulder. He continued driving
westbound on the eastbound south shoulder for 450 feet at which point he again crossed
the eastbound travel lanes and lost control for a second time. The units jack-knifed
blocking the eastbound travel lanes and the semi-trailer was subsequently struck by an on­
coming eastbound mini-van. Two occupants of the mini-van were killed in the accident.
The carrier's narrative provided on the MCS-50T report claims that a westbound pick-up
truck lost control in front of the semi-combination, compelling the at-fault driver to
execute an evasive action to avoid a collision. The narrative further states that the semi­
combination came to rest at the accident impact point as a result of a single loss of
control. The accident reconstruction report clearly refutes this version of the incident. Its
authors wrote that, had the at-fault driver allowed his vehicle to remain at rest in the median after the first loss of control, the accident would not have occurred.

Similarly, the MCS-50T narratives associated with the remaining 14 accidents altered or embellished the facts so that the culpability of the at-fault carrier was mitigated. In 6 of these 14 accidents, carriers claimed the actions of other drivers were responsible for triggering the mishaps. Four other MCS-50T narratives asserted that mechanical problems triggered the accidents, although the at-fault drivers failed to mention these problems to investigating officers when the accidents took place. Of the remaining 4 accidents, one MCS-50T narrative claimed weather conditions far more severe than indicated on the police report decreased visibility, thus contributing to the incident. Another MCS-50T report stated a shifting load triggered the accident. This account contradicted the police report which held that the driver had fallen asleep. In yet another case, the carrier's MCS-50T narrative indicated that the driver failed to stop for a posted construction zone due to lack of adequate warning signs. The accident reconstruction report invalidated this claim by establishing that warning signs were appropriately placed to permit a safe stop had the at-fault driver complied with them.

Of the 204 accident files evaluated, 37 exhibited absolutely no discrepancies. These 37 files contained multiple accounts of the accident sequences documented in them, included the MCS-50T carrier self-reports when appropriate, and revealed no content inconsistencies between documents.
CARRIER EVENT CASCADE AGGREGATION SUMMARIES

The 204 preventable accidents analyzed in this study involved vehicles belonging to 52 motor carriers. Of those 52 carriers, 15 exhibited multiple preventable accident histories sufficiently expansive to merit stage two evaluation. Figure 9 identifies those 15 carriers and provides operational information about each. Of these 15 firms, stage two procedures ultimately identified distinctive recurrent elements in only 4 carriers' event cascade aggregations.

The minimal findings yielded through stage two procedures can be partially attributed to the lack of consistent information across files. Ninety-seven of the 204 accident files evaluated contained only solitary accounts of mishaps. Table 2 shows that 79 of these files are associated with carriers for which stage two procedures were conducted. The majority of these single-document files lacked depth. As such, numerous recurrent elements remained obscured simply because information about them was not recorded. For example, of the 29 accident files obtained for May Trucking Company, 18 consisted of a single document. Eight of these contained only the MCS-50T report while 10 contained only the police investigation report. Furthermore, although the MCS-50T reports revealed greater detail about carrier operations than did the police investigative reports, police reports described the accident sequences with greater clarity. So in practical terms, files that consisted only of MCS-50T reports revealed important information not contained in files comprised solely of police reports, and vice versa. Such inconsistencies greatly impeded the ability of stage two procedures to identify recurrent elements.
<table>
<thead>
<tr>
<th>Carrier Name</th>
<th>Domicile City / State</th>
<th>Nature of Operations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arrow Transportation Company</td>
<td>Portland, OR</td>
<td>For-Hire Carrier Hauling Bulk Liquid &amp; Solid Hazardous Materials</td>
</tr>
<tr>
<td>Boise Cascade Corporation</td>
<td>Boise, ID</td>
<td>Private Carrier Hauling Construction Materials &amp; Paper Products</td>
</tr>
<tr>
<td>J. B. Hunt Transport Incorporated</td>
<td>Lowell, AR</td>
<td>For-Hire, Truck Load Carrier Hauling General Commodities</td>
</tr>
<tr>
<td>May Trucking Company</td>
<td>Payette, ID / Salem, OR</td>
<td>For-Hire, Truck Load Carrier Hauling General Commodities</td>
</tr>
<tr>
<td>Navajo Express incorporated</td>
<td>Commerce City, CO</td>
<td>For-Hire, Truck Load Carrier Hauling Refrigerated &amp; Other Food Products</td>
</tr>
<tr>
<td>Prime / New Prime incorporated</td>
<td>Springfield, MO</td>
<td>For-Hire, Truck Load Carrier Hauling General Commodities</td>
</tr>
<tr>
<td>Safeway Incorporated</td>
<td>Clackamas, OR</td>
<td>Private Carrier Hauling Grocery Retail Products</td>
</tr>
<tr>
<td>Schneider National / Schneider Specialized Carriers</td>
<td>Green Bay, WI</td>
<td>For-Hire, Truck Load Carrier Hauling General Commodities</td>
</tr>
<tr>
<td>Sherman Brothers Incorporated</td>
<td>Eugene, OR</td>
<td>For-Hire Carrier Hauling Machinery, Construction Materials, &amp; Steel Products</td>
</tr>
<tr>
<td>Silver Eagle Company</td>
<td>Portland, OR</td>
<td>For-Hire, Less-than-Truckload Carrier Hauling General Commodities</td>
</tr>
<tr>
<td>System Transport Incorporated</td>
<td>Spokane, WA</td>
<td>For-Hire, Truck Load Carrier Hauling General Commodities</td>
</tr>
<tr>
<td>TNT Reddaway Truck Line / TNT United Truck Lines incorporated</td>
<td>Clackamas, OR / Spokane, WA</td>
<td>For-Hire, Less-than-Truckload Carrier Hauling General Commodities</td>
</tr>
<tr>
<td>United Parcel Service</td>
<td>Downers Grove, IL</td>
<td>For-Hire, Package / Courier Carrier Hauling Small Parcels</td>
</tr>
<tr>
<td>Viking Freight System Incorporated</td>
<td>San Jose, CA</td>
<td>For-Hire, Less-than-Truckload Carrier Hauling General Commodities</td>
</tr>
<tr>
<td>Werner Enterprises Incorporated</td>
<td>Omaha, NE</td>
<td>For Hire, Truck Load Carrier Hauling General Commodities</td>
</tr>
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Figure 9: Carriers Selected for Stage Two Procedures
<table>
<thead>
<tr>
<th></th>
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</tr>
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<td>2</td>
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**Table 2: Distribution of Preventable Accidents by Critical Proximal Elements**
Figures 10 through 13 present the carrier event cascade aggregation summaries for the four firms with adequate data to conduct stage two procedures. Figure 10 notes that J. B. Hunt Transport vehicles were involved in 6 preventable accidents resulting from excessive speed on icy or snowy highways. At least 3 of these 6 accidents occurred when drivers were operating vehicles transporting either very light weight cargo or no cargo at all. Light or empty trailers are much more apt to skid on slippery road surfaces than are fully loaded trailers. We see a similar trend at Schneider National / Specialized Carriers as depicted in Figure 12. These incidents emphasize a need for training to heighten drivers' awareness regarding the risks associated with such conditions.

The event cascade aggregation summary for May Trucking Company displayed in Figure 11 indicates that eight preventable accidents resulted when drivers failed to remain attentive. Accident documentation further noted that the average employment tenure of the drivers involved in these incidents was five months. Lack of experience can partially explain these episodes. Over the years, drivers gain familiarity with the symptoms of fatigue and drowsiness. As such, they know at what point they must pull off the highway and rest. Less experienced drivers may be caught unaware. Again, lack of experience coupled with insufficient training can logically account for the five preventable accidents that resulted when May personnel failed to adequately inspect equipment as required by Parts 392.7 and 396.3 of the Federal Motor Carrier Safety Regulations (1998). Experienced drivers know that the failure to conduct thorough pre-trip inspections can lead to costly delays if any mechanical problems are subsequently detected at state weigh stations. State and federal inspectors have the authority to place defective vehicles "out of service" as specified in Part 396.9 of the Federal Motor Carrier Safety Regulations (1998). Vehicles declared
<table>
<thead>
<tr>
<th>HUMAN FACTOR CATEGORY</th>
<th>RECURRENT ELEMENT</th>
<th>INFERRED DISTAL CONTRIBUTOR</th>
<th>EVIDENCE &amp; RATIONALE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Behavioral</td>
<td>Decision to drive at unsafe speed</td>
<td>Occupational socialization</td>
<td>Six preventable accidents attributable to loss of control on icy or snowy roads (Element C)</td>
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<tr>
<td>Medical</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operational</td>
<td>Training program</td>
<td></td>
<td>Multiple winter-related accidents involving light loads or empty trailers</td>
</tr>
<tr>
<td>Task</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Equipment Design</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Environmental</td>
<td></td>
<td></td>
<td></td>
</tr>
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Figure 10: J. B Hunt Transport Incorporated Event Cascade Aggregation Summary
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<tr>
<th>HUMAN FACTOR CATEGORY</th>
<th>RECURRENT ELEMENT</th>
<th>INFERRED DISTAL CONTRIBUTOR</th>
<th>EVIDENCE &amp; RATIONALE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Behavioral</td>
<td>Decision not to focus full attention on driving duties</td>
<td>Occupational socialization</td>
<td>Eight preventable accidents attributable to failure to remain attentive, alert, or awake (Element D)</td>
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<tr>
<td>Medical</td>
<td>Drowsiness and fatigue</td>
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<td></td>
</tr>
<tr>
<td>Operational</td>
<td>Training Program</td>
<td>Maintenance Policies</td>
<td>Five preventable accidents attributable to failure to conduct required equipment inspections (Element J)</td>
</tr>
<tr>
<td>Task</td>
<td>Driver Experience</td>
<td></td>
<td>Average employment tenure of drivers involved in these preventable accidents is five months</td>
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<td>Environment</td>
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</tr>
<tr>
<td>Design</td>
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Figure 11: May Trucking Company Event Cascade Aggregation Summary
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<th><strong>HUMAN FACTOR CATEGORY</strong></th>
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<th><strong>INFERRRED DISTAL CONTRIBUTOR</strong></th>
<th><strong>EVIDENCE &amp; RATIONALE</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Behavioral</td>
<td>Decision to drive at unsafe speed</td>
<td>Occupational socialization</td>
<td>Seven preventable accidents attributable to loss of control on icy or snowy roads (Element C)</td>
</tr>
<tr>
<td>Medical</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Operational</td>
<td></td>
<td>Training program</td>
<td>Multiple winter-related accidents involving light loads or empty trailers</td>
</tr>
<tr>
<td>Task</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Equipment Design</td>
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<td></td>
</tr>
<tr>
<td>Environmental</td>
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Figure 12: Schneider National / Specialized Carriers Event Cascade Aggregation Summary
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<tr>
<th>HUMAN FACTOR CATEGORY</th>
<th>RECURRENT ELEMENT</th>
<th>INFERRED DISTAL CONTRIBUTOR</th>
<th>EVIDENCE &amp; RATIONALE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Behavioral</td>
<td></td>
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<tr>
<td>Medical</td>
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</tr>
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<td>Four preventable accidents</td>
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</tr>
<tr>
<td></td>
<td>or chain down</td>
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</tr>
<tr>
<td></td>
<td>load to flat</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>bed trailer</td>
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<td>Equipment Design</td>
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<td></td>
</tr>
<tr>
<td>Environmental</td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

Figure 13: Sherman Brothers Incorporated Event Cascade Aggregation Summary
“out of service” cannot be moved until the necessary repairs are completed. Detained drivers lose wages, pay fines, and miss delivery appointments when defects are uncovered through such inspections. Enduring just one such costly delay usually teaches drivers that thorough pre-trip inspections are well worth the time.

Figure 13 presents the event cascade aggregation summary for Sherman Brothers Incorporated. This carrier specializes in the movement of heavy equipment, building products, and other materials transported on flat bed trailers. This firm’s vehicles were involved in four preventable accidents attributable to load slippage. Such accidents are almost exclusively related to flat bed operations. Given that these operations are the specialty of this carrier, these recurrent episodes indicate the need to address the problem through training.
CHAPTER 4

CONCEPTUAL ANALYSIS

In this chapter, the findings generated through the event cascade analysis process are integrated to formulate a conceptual model linking the proximal elements that directly trigger preventable motor carrier accidents with the more remote factors that underlie them. Figure 14 depicts these linkages. In the proximal environment, preventable accidents can be attributed to a combination of four factors: imprudent decision-making, failure to make a critical observation, failure to heed a directive, and compromised physical condition. The distal origins for these four conditions include occupational socialization, trip scheduling, training programs, task monotony, driver experience, and government regulations.

The conceptual model shown in Figure 14 was derived from the findings summarized in Figures 6, 7, and 8 from Chapter 3. The relative significance of the proximal contributors identified in Figure 14 was determined by the frequency that each factor triggered preventable accidents. Of the 204 accidents analyzed, 113 can be attributed to imprudent decision-making, by far the most influential factor. Imprudent decision-making was exhibited when drivers operated at speeds unsafe for conditions, failed to adequately secure their loads, became distracted from the primary task of operating their
vehicles, or failed to ask for assistance while executing turns in confined spaces or conducting backing maneuvers. The second most influential proximal contributor was the failure to heed a directive. This factor accounts for 35 accidents. These episodes occurred when drivers failed to obey traffic control devices such as lights, warning signs, or road restrictions. They also occurred when drivers failed to conduct daily vehicle inspections as directed by federal regulations. Compromised physical condition contributed to 31 preventable accidents, 30 of which were the result of falling asleep at the wheel. The remaining accident resulted because the driver was under the influence of cocaine. Lastly, the failure to make an observation accounted for 25 accidents. These episodes involved the failure to recognize conditions favorable for patchy ice, the failure to reduce speed before rear-ending a slower moving vehicles, the failure to observe pedestrians, and the failure to maintain a single lane of travel.

Interestingly, the relationships depicted in Figure 14 could be explained by a variety of established social science theories. For example, the decision to invest in occupational training could be understood using a human capital framework while the factors influencing the development of government regulations could be clarified using theories from political science and economics. In fact, many of the articles summarized in Appendix A were written by researchers who claimed to have used such established theoretical perspectives as the basis for their hypotheses. As stated in Chapter 1, however, these authors frequently failed to adequately demonstrate the linkage between their quantitative models and the underlying theory from which their hypotheses were ostensibly generated (See Appendix G).
Rather than attempting to explain the relationships identified in Figure 14 in terms of several discrete social science theories, I preferred to find a unifying body of knowledge specifically designed to address human performance in complex systems. The human factors literature provides such a framework. The following sections describe the relationships between the proximal factors and their distal origins specified in Figure 14 in terms of the human factors literature.

**IMPRUDENT DECISION-MAKING**

Wickens and Flach (1988) note general characteristics that define human decision-making activity. Individuals monitor external cues in an effort to assess environmental conditions on an on-going basis. These cues are evaluated on the basis of stored knowledge and past experience. The need for a decision is recognized when a cue is perceived as indicative of a problem. Individuals then enter into an assessment of the value and cost associated with each alternative capable of resolving the problem. The solution viewed as least expensive and most beneficial is ultimately enacted.

The Wickens and Flach framework can help us understand the distal origins of the imprudent decisions that contributed to many of the accidents analyzed in this study. According to this framework, drivers are routinely monitoring external cues. However, unless their existing knowledge base is adequate, cues indicative of danger may go completely unrecognized. Such was the case with the majority of the winter-weather-related (Element C) accidents in which drivers made decisions to operate at speeds that ultimately proved excessive for conditions, despite visual cues that highways were
Figure 14: Conceptual Model Linking Preventable Motor Carrier Accidents to Distal Contributors
hazardous. Based on the model advanced by Wickens and Flach, these drivers either lacked an adequate knowledge base to accurately evaluate the cues, or they erroneously decided that the benefits associated with driving too fast outweighed the potential costs.

Three distal factors account for such flawed reasoning. The failure to accurately evaluate cues can be directly linked to truck driver training programs. In schools operated both by carriers and private firms, classroom and behind-the-wheel training is often completed in less than two months. Based on recruiting literature distributed by Schneider National Carriers (1997), new hires without trucking experience spend two weeks attending classes followed by four weeks of over-the-road training, at which time they are declared fit to assume the duties of solo drivers. The Professional Truck Driver Institute of America (1988) maintains that drivers require additional training beyond these bare minimums before they are truly qualified to handle the responsibilities of solo operations. Lemay and Taylor (1988) point out, however, that carriers requiring even one year of over-the-road experience find it difficult to fill vacancies because the industry as a whole is plagued by a truck driver shortage. As long as these labor market conditions prevail, carriers are going to turn control of semi-trucks over to very inexperienced people, with one result being accidents attributable to imprudent decision making.

The cost-benefit aspect of the Wickens and Flach model explains how decisions to drive at unsafe speeds are influenced by yet another distal factor—trip scheduling. Almost all over-the-road truck drivers are compensated by the mile (Corsi and Stowers, 1991; Belzer, 1995; Kennedy, 1996): if the truck isn’t moving, wages aren’t being earned. Given this condition, drivers frequently conclude that the costs associated with slower speeds simply can’t be justified, regardless of cues indicating speeds should be reduced. Further
influencing drivers to press on regardless of external cues are the penalties associated with missing a scheduled delivery appointment. Missing a scheduled delivery time often translates into long delays until another appointment time can be arranged. Idle time is generally uncompensated time for the over-the-road driver. Thus, the benefits associated with meeting scheduled appointments are perceived to outweigh the risks connected with speeding.

**FAILURE TO MAKE A CRITICAL OBSERVATION**

The failure to make critical observations contributed to numerous preventable accidents analyzed in this project. In particular, the failure to recognize signs of drowsiness and fatigue were associated with 16 Element D accidents (failure to remain attentive to the driving task) and suspected in 14 others. For years, the federal hours of service regulations have been criticized by industry leaders, truck drivers, and the public in general as an ineffective method for addressing the safety risks posed by fatigued truckers (Ryder, 1990; Brandt, 1998; King, 1998). These criticisms are understandable since the hours-of-service regulations were implemented in the 1930s by the Interstate Commerce Commission and have remained fundamentally unchanged despite significant advancements in the understanding of circadian rhythms, a biological phenomena naturally regulating sleep patterns during a twenty-four hour period (Graeber, 1988).

Beaty (1995) notes that sleepiness exhibits a consistent twelve-hour rhythmic pattern. Hence, left to their own devices, people will be alert and active during the same time periods each calendar day. The hours of service rules articulated in Part 395 of the
Federal Motor Carrier Safety Regulations (1998) were written before knowledge about circadian rhythms had evolved to current levels. These rules state that drivers may legally drive for 10 hours, followed by 8 off-duty hours, followed by yet another 10 hour driving shift, and so on until the maximum on-duty time of 70 hours in 8 days have accrued. Clearly, adhering to this schedule requires drivers to sleep during different hours each day, a practice the medical community argues contributes to the likelihood of fatigue-related accidents (Mitter, Miller, Lipsitz, Walsh, and Wylie, 1997). This evidence indicates that the distal origins for some inattention-to-task accidents can be traced to antiquated government regulations which have not been updated as medical knowledge about sleep patterns has evolved.

The failure to make a critical observation can also be attributed to the fact that the driving task itself is one of vigilance (Shinar, 1978); that is, it requires continuous monitoring of cues which frequently reveal nothing significant. Such conditions breed boredom and complacency. Wilkinson (1969) conducted experiments that revealed humans can rarely maintain sustained concentration under such conditions for longer than thirty minutes. Hence, when engaged in boring tasks, they seek alternative ways to remain stimulated. Beatty (1995) relays an incident in which a commercial aircraft crew experiencing a period of boredom dealt with the problem by engaging in cockpit mischief. The DC-10 crew decided to see what would happen if they tried to override the automated control of an engine function. The episode culminated in an explosion, which projected engine parts through a cabin window allowing rapid depressurization, which in turn, led to the death of one passenger who was sucked out through the opening. Such
behavior on the part of a highly-trained, professional cockpit crew raises salient questions about the lengths to which a less disciplined truck driver might go to combat boredom.

**FAILURE TO HEED A DIRECTIVE**

Shinar (1978) speaks extensively about the aspects of driver personality that contribute to motor vehicle accidents. He and others (Tillman and Hobbs, 1949; McGuire, 1976; and Mayer and Treat, 1977) conclude that dangerous driving behavior is associated with social and personal maladjustment. For example, the unsafe driver is more likely to have encountered past trouble with the law or experienced conflict with other authority figures. Careless driving habits are commonly exhibited by people who are "loners" and lack significant social ties. Mayer and Treat's research indicates that persons with high accident involvement exhibit strong external locus of control tendencies, a personality trait associated with a failure to accept personal responsibility for life events. And Black (1966) conducted research that reveals people subconsciously belittle the more cautious, slower-paced driver, consider the use of seatbelts as "sissy" behavior, and believe a vehicle's greatest virtue is its sense of power and speed.

The dangerous driver profile drawn from this research stream is reflected in many of the beliefs and attitudes embraced by over-the-road truck drivers. Ouellet (1994) describes the "super trucker" persona to which many drivers aspire. These individual identify with independence and seek freedom from authority, work long shifts away from family and friends, and spend countless hours cleaning and polishing their trucks since vehicle appearance directly implies self-worth. Ouellet further notes that some super
truckers “cultivate an outlaw persona antagonistic to all authority.” Coupling these traits with the machismo attitudes articulated and rewarded throughout the industry, it is not surprising that a significant number of accidents examined in this research resulted from the failure to heed directives. Virtually all Element J (failure to conduct required equipment inspections) accidents are directly linked to such failures. Several Element H (speed excessive for maneuver attempted) accidents, a number of Element B (failure to avoid rear-end collisions) accidents, and at least two Element C (loss of control on icy or snowy road) accidents can also be tied to the failure to obey directives or heed warnings. The underlying attitude motivating such behavior can be traced to occupational socialization, a distal environment contributor.

COMPROMISED PHYSICAL CONDITION

Several distal factors augment the likelihood that compromised physical condition will play a role in triggering preventable accidents. Dement (1997) contends that for many occupations, including truck driving, the state of being sleep-deprived is considered a “badge of honor indicating hard work on an important job.” As mentioned previously, this attitude is transmitted to neophyte truckers through the occupational socialization process. It is further reinforced by carrier representatives who scoff when drivers plead fatigue before they log their maximum number of legally permitted driving hours. Even then, dispatchers quite often quibble about the number of hours logged for tangential duties such as loading, unloading, vehicle inspections, and fuel stops, implying that drivers overstate time spent performing these duties. I personally endured one such log book
"audit" in which the carrier's safety director ordered me to alter accurate entries into ones that significantly understated time spent loading the truck at a shipper's facility. The motivation for the directive was to remedy my out-of-hours status so that scheduled delivery times could be met.

Stone and Babcock (1988) point out that similar pressures are experienced by commercial flight crews. As is the case in the trucking industry, the expectation that trips be completed irrespective of physical condition is conveyed to pilots through occupational socialization. Pilots who delay trips for any reason, including fatigue, often experience ridicule and hazing by fellow pilots and superiors. Such pressure tends to result in conformity to others' expectations. Beaty (1995) describes such conformity as a "three-headed hydra" that threatens to set accident sequences in motion. According to Beaty, it arises in three forms: as blind obedience to an authority who may be mistaken, as acquiescing behavior used to avoid conflict, and as a means for garnering approval. Because conformity, regardless of its form, encourages individuals to do as other people are doing, rather than thinking through circumstances independently, one's behavior may be predicated on the judgment of the greatest risk-taker rather than on that of the most circumspect thinker.

Tolerance for driving while in a compromised physical state comes more frequently than one might expect from an unexpected quarter - the law enforcement community. Drivers involved in single vehicle Element D accidents (failure to remain attentive) evaluated in this study were rarely issued traffic citations. However, when sleep-deprived drivers triggered accidents that injured or killed other people, citations for careless driving were frequently written, and in the more heinous episodes, investigating
officers recommended that criminal charges be pressed. Dement (1997) compares this inconsistent response toward sleep-deprived drivers to the attitude exhibited toward drunk drivers in years gone by. He notes that activist groups such as Mothers Against Drunk Drivers effectively changed public opinion, thus modifying law enforcement's tolerance for such behavior. Dement further contends that a similar attitudinal metamorphosis is occurring with regard to sleep-deprived drivers. Groups such as Parents against Tired Truckers and Victims of Irresponsible Drowsy Drivers are increasingly lobbying legislative bodies to enact harsher laws to punish those who drive in a sleep-deprived state.

TESTING THE CONCEPTUAL MODEL QUANTITATIVELY

Numerous obstacles must be addressed before the conceptual model developed in this project can be tested quantitatively. Beyond the obvious challenges associated with operationalizing abstract concepts, more fundamental problems exist with data availability. As detailed in Chapter 3, accident files varied dramatically with regard to the information contained in them. Even in original police reports, a researcher isn't ensured that every file will contain the desired data. Relying exclusively upon reports that have been electronically transmitted to the Office of Motor Carrier Safety also fails to satisfactorily remedy the problem: these reports are very cryptic; furthermore, the researcher relying exclusively upon them lacks access to the ancillary reports from which details could be obtained. Examples of data omitted from electronically transmitted notifications include the number of years the at-fault driver was employed by the carrier, the source of his or her vocational training, the eight day hours-of-service history, and a comprehensive narrative of the
accident sequence. Unfortunately, the Federal Highway Administration's machine readable
data base, so attractive to quantitative researchers, is compiled exclusively from these
reports. Due to omitted information, its usefulness for testing the conceptual model
presented in Figure 14 is extremely questionable.

Other factors compound data access problems for researchers hoping to obtain
files directly from state agencies. Many states have not enacted open records laws as
expansive as the one in Oregon. In fact, at least two states, Illinois and California, refuse to
provide copies of accident files to parties without vested interests in the incidents.
Another, Georgia, does not maintain motor carrier accident files by firm name. Instead
drivers' names are used. Consequently, unless the researcher can provide driver names,
files cannot be accessed. In yet other states, fees are assessed for reproducing files.
Nevada, for example, levies a $5.00 charge per file requested. Such costs may present
insurmountable financial hardship to academic researchers.

Additionally, implementation of changes in the motor carrier accident reporting
system scheduled to go into effect 4 March 1993 got off to a slow start. Under the revised
system, law enforcement agencies took over the responsibility of electronically
transmitting qualifying accident information directly to the federal Office of Motor Carrier
Safety, thus relieving carriers of their responsibility to file MCS 50-T reports. However,
some states were unable to meet the 4 March 1993 compliance deadline. In fact, ten states
- CA, NV, NM, SD, TN, FL, SC, WV, NY, and MA - failed to file a single report during
1993. The highway networks in three of these states - California, Florida, and New York
accommodate substantial truck traffic. The lack of data from these three states alone constituted a serious deficiency in the federal data base for that year.

During subsequent years, the situation gradually improved as additional states became compliant. Despite increased reporting, however, the federal data base still failed to capture all qualifying accidents since not all branches of law enforcement in every state filed reports. For example, in Oregon, numerous accidents investigated by county sheriff offices or city police departments failed to appear in the 1994 federal data base.

CONSTRUCTING A CONCEPTUAL MODEL FOR CARRIER LEVEL DATA

The model depicted in Figure 14 was derived exclusively from data generated through stage one event cascade analysis procedures. Applying stage two procedures, I had hoped to generate a model that linked aggregated accident data to carrier-specific attributes. However, the results produced using stage two techniques were disappointingly scant. In fact, only one factor systematically emerged as a predictor of preventable accidents at the firm level: carriers engaged in the cartage of flat-bed commodities seem predisposed to experience roll-over accidents attributable to load shifting. Carriers not hauling such products seem much less predisposed.

While drawing any firm conclusions on the basis of stage two findings is premature, a review of Table 2 found in Chapter 3 hints at some interesting trends that merit further investigation. First, regardless of the carriers' operational attributes, all firms experienced Element C (loss of control on icy or snowy road) accident involvement. Many experienced Element D (failure to remain attentive to the driving task) and Element H
(speed excessive for maneuver attempted) accident involvement. In other words, carriers frequently exhibited preventable accident involvement attributable to shared proximal factors irrespective of distal-level firm idiosyncrasies. These findings raise a significant question: Perhaps the carrier attributes capable of predicting firm level accident rates are different from what many researchers (See Appendix A) have previously posited.

In the case of most Element C accidents, for instance, imprudent decision-making at the level of individuals initiated the accident sequences. In particular, numerous erroneous decisions were made regarding the speeds at which tasks could safely be executed. The process of making task-related decisions is largely taught to drivers during vocational training. As such, the quality of such training becomes of paramount interest to the researcher, and a predictor model for carrier accident rates should include a measure of training quality. Yet, not a single study of those enumerated in Appendix A included that variable in any model.

The lack of such variables in quantitative models is very understandable. They present numerous methodological challenges. First the researcher must operationalize the abstract concept, such as quality of training, and measure it at the level of the firm. Answers to questions such as what constitutes quality training – hours spent in the classroom, hours of behind-the-wheel experience gained, number of topics covered, qualifications of the instructor, rigor of the testing process, or some combination of these factors – must be determined. Once operationalized, data must be collected. Since a centralized repository containing data on the quality of truck driver training does not exist, the researcher would have to survey carriers, a time-consuming and expensive process. And firms that don't conduct training in-house, but rather recruit drivers on the basis of
experience would require a different data collection strategy. Drivers from those carriers would have to be surveyed individually to gain insight about their training experiences. Quality of training at firms that hire graduates from formal truck driving schools would necessitate yet another tact. Those schools' programs would require evaluation, necessitating more information gathering. The hypothetical data collection process for just this one variable - quality of driver training - illustrates the obstacles confronting researchers interested in testing the carrier level hypotheses suggested by this study.

MODELING EVENTS WITHIN COMPLEX SYSTEMS

For some researchers, the inability to test a conceptual model using quantitative methods detracts from the model's value or merit. I don't believe such to be the case with the model presented in Figure 14. Rather, I think the model presents challenges to researchers precisely because the phenomena it attempts to depict is highly complex. At best, the model is a gross oversimplification of the process by which motor carrier accidents evolve. To illustrate, let's consider a driver who received mediocre training from an unqualified instructor. Further suppose that this person was assigned to traverse a monotonous route, while conforming to an inflexible, demanding schedule. Despite exposure to several distal factors that this research linked to preventable accident outcomes, he or she never has an accident. The obvious question is why not.

Suppose early on in his or her career, the driver from our example had fallen asleep at the wheel, the expected outcome given the distal conditions described. As the vehicle left the paved surface, the driver was jarred awake. Rather than overcorrecting in a
panic, he or she gently guided the vehicle back on the highway with no detectable harm done. As a result of the experience, the driver learned first hand about the ease of falling asleep at the wheel. On future trips, he or she wards off drowsiness by listening to books-on-tape or stimulating radio talk shows. The data analyzed in this project omits entirely episodes such as this one since no accounting of near-accidents—episodes in which accidents were narrowly averted—is included. Yet, much could be learned from such incidents about the weaknesses in systems that create the potential for accidents.

Woods, Johannesen, Cook, and Sarter (1994) point out that “the story of error is complex because there are multiple contributors to an incident or disaster, each necessary but only jointly sufficient.” Cook, Woods, and Miller (1998) emphasize that attempts to classify performance errors into categories, as I have done with data in this project, actually obfuscates essential patterns or connections vital to understanding the distal characteristics that contributed to the negative outcome. Hollnagel (1993) refers to such patterns of contributing factors as genotypes. Cook, Woods, and Miller (1998) maintain that reporting systems, such as the one used to track motor carrier accidents, fail to capture essential genotypical patterns.

Accident investigation itself tends to ignore genotypical connections. Rather, it focuses on assigning blame to a specific individual through the evidence manifested in the proximal environment. From the standpoint of accident investigators, the actions of specific people at the time of the mishap are evaluated, not the underlying system that motivated such actions. Such an approach predisposes us to think about safety as a function of individual behavior, rather than as a rational response to constraints and demands imposed by a system. It further leads us to believe that by removing “accident-
prone” people from the system, it can be rendered safe. Reason (1990) challenges such thinking. He argues that “one should think of accident potential in terms of organizational processes, task and environmental conditions, individual unsafe acts, and failed defenses.” Individuals unsafe acts then are typically the product of pressures that originate in the distal environment. Consequently, improving organizational safety requires identification of those systemic factors likely to trigger unsafe acts, factors referred to by Reason as “latent failures.”

Let’s return to the example of the driver disadvantaged by inadequate training, a monotonous work environment, and demanding trip schedules to further illustrate how distal factors are de-emphasized when researchers rely on accident reports as the sole source of data. Instead of the near-accident episode described previously, this time let’s assume that the driver fell asleep, left the highway, struck a disabled vehicle parked on the road’s shoulder, and killed that vehicle’s two occupants. Investigators evaluating this incident will be expected to make legal judgments regarding the appropriateness of the truck driver’s pre-accident behavior – behavior that led to highly undesirable results. Most likely, investigators will assign primary responsibility for the tragedy to the driver, with the underlying logic being that any reasonable person should have recognized the signs of drowsiness and pulled off the road for a nap before falling asleep. However, when researchers accept this assessment, they are allowing hindsight bias, the tendency for people to judge decisions and actions based on the results produced, rather than to judge them in light of the context in which they were made (Fischhoff, 1975), to occlude the underlying contributors – task boredom, trip scheduling, and so forth – that created the context ripe for this deleterious outcome.
This discussion highlights the need for researchers concerned with motor carrier safety to expand the scope of their investigative efforts beyond mere accident reports. To fully appreciate the complex interplay between factors in the proximal and distal environment that ultimately result in unsafe acts, researchers need to evaluate obscure phenomena such as near-accident episodes. They need to observe the normal day-to-day protocol followed by motor carrier agents when interacting with drivers. They need to document the routine working conditions of truck drivers. In short, researchers should fully immerse themselves in the contextual details that generally result in nothing more than normal, seemingly “safe,” motor carrier operations.
Motor carrier safety is an issue about which numerous studies have been commissioned, many sponsored by special interest groups with their own perspectives on the problem’s root cause. The Insurance Institute for Highway Safety (1985), for example, distributed a publication replete with gruesome photographs of fatal truck-at-fault accidents. The study concluded that exhausted truckers operating poorly maintained equipment constituted the major safety threat on the nation’s highways. Another study commissioned by the same organization determined that drivers operating in excess of eight consecutive hours presented a primary road hazard (Jones and Stein, 1987). The Institute’s research is funded by a coalition of insurance companies with a vested interest in reducing the number of motor carrier accidents.

The American Trucking Association (ATA), an organization supported by industry participants which has as one of its goals to advance their interests politically, strongly objects to such publications. Former ATA president Thomas Donohue told a 1996 Commercial Vehicle Safety Alliance conference that the organization planned to aggressively respond to “unfair attacks” regarding the industry’s safety record. He
specifically targeted the nonprofit group Citizens for Safe and Reliable Highways as responsible for placing an unfair proportion of blame for highway fatalities on the motor carrier industry.

Government representatives often find themselves caught between such polarized groups. Activist groups want stricter rules to ease the public's safety concerns while industry leaders want reductions in restrictive regulations. These competing demands led the Federal Highway Administration to sponsor a 1995 conference that brought interested parties together for the purpose of identifying safety-related problems. The meeting included 200 representatives from the trucking industry, the manufacturing sector, law enforcement, and safety advocacy groups (Hamilton, 1995).

Conference participants identified seventeen critical motor carrier safety issues. These issues in descending order of perceived significance as determined by participant votes were: 1) fatigue; 2) lack of information regarding motor carrier accidents and their causes; 3) inadequate driver training; 4) development and deployment of safety-related technology; 5) development of uniform motor carrier regulations between Canada, Mexico, and the United States; 6) stepped up enforcement of existing regulations; 7) reduction in the demands placed on drivers by shippers and carriers that result in unsafe operations; 8) enhanced communication between the motor carrier industry and the public; 9) enhanced communication among all highway users; 10) review of commercial driver license testing procedures; 11) increased funding to enhance highway safety; 12) research on the effects of vehicle size and weight on safety; 13) evaluation of driver workload; 14) regulatory consistency across federal and state government agencies.
15) identification of infrastructure configurations that affect safety; 16) improved resource allocation for highway safety; and 17) identification of non-punitive countermeasures to prevent accidents.

Several of these concerns pertain directly to the preventable accident evaluated in this study. Event cascade analyses indicated that the number one issue on the conference participants' list - driver fatigue - clearly presents a safety threat on the nation's highways. The current mechanism for preventing fatigue-related accidents, adherence to the federal hours of service regulations, is an abysmal failure (Ryder, 1990). Drivers' attitudes toward the regulations are contemptuous. Furthermore, the industry is clamoring that the hours of service rules need to become more flexible (King, 1998). Truck load carriers, a segment of the industry particularly hard hit by the truck driver shortage problem, went so far as to advocate raising the maximum allowable on-duty hours to 120 in 8 days from the current ceiling of 70, using the circadian rhythm argument to support their position (Schulz, 1992).

While the literature on circadian rhythm is certainly germane to the hours of service debate, it alone cannot be relied upon to justify sweeping regulatory change. So doing leads us to trade one problem for another. We must also consider that driving is a tedious task. Kantowitz and Casper (1988) demonstrated that as people become bored, they tend to be less attentive to a monotonous task. In this study, inattention to task accounted for thirty-six preventable accidents, a substantial number. And not one of the at-fault drivers involved in these episodes had been at the wheel anywhere near the number of hours that the 1992 proposal would have permitted.

In Chapter 2, parallels between the job duties of pilot and truck driver were drawn to justify adapting the National Transportation Safety Board's aviation human factor
schema to this project. That occupational comparison is extended here to include a
comparison of federal hours of service regulations for commercial pilots versus those for
tuck drivers. According to Part 135.267 of the Federal Aviation Regulations (1994), flight
time limitations and rest requirements for unscheduled one and two pilot crews restrict a
pilot's total flight time during any 24 hour period to 8 hours for a flight crew consisting of
one pilot or 10 hours for a flight crew consisting of two pilots. Furthermore, the
regulations prohibit the accumulation of hours to exceed 500 in any calendar quarter, 800
in any two consecutive quarters, and 1400 in any calendar year. These restrictions are far
more stringent than those imposed on truck drivers under the 70-hours-in-8-days rule.
While a commercial pilot can legally fly 1400 hours in any calendar year, a truck driver can
work 3193.75 hours in the same time period. Given the similarities between these jobs,
such enormous variation in permissible hours is difficult to comprehend. The situation
certainly merits further investigation before widening the chasm even further through an
increase in the existing motor carrier hours of service rules.

The second issue identified by conference participants — the need to further our
understanding about the factors that trigger motor carrier accidents — is quite possibly the
most significant because without a clear picture of how accidents actually evolve, policies
designed to decrease them may merely target symptoms, not root origins. A major
objective of this study was to identify the distal roots underlying the proximal behaviors
that initiated preventable motor carrier accidents. The findings revealed that preventable
accident evolution is a complex process involving far more than isolated errors in
judgment occurring at a single point in time. Attempting to fashion sound policy on limited information invites unintended consequences, as was pointed out in the discussion regarding proposed changes to the hours of service regulations.

The third item identified by conference participants, inadequate driver training, has direct ties to preventable accidents based on the results generated in this study. As mentioned previously, driver training in the motor carrier industry is often conducted by other truck drivers through on-the-job training programs. The training literature identifies two major drawbacks associated with on-the-job training that is delivered by a coworker. First, coworkers who are quite competent performing the tasks themselves may lack necessary communication skills to teach someone else effectively. Second, coworkers pass on their own poor work habits and negative attitudes to the new employees during the training period (Schuler, 1995). This second criticism is particularly disconcerting considering that many of the attitudes embraced by truck drivers emphasize risk-taking and disregard for authority, and that they are very likely being conveyed to newcomers during the training sessions.

Two concerns identified by conference participants are actually interrelated: the evaluation of driver workload and the reduction in the demands placed on drivers by shippers and carriers that result in unsafe operations. With just-in-time (JIT) management techniques gaining favor as a means for controlling production and inventory costs (Quinn, Lieb, and Millen, 1990), carriers have had to refine trip scheduling procedures to meet extremely demanding customer expectations; freight cartage agreements frequently specify that loads arrive during narrow delivery windows of a half hour or less. Since late deliveries can literally shut down a JIT production line, motor carriers are under
tremendous pressure to ensure compliance with customer demands (Lambert, Lewis, and Stock, 1993). A purchasing manager at a large truck assembly plant described the demands an expediter at his facility placed on a motor carrier to delivery critical parts during an ice storm that had closed all major highways. He overhead the individual order the carrier representative “to get the parts to the plant, and don’t let me hear excuses about weather-related delays” (Swan, 1998).

When important customers exert formidable pressure on carriers, that pressure is almost certainly communicated to truck drivers. The impact of these conditions must be considered in the overall evaluation of driver work load. Urging drivers to meet delivery appointments regardless of unforeseen difficulties may compel them to continue driving when they really shouldn’t be behind the wheel. As such, it undoubtedly contributes to the imprudent decision making that leads to preventable accidents.

The few examples highlighted here emphasize the need for additional research to enhance our knowledge of motor carrier safety before public policy is revised or discarded prematurely. The 204 accident files evaluated in this study clearly demonstrate that preventable accidents occur all too frequently, often with dire consequences for those unlucky enough to have been sharing the highway with big trucks at the wrong time. Industry representatives might correctly argue that the majority of these accidents didn’t hurt anyone; that many were single vehicle, property damage only episodes; hence, the industry is relatively safe. However, that logic can and should be challenged. Any of the single vehicle accidents analyzed in this study had the potential to involve other vehicles. Whenever an 80,000 pound vehicle with a combined length of 60 feet or more careens out of control for any reason, the conditions cannot be termed safe regardless of the outcome.
This fact raises a critical question: Should carrier accident rates be considered a viable measure of industry safety given that they fail to capture dangerous episodes that had the potential to do substantial harm to others, but due to nothing more than random luck, did not?

Nance (1989) makes a crucial distinction about the relative safety of the airline industry as objectively expressed in terms of accident rates as opposed to understanding it in terms of a shrinking margin of safety that is difficult to quantify. The margin of safety concept can be applied to the motor carrier industry as well. It can be easily understood through a practical example. Consider the Schneider National Carrier accident discussed at length in Chapter 3. In summary, the accident involved a driver who lost control on an icy interstate, entered the median, and came to a stop or near stop. He then attempted to exit the median, losing control a second time in the opposing traffic lanes. His trailer was subsequently struck by a passenger van and two people were fatally injured. This episode is included in any objective measure of accident rates for the carrier. Suppose for a moment though, that the driver had lost control, entered the median, exited the median in the opposing traffic lanes, returned to the proper side of the interstate, and continued on to his destination with no one the wiser. While still constituting an egregiously unsafe incident, since it had not caused an accident, it would not have been reflected in any quantitative measure of safety.

The margin of safety concept helps us see that accident rates alone aren’t a viable reflection of safety. Other sources of data must also be evaluated to paint a meaningful picture of a carrier’s commitment to safety. One such data source is the information generated through satellite tracking systems such as OmniTRACS marketed by Qualcomm.
Incorporated (1998). These tracking systems, which rely on Global Positioning System (GPS) technology originally developed for military use, are capable of providing real-time information regarding the location and operation of any vehicle in a carrier's fleet. The records generated by such tracking systems contain a wealth of data about where the vehicle traveled, how long it was driven and at what speeds, where it stopped, and for how long. Some systems record critical vehicle operating characteristics such as speed, RPMs, water temperature, oil temperature, and oil pressure — data that when analyzed could reveal potentially unsafe driver behavior.

The Federal Highway Administration's efforts to gain access to GPS satellite records have been blocked, however, as a result of litigation initiated by the American Trucking Association Brandt, 1997). The trucking association attorneys argued that the Federal Highway Administration failed to follow applicable administrative rules before implementing the policy requiring carriers to turn GPS records over to agents during routine safety audits. As a result of industry efforts, GPS records are now off limits to federal inspectors unless permission of the Federal Highway Administration regional director is obtained. According to an agency representative, such permission is given only if "compelling reasons" for obtaining the information can be demonstrated Scrivner, 1998). This stance is unfortunate because GPS technology is capable of generating data that could shed abundant light on motor carrier safety issues. Perhaps the industry would be less resistant if assured that GPS records would be used in a non-punitive fashion to prevent accidents, in keeping with the recommendations made by the Federal Highway Administration conference participants in 1995, rather than as a means to levy fines against carriers.
Clearly, partisan groups are attempting to influence the direction of public policy as it pertains to motor carrier safety. The motor carrier industry wants less government involvement in its activities, while groups such as Parents Against Tired Truckers want increased monitoring of trucking operations. All too often, these groups perceive that they have nothing in common. Yet, the reality is that they do: both want motor carrier safety enhanced. It is the means for achieving the goal that are in contention.

Currently, policy makers are being confronted by polarized factions claiming radically different strategies will accomplishing a shared goal – safer motor carrier operations. The concern raised by this study is that not nearly enough is known about the way in which preventable motor carrier accidents unfold to formulate policies that would be effective in reducing these episodes. The environment in which motor carriers activities occur is complex. As documented in this project, numerous factors, both proximal and distal in concert with one another, play a role in contributing to unsafe operations. Without a thorough understanding of the ways in which elusive distal factors influence driver behavior behind the wheel, we cannot hope to improve motor carrier safety.
## APPENDIX A

### OVERVIEW OF MOTOR CARRIER SAFETY RESEARCH

<table>
<thead>
<tr>
<th>YEAR PUBLISHED &amp; SOURCE TITLE</th>
<th>AUTHORS</th>
<th>DEPENDENT VARIABLE DATA SOURCE</th>
<th>RESEARCH OBJECTIVES</th>
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<tr>
<td>1964 The Logistics &amp; Transportation Review</td>
<td>Corsi, Fanara, &amp; Roberts</td>
<td>USDOT MCS 50T (All Accidents)</td>
<td>Verify link between safety regulation compliance &amp; carrier accident rates</td>
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<td>1967 Insurance Institute for Highway Safety</td>
<td>Jones &amp; Stein</td>
<td>Commercial Vehicle Enforcement Section - Washington State Patrol</td>
<td>Identify factors associated with motor carrier accidents</td>
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<tr>
<td>1968 Journal of the Transportation Research Forum</td>
<td>Betlock &amp; Capelle</td>
<td>Survey conducted @ Florida Agricultural Inspection Station</td>
<td>Determine safety-related practices of long distance truck drivers</td>
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<tr>
<td>1968 Journal of the Transportation Research Forum</td>
<td>Betlock &amp; Capelle</td>
<td>Survey conducted @ Florida Agricultural Inspection Station</td>
<td>Explore perceptions of safety following speed limit increase to 65mph</td>
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<td>1968 American Journal of Public Health</td>
<td>Stein &amp; Jones</td>
<td>Commercial Vehicle Enforcement Section - Washington State Patrol</td>
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<td>1968 Transportation Journal</td>
<td>Corsi, Fanara, &amp; Jarrell</td>
<td>USDOT MCS 50T (All Accidents)</td>
<td>Evaluate the effects of deregulation on motor carrier safety</td>
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Figure 15: Overview Of Motor Carrier Safety Research

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<th>YEAR PUBLISHED &amp; SOURCE TITLE</th>
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<tr>
<td>1968 Journal of the Transportation Research Forum</td>
<td>Corsi &amp; Fanara</td>
<td>USDOT MCS 151 (Carrier Safety Audits)</td>
<td>Compare safety records of established carriers to new entrant carriers</td>
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<td>1968 The Logistics &amp; Transportation Review</td>
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<td>Identify carrier characteristics that predict accidents</td>
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<td>Chow</td>
<td>Motor Carrier Annual Reports - American Trucking Association</td>
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<td>1969 Transportation Research Record</td>
<td>Jovanis, Chang, &amp; Zabaneh</td>
<td>USDOT MCS 50T (Selected Routes - All Accidents)</td>
<td>Examine effect of vehicle configurations on accident rates</td>
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Figure 15 (continued)

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<tr>
<td>1995 National Transportation Safety Board</td>
<td>Investigation Team Report # PB95-917001</td>
<td>Driver Interviews</td>
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<td>Hunter &amp; Mangum</td>
<td>USDOT MCS 50T (Preventable Accidents)</td>
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APPENDIX B

A GUIDE TO DETERMINING PREVENTABILITY OF ACCIDENTS

The heart of accident analysis is the determination of the preventability based on the facts furnished in the accident report (MCS-50). The report must be evaluated in the light of all the facts pertinent to the cause of the accident. Digging out these facts from the information on the report form is difficult in practice due to the limited data contained on some reports. But the information can be obtained in many instances by a detailed analysis and reconstruction of the accident sequence.

Each accident must be judged individually. Certain types will generally fall in the non-preventable category, and certain others, in the absence of extenuating circumstances and conditions fall in the preventable category. The types of accidents listed below cannot cover every accident which may occur, but they are intended to provide general guidance to assist in determining preventability.

NON-PREVENTABLE ACCIDENTS

A. STRUCK IN REAR BY OTHER VEHICLE

Non-Preventable if:

1. Driver's vehicle was legally and properly parked;
2. Driver was proceeding in his own lane of traffic at a safe and lawful speed;
3. Driver was stopped in traffic due to existing conditions or was stopped in compliance with traffic sign or signal or the directions of a police officer or other person legitimately controlling traffic;
4. Driver was in proper lane waiting to make turn.
B. STRUCK WHILE PARKED

Non-Preventable if:

1. Driver was properly parked in a location where parking was permitted;
2. Vehicle was stopped, parked, or left standing in accordance with Sections 392.21 and 392.22 of the Federal Motor Carrier Safety Regulations.

PREVENTABLE ACCIDENTS

A. ACCIDENTS AT INTERSECTIONS

Preventable if:

1. Driver failed to control speed so that he could stop within available sight distance;
2. Driver failed to check cross-traffic and wait for it to clear before entering intersection;
3. Driver pulled out from side street in the face of oncoming traffic;
4. Driver collided with person, vehicle or object while making right or left turn;
5. Driver collided with vehicle making turn in front of him.

B. STRIKING OTHER VEHICLE IN REAR

Preventable if:

1. Driver failed to maintain safe following distance and have his vehicle under control;
2. Driver failed to keep track of traffic conditions and not slow-down;
3. Driver failed to ascertain whether vehicle ahead was moving slowly, stopped or slowing down for any reason;
4. Driver misjudged rate of overtaking;
5. Driver came too close before pulling out to pass;
6. Driver failed to wait for car ahead to move into the clear before starting up;
7. Driver failed to leave sufficient room for passing vehicle to get safely back in line.

C. SIDESWIPE AND HEAD-ON COLLISIONS

Preventable if:

1. Driver was not entirely in his proper lane of travel;
2. Driver did not pull to his right and slow down and stop for vehicle
  encroaching on his lane of travel when such action could have been taken
  without additional danger.

D. STRUCK IN REAR BY OTHER VEHICLE

Preventable if:

1. Driver was passing slower traffic near an intersection and had to make sudden
   stop;
2. Driver made sudden stop to park, load or unload;
3. Vehicle was improperly parked;
4. Driver rolled back into vehicle behind while starting on grade.

E. SQUEEZE PLAYS AND SHUTOUTS

Preventable if:

1. Driver failed to yield right-of-way when necessary to avoid accident.

F. BACKING ACCIDENTS

Preventable if:

1. Driver backed up when backing could have been avoided by better planning of
   his route;
2. Driver backed into traffic stream when such backing could have been avoided;
3. Driver failed to get out of cab and check proposed path of backward travel;
4. Driver depended solely on mirrors when it was practicable to look back;
5. Driver failed to get out of cab periodically and recheck conditions when
   backing a long distance;
6. Driver failed to check behind vehicle parked at curb before attempting to leave
   parking space;
7. Driver relied solely on a guide to help him back;
8. Driver backed from blind side when he could have made a sight-side approach.

G. ACCIDENT INVOLVING RAIL OPERATED VEHICLES

Preventable if:

1. Driver attempted to cross tracks directly ahead of train or streetcar;
2. Driver ran into side of train or streetcar;
3. Driver stopped or parked on or too close to tracks.
H. ACCIDENTS WHILE PASSING

Preventable if:

1. Driver passed where view of road ahead was obstructed by hill, curve, vegetation, traffic, adverse weather conditions, etc.;
2. Driver attempted to pass in the face of closely approaching traffic;
3. Driver failed to warn driver of vehicle being passed;
4. Driver failed to signal change of lanes;
5. Driver pulled out in front of other traffic overtaking from rear;
6. Driver cut-in short returning to right lane.

I. ACCIDENTS WHILE BEING PASSED

Preventable if:

1. Driver failed to stay in his own lane and hold speed or reduce it to permit safe passing.

J. ACCIDENTS WHILE ENTERING TRAFFIC STREAM

Preventable if:

1. Driver failed to signal when pulling out from curb;
2. Driver failed to check traffic before pulling out from curb;
3. Driver failed to look back to check traffic if he was in position where mirrors did not show traffic conditions;
4. Driver attempted to pull out in a manner which forced other vehicle(s) to change speed or direction;
5. Driver failed to make full stop before entering from side street alley or driveway;
6. Driver failed to make full stop before crossing sidewalk;
7. Driver failed to yield right-of-way to approaching traffic.

K. PEDESTRIAN ACCIDENTS

Preventable if:

1. Driver did not reduce speed in area of heavy pedestrian traffic;
2. Driver was not prepared to stop;
3. Driver failed to yield right-of-way to pedestrian.
L. MECHANICAL DEFECTS ACCIDENTS

Preventable if:

1. Defect was of a type which driver should have detected in making pre-trip or enroute inspection of vehicle;
2. Defect was of a type which driver should have detected during the normal operation of the vehicle;
3. Defect was caused by driver's abusive handling of the vehicle;
4. Defect was known to driver, ignored;
5. Driver instructed to operate with known defect.

M. ALL TYPES OF ACCIDENTS

Preventable if:

1. Driver was not operating at a speed consistent with the existing conditions of road, weather and traffic;
2. Driver failed to control speed so that he could stop within assured clear distance;
3. Driver misjudged available clearance;
4. Driver failed to yield right-of-way to avoid accident;
5. Driver failed to accurately observe existing conditions;
6. Driver was in violation of company operating rules or special instructions, the regulations of any Federal or State regulatory agency, or any applicable traffic laws or ordinances.
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Table 3: Motor Carrier Accident Files Obtained

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<td><strong>Totals</strong></td>
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# APPENDIX D

## MOTOR CARRIER ACCIDENT FILES ANALYZED

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APPENDIX E

MOTOR VEHICLE ACCIDENT RECONSTRUCTION REPORT

Company: Martinez & Elizalde Trucking
Warden, Washington

Date: 19 November 1992

Time: 9:00 PM

Location: Hermiston, Oregon
OPERATOR #1: GONZALEZ, JESSIE, PO Box 511, Warden, WA, Washington DL/J#3513R, DOB/12-23-65

OPERATOR #2: PETTITJOHN, HOWARD LAWRENCE, PO Box 574, Heppner, OR, ODL/599939, DOB/09-28-26, (DECEASED)

PASSENGER UNIT #2: PETTITJOHN, JO ANNE, PO Box 574, Heppner, OR, DOB/08-08-29 (DECEASED)

MEN YONED OTHERS:

MARTIN, CARL D., SR.TPR., Oregon State Police, Umatilla, Oregon, PH/922-5752

HOFFMAN, DAVID E., STG., Oregon State Police, Umatilla, OR, PH/922-5752

MACRANIAN, DAVID C., TPR., Oregon State Police, Umatilla, OR, PH/922-5752

STEWART, JACK, DEPUTY, Umatilla Co. Sheriff's Office, Hermiston, OR, PH/567-2346.

EXHIBITS:

#1: One urine sample from Jessie Gonzales

#2: Two red, round tail lights from Unit #1A

#3: One red, oval, rear marker light from Unit #1A

#4: One amber round, side marker light from Unit #1A

#5: One plastic wrap containing white substance.

Exhibits #2 through 5 were seized by Sgt Hoffman and stored at the Umatilla Patrol Office.

NARRATIVE:

Unit #1 and Unit #1A were just entering SR 207 near MP 14.6 to go northbound when Unit #2 which was southbound ran into Unit #1A. During the investigation interviews were made and exhibits seized.
On 11-19-92 at 9:15 PM, I was dispatched to a two vehicle accident on Hwy 207 near MP 14. Upon arrival I found a semi truck and trailer involved with a passenger car which was lodged under the semi trailer. The car and semi trailer were engulfed in flames and the Hermiston Fire Department was on the scene attempting to extinguish the blaze. I was advised by the fire department personnel that two subjects were trapped in the car (deceased) and that they had done nothing to the vehicle except use water to extinguish the fire.

Deputy Stewart was already on the scene and Sergeant Hoffman and Tpr. Macmaniman arrived a short time later. The Oregon Highway Department was notified and later came to the scene for traffic control and assisted in removing Unit #1A.

Trooper Macmaniman photographed the scene and obtained a scale diagram with the help of Sergeant Hoffman. The scene was also maintained to allow only emergency personnel on site. I contacted the witness and Operator #1 for statements. (refer to mentioned accident report.)

Upon completing Operator #1's statement, Sergeant Hoffman advised me that Deputy Stewart had found a possible controlled substance in the brush near Unit #1. I had given Operator #1 some field sobriety tests prior to this with his permission to include finger count and nystagmus. Operator #1 had no odor of alcohol on his breath and I noted only a jump in his eye pursuit when tracking first began at 90 degrees. No vertical gaze nystagmus was present.

Exhibit #5 was shown to Mr. Gonzalez by Sergeant Hoffman and Mr. Gonzalez denied it being his. I asked Mr. Gonzalez for a urine sample to which he agreed.

At 11:00 PM, at Good Shepherd Hospital Mr. Gonzalez was advised of his rights, which he understood and signed. The same form was turned over and filled out for a urine sample which Mr. Gonzalez understood and signed. Hospital staff supplied a urine collector whereby I accompanied Mr. Gonzalez to the restroom and witnessed the sample being given at 11:25 PM. With Mr. Gonzalez the sample was taken to the hospital laboratory where it was sealed with red tape and secured by myself. Mr. Gonzalez was then returned to the scene where he departed with the witness.
Sergeant Hoffman maintained Exhibit #5 and also gathered Exhibits #2 and #3 and #4 from Unit #1A. These exhibits were later turned over to myself at the Umatilla Patrol Office and along with Exhibit #1, all were entered into the evidence locker.

The two bodies at the scene were seated in the driver's seat and right front passenger seat of Unit #2. Both were badly burned, but the person in the passenger seat was identifiable as a female. Upon being removed the driver had a wallet under him which contained a driver's license to Howard Pettyjohn. Near the passenger was another wallet which contained a driver's license to Jo Anne Pettyjohn. Identification was made using these pieces of identification. Burns Mortuary was advised and proceeded to the scene and took possession of the remains after the fire department removed the doors from Unit #2.

Sergeant Hoffman, a Deputy Medical Examiner, was at the scene and authorized the removal of the remains. Umatilla County Deputy District Attorney, Robert Hill, was contacted by Sergeant White of the Bend Regional Dispatch Center and advised of the situation. Mr. Hill did not proceed to the scene.

At 3:23 AM, Sr. Tpr. Martin contacted a sister of Jo Anne Pettyjohn and made the death notification.

The driver's licenses belonging to Howard and Jo Anne Pettyjohn are being maintained at the Umatilla Patrol Office for safekeeping in the evidence locker.

Sergeant Hoffman and Tpr. Macmaniman subsequently recontacted Unit #1 and upon checking found all lighting equipment on Unit #1 operational.

Film taken at the scene is being forwarded to General Headquarters, Salem for developing. I request contact sheet returns only at this time.

Exhibits #1 through #5 will be forwarded to the Pendleton Crime Laboratory requesting a drug analysis on Exhibit #1 and an analysis of Exhibit #5 for controlled substance. Exhibits #2, #3 and #4 are to be checked for illumination upon impact.

Visibility from the accident north to the hill crest was checked with the aid of an odometer and found to be .4 of a mile.

Investigation continuing.
INFORMATION REPORT

DEPARTMENT OF STATE POLICE
SALEM, OREGON 97310

FATAL MOTOR VEHICLE CRASH

6 TIME
5:36 PM 30-FEB-92

8 COUNTY
1. Umatilla

INFORMATION REPORT dated 12-30-92 by Sergeant David Hoffman listing Howard Pettyjohn as the victim.

Mentioned for Data Entry

HOFFMAN, DAVID, Sergeant
Oregon State Police
Umatilla, OR
ph/922-5752

MACHANIKAN, DAVID, Tpr
Oregon State Police
Umatilla, OR
ph/922-5752

CAUDELL, RONALD, Sr Tpr
Oregon State Police
Umatilla, OR
ph/922-5752

CARTER, RICHARD, Criminalist
Oregon State Police Crime Lab
Pendleton, OR
ph/276-1816

SCHUERING, DAVID, Tpr
Oregon State Police
Pendleton, OR
ph/276-4090

Approved By

R.A. 1/22/92
SUMMARY: On 11-19-92 at 9:00 PM a motor vehicle crash occurred on SR207 near MP 14.6. Preliminary findings indicated that a 1987 Ford Taurus bearing Oregon License/NJR994 was southbound at an undetermined rate of speed. The vehicle was occupied by HOWARD and JO ANNE PETTYJOHN who were enroute from the Till City area to Hermiston.

A 1972 Kenworth Truck Tractor pulling a loaded 1988 Martinez potato pulled onto the roadway from a potato warehouse at that location. The Truck/Trailer unit attempted to make a left (northerly) turn with essentially the left middle of the trailer was struck by the Ford Taurus. After impact a fire erupted and both occupants were deceased at the scene.

ACTION TAKEN: On 11-25-92 at 9:00 PM, I was contacted by Sergeant DAVID HOFFMAN. He requested that I assist their office in the investigation of the above Motor Vehicle Crash.

On 11-27-92 at 3:00 PM, I contacted the above crash site. The location is on SR207/MP 14.6 approximately 2 miles south of MP 1.84.

SR207 at this location is a north-south/two lane/state maintained highway. The road surface is constructed of asphalt and appears to be in good condition. The surface area at the accident site is substantially damaged in the area of and adjacent to where the vehicles were engulfed in flames. The location of the resting position of the Ford was still evident from roadway damage. Slight shoulders and fogline border each side of the road surface and both lanes are divided by a broken yellow center line.

SR207 is a rural highway with occasional farms, ranches, and residences scattered throughout. Visibility at the crash site is restricted to approximately 1/8 mile in a southerly direction and approximately 4/10 of a mile to the north.

The road surface grade was not measured but seems nearly level.

At this time, I contacted Sergeant Hoffman who gave me a brief overview of the crash site, vehicle information, and statements. Sergeant Hoffman indicated there were absolutely no tire marks prior to the crash that they could locate. He further indicated that a small bundle of cocaine was found outside of the passenger compartment adjacent to the Truck Unit.

The trailer unit of unit #1 was still at the crash site and parked on an adjacent lot. The trailer was examined and is detailed along with vehicle damage analysis. (Refer figure 1) Contact damage...
appeared to begin on the left side 19 feet 6 inches from the front. The trailer showed severe tire
damage which appears to have started from the center and worked out towards each end. The lights
were missing as they had already been seized by Sergeant Hoffman. The trailer is a standard
agricultural trailer with an unloading belt in the bottom. The trailer is 40 feet in length. There
is no discernible related damage forward of 19 feet 6 inches. There is moderate undercarriage
damage that goes underneath the trailer from the 3rd cross member to the spare tire holder at an
angle of approximately 35 degrees and at a distance of 7 feet. The front axle of the tandem had
been displaced slightly, but at an angle not associated with the frontal impact but with the forward
motion of the trailer unit after impact. As the vehicle was situated there is 66 inches clearance
from the ground to the bottom of the trailer. There is 31 inches clearance from the ground to the
bottom of the 3rd cross member. 31 inches is also the height to the same location on the hood of
a normal Ford Taurus which is sitting level where gouges begin. This would indicate the Taurus was
level (not braking upon impact).

Sergeant Hoffman and myself conducted some testing regarding visibility, distances, speeds and
times. Results of these tests are listed in Table 1. These tests indicated there is approximately
2,179 feet of visibility from the where the truck began his acceleration and left turn from the
private drive. These tests also indicate that a vehicle entering the road at the private drive and
making a left turn (north) has approximately 21.36 seconds of time to complete that maneuver to
avoid a vehicle travelling southbound at 70 mph which is the alleged speed of the victims by the
witness statement. Sergeant Hoffman also timed my vehicle from the driveway to being fully in the
northbound lane at 18 seconds. This was done at an extremely low speed and acceleration rate easily
obtainable by this truck.

At 4:45 PM date Sergeant Hoffman and myself contacted Bert's Salvage in Hermiston to examine the
Ford Taurus. Examination of the Ford showed severe contact damage to the front end and all the way
back to the C-frame on the driver's side. The damage was nearly head-on, having an approximate
thrust angle of 90 degrees (Refer Figure 2). The roof portion of the vehicle showed significantly
more impact damage than the front end of the vehicle, however both areas were severely damaged. The
vehicle was heavily damaged by fire. The remaining front right tire showed good tread and appeared
to be in good condition. The steering axle was locked straight ahead. Existing contact damage would
prohibit any movement from this position upon removal. Remnants of the right front headlight were
located with the filament intact. The exposed filament was substantially uncoiled and indicates hot
shock indicating the right front headlight of the vehicle was activated at the time of the crash.

Additional examination showed a split fuel filler spout near the gas tank. A large gouge located
16 inches from the left front of the hood towards the center that went towards the driver.
Seat belt attachments were checked but were unable to be located. No crush measurements were taken of the Ford. The Ford subjectively was evaluated based on front impact damage at a range of speeds between 55 - 70 MPH. Speeds greater than this would most likely cause more damage to both vehicles. A speed substantially greater than this the Ford most likely would have exited the other side of the trailer.

At 6:00 PM date 1 contacted the Umatilla Patrol Office with Sergeant Hoffman. Visual examination was conducted of seized marker lamps. All lamps either showed no signs of hot shock or were indeterminate which was expected. What was notable is that all lamps were covered with dirt, hence reducing their visibility. The left middle marker lamp was unable to be seized as the lamp had completely melted during the fire.

On 12-10-92 at 4:00 PM, I was contacted by Criminalist RICHARD CARTER of the Pendleton Crime Laboratory. He advised that the urine sample obtained from the operator of the truck, JESSIE GONZALES, was positive for cocaine. He indicated by the concentrations in the urine that Mr. Gonzalez had most likely ingested the cocaine within 24 hours of the crash. He indicated the urine would be forwarded to a private company for additional analysis.

On 12-10-92 Sergeant Hoffman examined the Power unit of Unit #1. The vehicle was equipped with a Fuller Transmission Model RTO 9513 with a Rockwell 4.63 rear end. Driver Tires were 11R24.5 Goodyear and Toyo. Retreads with good tread. All lights worked except side marker light below passenger door at the rear.

On 12-10-92 at 9:00 PM I had Trooper DAVID SCHUENING observe and time 18 wheel truck trailer combinations as they exited the Arrowhead Truck Plaza. The times generated were from both a stop and a rolling stop (est. 4 Fps) and to where the entire unit after making a left turn onto the highway was completely in its lane of travel (Refer Table 2). Based on this information the average acceleration rate for a stopped truck was 0.10. The average time was 16.98 seconds and the distance was approximately 140 feet.

The average time for a rolling stop was 13.65 seconds (Table 1).

On 12-11-92 at 2:00 PM I began a time/distance/speed analysis based on stated speeds, witness statements, testing, and estimated acceleration factors. These analyses allow for the following conclusions:
1. The crash could not have possibly occurred if operator #1 had come to a complete stop, observed no traffic, and proceeded to make a left turn unless the Ford was travelling in excess of 92 MPH at a truck acceleration factor of 0.26, 99 MPH at 0.30, and 128 MPH at 0.50 (Table 6).

2. Unit #1's vehicle was not able to be tested for acceleration factor, however with a Cummins NVG 500 Engine, and a 4-63 rear end, coupled with drive axle tires of 11R24.5 it should be closer to 0.50 than to 0.30. This rear end gearing is designed for acceleration rather than top end. As would be the case with a 4-70 or a similar drive axle ratio.

3. Using the most probable acceleration factor of 0.30 to 0.50 for Unit #1, Unit #2 would have to be travelling 99-128 MPH for the collision to occur as described by operator #1 and witness #1 which is extremely unlikely if not impossible.

4. Using an acceleration factor for the truck of 0.50 and starting the truck out at 10 Feet per second (6.8 MPH) without stopping Unit #1 would have been at the impact area in approximately 5.5 seconds.

5. Using a range of acceleration factors of 0.26 - 0.30 the truck would have been 167 - 206 feet north of the access road. This is 27 - 66 feet more distance than necessary to avoid the collision. Any moving start would increase this distance and further reduce the ability of a collision. Using an acceleration factor of 0.50 would even place the truck further down the road. The distance from entering the roadway to collision point is about 108 feet. The times vary depending on acceleration factor and whether vehicle was stopped or moving when entering roadway (Table 3). The truck would have completely cleared the southbound lane in 140 feet.

6. The driver of the truck indicates his speed was around 7 MPH. Acceleration estimates provide a speed of 9-12 MPH. Based on the distance travelled after impact of approximately 8 feet, those speeds would appear to be reasonable. Any higher speed the truck unit most likely would have continued further prior to coming to rest.

7. The operator of the truck at an average acceleration factor of 0.30 would have been entirely within his lane in 17.07 seconds, travelling 11.21 MPH, and should have travelled 160 feet. Any higher acceleration factor would place unit #1 even further down the road and further away from the accident site.
FATAL MOTOR VEHICLE CRASH
V/ PETTYJOHN, HOWARD & JOANNE (Deceased)

Page 6

8 The Ford II travelling 70 MPH would have travelled the Point of Possible Perception Distance in 21.36 seconds, 65 MPH would have been in 23 seconds and 55 MPH would have been in 27 seconds (Table 1).

9 Distance from impact area to Point of Possible Perception is approximately 2,179 feet or 41 miles.

Analysis of statements of the surviving driver and witness provide the following information:

Operator #1 states that he stopped to take off his coat while witness #1 proceeded on SR20. He says he pulls to the highway, stops and looks, and no one was in sight. The witness is just tapping the rise. He then pulls out and gets hit. He never sees the Ford Taurus.

First of all it has been determined that the headlights and park lights of the Ford Taurus were on both through my visual examination and crime lab examination. The rise in question is approximately 2,179 feet north of the access road and is clearly visible.

The statements of operator #1 are not possible. If he could not yet observe the Ford then the Ford would have to be traveling at an excess of 99 MPH for the crash to occur. Also he would have had to see the headlights.

If operator #1 observed the witness to be at the rise, the witness would have had to back up nearly 2200 feet to the scene taking 5.8 minutes and at night which would be extremely unlikely let alone nearly impossible.

The witness states that he had pulled out and was in 2nd gear and about 1/4 mile north of the crash site. This would be approximately 1320 feet north of the scene at a minimum. He hears Operator #1 say "Here I come" on the CB and replies "Okay". The witness then sees the Ford go by him at what he estimates at a high rate of speed "Hauling ass" near 70 MPH. The operator then advised him to get back there because of an accident. He then backs up more than 1/4 mile to the crash site and assists.

The witness' statement appears to be not possible in that 1) He would not be in 2nd gear 1/4 mile north of where he pulled out and 2) He would be unable to back up over 1/4 mile during darkness and even if he did it would take him well over 5 minutes to back up. Back up speeds would be near 3 MPH, based on the gear ratio of low/reverse for that vehicle and available lighting. Therefore it
would appear to be more reasonable to conclude that the witness was substantially closer to the crash site than he indicates.

On 12-11-92 I contacted Senior Trooper RONALD CAUDELL. He advised that upon contact at the scene a Sheriff's Deputy had located a clear tinfoil type bundle with white powder adjacent to the passenger side of the truck on top of the grass just off the road. Sr Tpr. Caudell also indicated he observed a similar type package, opened and empty on the floor in the sleeper compartment of the truck. He indicated the driver's pupils were pulsating.

On 12-23-92 at 4:00 PM I contacted the Ford Dealership in Pendleton. They advised that ABS systems did not apply to Ford passenger vehicles until the 1990 model year. This eliminates ABS braking prior to impact.

On 12-23-92 at 5:00 PM I recontacted Criminalist Carter. He advised that it is his opinion based on the times of the urine sample and cocaine ingestion rates that the operator of Unit #1 most likely ingested cocaine just prior to the crash. He also advised that individuals under the influence of cocaine suffer impairment with time and distance determinations.

On 1-26-92 I again contacted Sr. Tpr. Caudell. He advised that he had contacted another witness who provided additional information regarding this crash. This witness stated that he came across the accident site after it happened, but did not see it. The operator of Unit #1 was out of his vehicle running around acting goofy. The witness vehicle was about 50-100 yards north of the accident scene backing up. The car was not on fire and the driver of Unit #2 was observed to move his hands. Some other people tried to help get the door open but they couldn't. A fire started and the people began to burn up and he left as there was nothing he could do.

Based on evidence gathered from the accident site, interviews and investigations by Sr. Tpr. Caudell, data collected by Trooper DAVID MACMANUS and Sergeant Hoffman, vehicle damage analyses, and time/distance analyses it is my opinion and conclusion that the crash occurred in the following manner:

CONCLUSIONS

First of all there is no reasonable explanation of how the accident could occur as described by witness #1 and operator #1.
Secondly, it is virtually impossible for the accident to occur as described by witness #1 and operator #2 if the vehicles would have been moving as described in locations as described there would have been no accident by at least 5 seconds and probably substantially more time.

The operator of Unit #2 was southbound at an undetermined speed but most likely travelling in the range of 55-70 MPH. The operator of Unit #2 probably observed the lead truck (Witness) pull out of the access road onto SR207 northbound. He was either distracted by the lights of the lead truck or temporarily blinded and was unable to perceive Unit #1 enter the roadway behind Witness #1. The headlights of the Truck of Unit #1 would be directed east and the trailer lights may not have been detectable due to being covered with dirt and being displayed at an angle.

The operator of Unit #1 while in the shed area ingested cocaine. He then rapidly entered the highway and did not look for any traffic. He told the lead truck “Here I come” and entered the highway. Since the headlights of Unit #2 were on, he should have been able to perceive Unit #1 and should not have attempted the maneuver. If Unit #2 headlights were not detectable to the operator of Unit #1 then Unit #2 would have been more than 2,139 feet away which is 5 seconds more than necessary for Unit #1 to clearly be in its proper lane and as indicated by time/distance analyses.

The operator of Unit #2 never did perceive the hazard until after he had reached the point of no escape and most probably not within his reaction time since there was no sign of reaction. The lights and movement of the witness vehicle, angle of the trailer, negligence of operator #2 in misjudging or not looking for a vehicle appear to be reasonable conclusions.

Unit #2 impacted the left side of the trailer 19 feet 6 inches from the front of the trailer at an angle of 35 degrees. The impact was entirely with the southbound lane which is the proper lane of travel for Unit #2. After impact Unit #1 travelled approximately 8 feet, which indicates a relatively low speed of 9 12 MPH. Unit #2 moved about 2 feet with the forward momentum of Unit #1 and rotated approximately 75 degrees.

The most reasonable conclusion for this crash is that witness #1 entered the highway at a normal rate of acceleration taking approximately 16-20 seconds to pull out into its correct lane of travel. As he was nearing the completion of his acceleration out of the drive he observed the headlights of Unit #2 coming towards him at a probable safe distance. At this time the operator of Unit #1 entered the highway at a rolling start of approximately 5-10 MPH and said on his CB that he was coming. Witness #1 saw Unit #2 coming and attempted to warn Operator #1, however operator #1 had already committed himself to the maneuver and had entered without looking for traffic. He
continued accelerating and was struck in the side of his trailer by Unit #2. The operator of Unit #2 most likely perceived Unit #1 outside of his reaction time (1.5 secs or approximately 120-150 feet from impact) therefore was unable to react prior to impact. The witness vehicle was only about 400 feet north of the scene and after being told of the accident by operator #2 backed up and eventually pulled back into the potato shed lot. These time frames take into account reasonable acceleration rates and time/distance analyses for all vehicles. This analysis also takes into account features of all statements that are reasonable and even somewhat remotely possible.

The operator of Unit #1 was under the influence of cocaine at the time of the crash. After the crash the operator of Unit #1 disposed of a bundle of cocaine from his person or vehicle outside the passenger compartment of Unit #1.

This crash was caused by the negligence of the operator of Unit #1. This operator was under the influence of cocaine and entered the roadway in an unsafe manner without first ascertaining if it was safe to do so and was unable to establish proper time/distance relationships due to being under the influence of cocaine. The operator never did see Unit #1 which is unexplainable. The operator most likely did not stop prior to entering the roadway and most likely entered at a speed greater than 5 MPH. The operator of Unit #1 most likely followed Witness #1 within 25-30 seconds after he left the access road.

**ACTION REQUESTED:** Request the Umatilla District Attorney's Office review this report to determine if sufficient evidence exists for the prosecution of FIRST DEGREE MANSLAUGHTER and POSSESSION OF A CONTROLLED SUBSTANCE - COCAINE against the operator of Unit #1, JESSIE GONZALEZ.

**EXHIBITS:** One Large 1", 20' Time/Distance Diagram is retained at the Pendleton Patrol Office (Partitioned diagram attached)

**CASE STATUS:** No further investigation
INFORMATION REPORT
DEPARTMENT OF STATE POLICE
SALEM, OREGON 97310

FATAL MOTOR VEHICLE CRASH

3 ORIGINAL SUBJECT OF THIS REPORT

11:19:22

9 Time

9:00 PM

15 Miles

12 Res Phone

13 Sex

13 DOB

SUMMARY

On November 19, 1992 at approximately 9:00 PM a fatal motor vehicle crash occurred on SR 207 near milepost 146. A southbound Ford Taurus struck the side of a truck/trailer combination and both occupants in the Ford were killed. Investigation into the crash indicated through time/distance analyses that the driver of the truck/trailer unit pulled out into the path of the Ford Taurus. The investigation also indicated that the operator of the truck/trailer unit was under the influence of cocaine at the time of the crash. The operator of the truck/trailer unit was subsequently charged with two counts of Criminal Negligent Homicide.

Initial testing was performed to determine various time/distance analyses of the crash situation to determine probability of speeds associated with each vehicle and compared with the witness statement and the surviving operator statement. These analyses that were performed in daylight hours concluded that the truck/trailer combination at very conservative acceleration factors would have easily been able to avoid the condition unless the Ford was travelling at rates in excess of 92 mph or more reasonably 99 mph.

On March 7, 1993 at 6:05 PM Sergeant DAVID HOFFMAN and myself conducted additional time distance analyses during the hours of darkness. The following results indicate an even greater speed would have to be developed by the Ford Taurus to have impacted the trailer based on the statements of the witness and surviving driver.
The following information was developed in accordance with the above nighttime testing:

- Measured distance from perception of headlights north of the site to driveway: 2.326 feet.
- Measured distance of onset of visible headlamp glow for southbound traffic on low beam: 2.810 feet (app).
- Additional time of observing headlamp glow during hours of darkness: 7 seconds (app).
- Total time of obvious vehicle approach from driveway (2 second time lag given): 21.55 seconds at 70 mph.

The following are the speeds that the Ford Taurus would have to generate for the crash to occur as the witness and operator stated:

**Acceleration Factor (Conservative): 0.26**

- At time of initial headlamp glow (2 second time lag given): 119 mph or 174 Fps
- At time of full headlamp visibility: 94 mph or 148 Fps

**Acceleration Factor (Probable Minimum): 0.30**

- At time of initial headlamp glow (2 second time lag given): 127 mph or 187 Fps
- At time of full headlamp visibility: 101 mph or 148 Fps

**Acceleration Factor (Possible): 0.35**

- At time of initial headlamp glow (2 second time lag given): 135 mph or 242 Fps
- At time of full headlamp visibility: 130 mph or 191 Fps
Several acceleration tests were also performed using the VG2002 accelerometer, an inertial navigation device. These tests showed that at acceleration rates as low as 0.17 (which was as slow as I could go) sufficient time existed to easily and safely enter the roadway and be in the northbound lane when southbound traffic headlights were easily observed.

CONCLUSIONS
The above testing concludes an even greater distance and speed analysis exists during the hours of darkness than existed during the hours of daylight, which was expected. This also creates an even larger discrepancy regarding the surviving operator's statement, which was also expected.

CASE STATUS
No further investigation
POST CRASH SITUATION MAP

Date: November 19, 1992
Time: 9:00 PM
Location: SR207, MP146
Inc. Officer: (Name Redacted), Senior Trooper
Diagram By: Gary G. Miller, Senior Trooper
## MOTOR CARRIER ACCIDENT REPORT

This form, MCS 50-T, shall be filed with the Oregon Public Utility Commission as required by ORS 394.9. Copy shall be retained in carrier's file. Circle (X) appropriate boxes below.

### 1. Name of carrier

Josie Elizalde & Damien Martinez

### 2. Principal Address (Street and No., City, State, Zip Code)

PO Box 164, Warden, WA 98857

### 3. AP No. 132229

### 4. Type of trip

- Over-the-road
- Local pick-up and delivery operation

### 5. Place accident occurred (Nearest Town or City, State)

Hermiston, OR

### 6. Street or highway (Rout Number or Name and Milepost)

Highway 301 (Blissfer Rd.)

### 7. Day of week

- M
- T
- W

### 8. Date accident occurred

11/19/92

### 9. Time accident occurred (Military time to nearest hour)

9:00 pm

### 10. ACCIDENT TYPE (Primary Event)

- Collision with moving object
- Collision with fixed or parked object

### 10A. Collision (Check appropriate box)

- Not applicable
- Collision with moving object
- Collision with fixed or parked object

### 10B. Collision (Check other object involved)

- Not applicable
- Pedestrian
- Animal
- Fixed object
- Bicycle
- Motorcycle

### 10C. Collision with another vehicle — Accident Classification (Check appropriate box)

- Not applicable
- Collision with another vehicle
- Collision with object

### VEHICLES

<table>
<thead>
<tr>
<th>VEHICLES</th>
<th>ACTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Slowing — Stopping</td>
</tr>
<tr>
<td>2</td>
<td>Intersection</td>
</tr>
<tr>
<td>3</td>
<td>Passed</td>
</tr>
<tr>
<td>1</td>
<td>Changed Lanes</td>
</tr>
<tr>
<td>2</td>
<td>Sideswipe — Opposite Direction</td>
</tr>
<tr>
<td>3</td>
<td>Ran-On — Crossed into Opposing Lane</td>
</tr>
<tr>
<td>4</td>
<td>Sideswipe</td>
</tr>
<tr>
<td>5</td>
<td>Vehicle Out-Of-Control</td>
</tr>
<tr>
<td>6</td>
<td>Roll-Away</td>
</tr>
<tr>
<td>7</td>
<td>Uncontrolled Railroad Crossing</td>
</tr>
</tbody>
</table>

### 10D. Non-collision (Check primary event)

- Collision with another vehicle
- Collision with object
- Overturn
- Separation of units
- Separation of units
- Fire
- Explosion
- Other (Specify)

### 10E. If not primary event, did accident result in

- Spillage of hazardous cargo
- Spillage of non-hazardous cargo

### 11. DRIVER INFORMATION

<table>
<thead>
<tr>
<th>Name of driver</th>
<th>Age</th>
<th>License No. (State)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Josie Gonzalez</td>
<td>26</td>
<td>GONZA J X 353 R3</td>
</tr>
</tbody>
</table>

### 11A. How long employed as your driver (To nearest year)

1 year

### 11B. Date of last medical certification

02-14-92

### 11C. Date of next medical certification

### 11D. Condition of driver

- Apparently normal
- Lost at wheel
- Medical waiver

### 11F. Hours driving since last period of 8 consecutive hours off duty

- 1 hr
- 3 hrs
- 5 hrs.
- 7 hrs.
- 9 hrs.
- 11-12 hrs
- Not applicable

### 11G. Total hours ON DUTY during last 7 consecutive days

- 5.5
- 8 consecutive days

### 11H. Estimate of hours worked during last 7 consecutive days

- Actual
- Estimated

Form MCS 50-T

PUC Form 239 (77) (05-68)
I was stopped before entering Highway 207 and turned my four
way lights on and looked both ways. Everything looked clear so
I proceeded to pull to Highway 207. Then my partner about a
mile in front of me called me on the radio and said a car
was headed my way in an excessive speed. Then vehicle 2
became visible and struck my axles on my left side of trailer.
APPENDIX F

MOTOR VEHICLE ACCIDENT RECONSTRUCTION REPORT

Company: Schneider National Carriers, Inc.
          Green Bay, Wisconsin

Date: 31 December 1993

Time: 5:16 AM

Location: Umatilla County, Oregon
<table>
<thead>
<tr>
<th>AGENCY</th>
<th>OREGON STATE POLICE - Pendleton</th>
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<table>
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<tr>
<th>INFORMATION REPORT</th>
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<tr>
<td>DEPARTMENT OF STATE POLICE</td>
</tr>
<tr>
<td>SALEM, OREGON 97310</td>
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</table>

| ORIGINAL SUBJECT OF THIS REPORT |
| FATAL MOTOR VEHICLE COLLISION |

| CASE STATUS |
| Cl by Accident |
| Unlocked |
| No Prosecution - Complainant |
| No Prosecution - Dist Any |
| Pending |

| Original Report Date | 12-31-93 |
| Time | 5:16AM |
| Written By | Markus W. Powell, Senior Trooper |

| Victim or Complainant |
| STIRLING, DOLORES ANNE |

| Residence Address |
| 65 West, 1200 North, Pleasant Grove, UT 84062 |

| Phone | 571-1234 |
| Race | White |
| DOB | 01-01-74 |

| Details (Use Additional Plain Sheets as Necessary) |
(Refer to attached sheets)
ADDITIONAL VICTIMS:

STIRLING, DANIEL JAMES (Deceased)
Same Address
DOB/042678

STIRLING, DEL ARTHUR (Injured and Operator of the Plymouth)
Same Address
DOB/013075

STIRLING, KEITH HENREY (Injured)
Same Address
DOB/040338

VEHICLES:

Unit #1, #1A - 1992 Intl TT, Il Lic/P103676 and a 1990 Wabash ST/ Il Lic/508263ST registered to Schneider Inc.

Unit #2 - 1990 Plymouth Grand Voyager, Ut Lic/817EFF registered to Keith H. Stirling.

MENTIONED:

BELL, WILLIAM ARZELL; 2680 E. Highland Apt #812, Highland, CA
Phone/1-800-848-6581 (Operator of Schneider Vehicle prior to Jack-knife)

MORRIS, ROGER L., Sergeant
Oregon State Police
700 SE Emigrant
Pendleton, OR 97801
Phone/278-4090

POWELL, MARKUS W., Senior Trooper
Oregon State Police
REFER TO:

Information report dated 01-03-94 by Trooper David Schuening listing the victim as STIRLING, DOLORES ANNE (DECEASED).

NARRATIVE:

On 12-31-93 at approximately 5:16AM a motor vehicle collision occurred on I84/MP198.1. The collision was in the eastbound lanes and involved a stationary truck trailer combination that had jackknifed and was blocking most of the roadway. This vehicle was struck in the left rear of the trailer by a Plymouth Voyager. Two occupants of the Plymouth were
deceased at the scene.

ACTION TAKEN:

On 12-31-93 at approximately 6:45AM I was contacted at my residence by Sergeant Roger Morris and requested to respond to the above collision scene.

At approximately 7:25AM date I arrived just east of the collision sight. At this location approximately 1/4 mile east of the scene I conducted 3 deceleration tests with the VC2000. The results of the tests were that the deceleration factor for the icy road surface was .18. This is for the tested vehicle which is equipped with 4, studded traction tires. A non-studded vehicle would have a lower deceleration factor of approximately .15.

At, approximately 7:30AM date I arrived at the scene. I was contacted by Sergeant Morris, Senior Trooper Markus Powell, and Trooper David Schuening and apprised of the situation.

The scene was photographed and then measured using a total measuring station along with conventional methods.

At 11:45AM date both vehicles were examined at Batt's towing, Pendleton. PUC inspector Paul Leidig and myself conducted the examinations. Unit #1 was in good working order with the exception that the right rear trailer duals were both out of adjustment and therefore the vehicle was placed out of service for defective brakes.

At approximately 12:30PM a urine sample was obtained with consent from the prior operator of the vehicle Mr. Bell. this sample was forwarded to the Pendleton Crime Lab for Analysis.

Port of Entry personnel at Farewell Bend advised of the following information:

Unit #1 crossed the scales at 5:57PM MST

Weights:

Drive axle - 10,900
Drivers - 15,200
Trailers - 15,000
Total - 41,100

Preliminary Observations:

The road surface was extremely icy. There was an area of tire ruts and furrows in the median strip just east of the scene. Located in the left lane/shoulder area was a Plymouth Grand Voyager that was facing north. Located in the middle left rear seat was a deceased middle aged female that had massive head injuries.

West of the Plymouth was another deceased subject. This subject was a younger male and again had massive head injuries. There was substantial brain matter on the roadway and throughout the scene. This matter appears to have come from the deceased female as the head of the younger male appeared to be intact.

Just west of the male deceased was a Schneider truck/trailer combination that was in a jack-knife position blocking most of the roadway. Between the left rear of the trailer and the south fog line was the rear hatch door of the Plymouth.

Examination of the tire tracks of the Schneider Truck appeared to indicate that the unit was westbound in the westbound lanes where the vehicle began a trailer swing/jack-knife type motion while in the middle of the lanes westbound. The unit then slid sideways through the median. Just prior to entering the eastbound lanes the furrows and ruts stopped and two sets of very deep, rutted, in-line tire acceleration marks were observed. The tire marks turned into tire prints as it entered the eastbound lanes going westbound. The tire prints continued in a gradual steering motion towards the south shoulder of the westbound lanes and then continued parallel to the right lane down the shoulder area for about another 100 feet. Where the unit entered the westbound lanes there was a normal amount of trailer off-tracking included with the tire prints. Trooper Schuening advised that these westbound tire prints had been detected for another couple hundred feet upon his arrival some 45 minutes to an hour earlier. There is an area of about 100 feet of no tire markings detected, then there were numerous tire skid marks that veered off into the location of where the truck had jack-knifed and came to a rest in the median.

No roadway markings of any kind could be observed prior to the collision scene in the
eastbound lanes. Senior Trooper Markus Powell advised upon his arrival there were approximately 3 feet of tire slide marks west of the left rear trailer duals, however they were unable to be detected upon my arrival. There was a moderate amount of trailer scrape damage on the left side of the trailer. The operator of the Schneider unit advised that much of that was prior damage. Near the far left rear of the trailer, fresh paint, scraping, and glass debris was observed. Underneath the rear of the trailer and on the front (inside) of the ICC bumper was paint, scrapings, and brain matter debris. From the rear of the trailer rotational skidmarks were observed to the Plymouth. There were several pieces of reflectors scattered about and two reflector bases were observed.

The Plymouth was severely damaged with left side, top, and rear damage contact damage being present. There was a heavy amount of induced damage throughout the vehicle.

Roadway analysis:

I-84/MP198.1 is a state maintained, four lane freeway, constructed of concrete, with each set of lanes bordered by asphalt shoulders. The lanes are divided by a grassy median. The road surface has standard fog line and center line configurations. The road surface appears to be in good condition and no surface defects were noted. The road surface was covered with ice at the time of the collision. In the westbound lanes approximately 108 feet prior to the median ruts were skidmarks as the Schneider vehicle initially lost control. These tire skids continued through the median as the trailer slid in an angular movement for about another 150 feet. The vehicle then straightened out and drove up onto the westbound lanes where tire prints were observed for about 200 feet where they ceased to be observed. There are about 90 feet of skidmarks from the Schneider vehicle as it jack-knifed once again and slid to a rest into the median.

There were no pre-impact marks detected for the Plymouth. Post impact rotational skidmarks were observed and measured at approximately 107 feet.

The roadway had southbound and westbound grades of minus .01 percent respectively.

Vehicle analysis:

Plymouth: The Plymouth had initial contact damage beginning 11 inches rear of the B-
pillar at a maximum height of 36 inches from the ground. There was extreme amounts of contact and induced damage throughout the vehicle. Indications are that the Plymouth initially collided with the left rear of the trailer with the left rear of the Plymouth, however initial thrust forces for the Plymouth are difficult to determine, as well as the rotational and exit pattern of the Plymouth. My opinion would be that the vehicle collided left side between the duals and ICC bumper, rotated clockwise with the left side and rear of the Plymouth striking the inside of the ICC bumper. This action tore off the rear door and ejected the cargo and male deceased to their resting points. The vehicle then rotated through to its point of rest after deflecting off the ICC bumper.

Schneider Tractor and Trailer: The Tractor was essentially undamaged. There was some minor amounts of damage to the right rear due to the jack-knife action. The trailer had recent damage in several areas. There was very fresh damage beginning 64 inches forward of the left rear of the trailer. There were paint transfer marks and safety glass beads on the frame rail. Underneath and on the inside of the ICC bumper were similar marking along with substantial amounts of brain matter.

Vehicle Dynamics:

Unit #1 was westbound at an excessive speed for the road conditions. The operator lost control of his tractor/trailer combination and slid at least 108 feet before entering the median strip. From there the vehicle was in a sideways skid or trailer swing for another 164 feet through the median. At this point the tractor tires were causing cuts from acceleration. The vehicle tracks then begin to straighten out. The unit then drives leaving rolling tire prints for 80 feet as it crosses the eastbound lanes towards the south shoulder. From there the tire prints continued for a reported distance of approximately 200-300 feet. About 90 feet prior to the resting position of the Schneider unit Skidmarks could be detected near the middle of the roadway indicating the tractor/trailer unit had attempted to cross back over the eastbound lanes. The operator again lost control of the vehicle and slid some 60 feet on ice and an additional 30 feet on gravel and dirt to where it came to a rest in a jack-knifed position. The entire scene of the first loss of control, the second loss of control and of where the unit came to rest encompassed a total distance of at least 803 feet.
After a duration of up to 15 minutes Unit #2 (Plymouth) encountered the disabled truck blocking the roadway. The operator of Unit #2 was travelling at a speed which was excessive for the road conditions. The operator was unable to evade the rear of the disabled vehicle and collided with the left rear of the semitrailer. Unit #2 then went under the rear portion of the trailer and deflected off the inside of the ICC bumper some 107 feet where the vehicle came to a rest on the north shoulder of the eastbound lane.

**Speed Analysis:**

Unit #1: The operator of Unit #1 stated to me he had just entered the freeway from Exit 202 and was in 7th gear at an unknown RPM. He was travelling 35-40mph (later said 30-35mph) as other truckers had told him the roads were okay. The vehicle was equipped with a Fuller 9 speed transmission having a black handle and black flipper switch. A request was made with Schneider for drive axle ratio and transmission gear ratios with negative results. The radius of the drive axle tires were measured at 20 inches. Using comparables of a 3.9 drive axle ratio, 1.34:1 gear ratio for 7th gear, and 1600 to 1900 rpm values an approximate gear speed analysis would be 36 to 43 mph. Using a Slide to Stop analysis the estimated speed at initial control loss would be approximately 40 mph.

**Gear Speed analysis:**

\[ V = \left( \frac{\text{RPM} \times 2 \times \pi \times R}{T \times D \times 60 \times 12} \right) \]

\[ S = \frac{V}{\left( \frac{5280}{3600} \right)} \]

**Definitions:**

- \( \text{RPM} \) = Rpm's of vehicle
- \( \pi \) = 3.1415
- \( R \) = Rolling Radius of Drive Axle tire
- \( T \) = Transmission gear ratio
- \( D \) = Drive Axle gear ratio
- 60 = constant
- 12 = constant
An analysis of pre-impact skids and tire marks breaks down as follows:

\[
\begin{align*}
D_1 &= 108 \\
D_2 &= 119 \\
F_1 &= .15 \\
F_2 &= .45 \\
N_1 &= .85 \\
N_2 &= .85 \\
F_{a1} &= .12 \\
F_{a2} &= .38 \\
S_1 &= 19 \text{ mph} \\
S_2 &= 36 \text{ mph} \\
S &= 40 \text{ mph}
\end{align*}
\]

\[S = S_{gr}(30N*F*D)\]

This analysis indicates an estimated minimum speed of Unit #1 at initial control loss of 40 mph.

Speed analysis at the area of second control loss, jack-knifing and disablement is as follows:

\[
\begin{align*}
D_1 &= 60 \\
D_2 &= 30 \\
F_1 &= .15 \\
F_2 &= .45 \\
N_1 &= .85
\end{align*}
\]
N2 = .85  
S1 = 15 mph  
S2 = 18 mph  
S = 23 mph

Total Speed for continual motion from initial control loss to point of rest would be as follows:
D = 450 feet (Rolling Resistance for distance between both skid areas)  
F = .05  
S = 25 mph  
S1 = 40 mph (slide to stop estimate for initial control loss)  
S2 = 25 mph (above rolling resistance estimate)  
S3 = 23 mph (slide to stop estimate for secondary control loss)

Combined Speed = 52 mph

Unit #2:
No Pre-Impact speed analysis can be made on Unit #2

Post Impact speed analysis would be as follows:
D = 107  
F = .15  
N = .8 (Rotating Vehicle)  
S = 19 mph

Speed necessary to avoid collision:
Unanticipated Perception/Reaction time = 1.5 secs
f = .15

Visibility (limited only by darkness and headlamp configuration) = app. 300 feet

Distance to brake = 227 feet
Distance to react = 70 feet

Probable avoidance speed = 32 mph

STATEMENTS:

The following subjects gave insubstance statements to myself or Senior Trooper Powell regarding circumstances surrounding this collision. Listed below is a summary of their statement:

Craig Desler - He was operating a pickup going 35-40 mph as it was very icy. He observed some headlights gaining on him and realized it was a truck. He pulled over to the shoulder area so as there was more room for the truck to get by. As the truck went by it went out of control and slid into the median. He then watched the vehicle go the wrong down the freeway for a couple hundred yards. He did not see the collision only the initial loss of control.

Larry Weems - He could hear talk on the CB radio of a truck jack-knifed in the road and other people telling the driver to get his reflectors out. He first saw the truck and flashers going at 195 EB. As he approached the area of the blockage he was within 100 yards of the truck before he could see it. He was going about 45 mph and almost collided with the truck. The driver of the jack-knifed truck was still sitting in the cab talking and everyone was telling him to get his reflectors out. The Jack-knifed driver was still talking on the CB when he passed Woodpecker Trucks.

Del Stirling (Operator of Plymouth) - He was travelling at 65 mph. He was unaware that it was icy. He saw reflectors and then saw one subject standing by the rear of the trailer. He hit his brakes and the van slid sideways into the back of the semi-trailer.
William Bell (Operator of Schneider) - He had stopped at the Exit 202 PM at around 6:00PM last night. The roads were bad so they just stayed there. He had just left that area a few minutes prior to the incident. He was westbound in 7th gear at an unknown rpm and travelling at a speed of 35-40mph (later said 30-35mph) A small pickup he was following hit its brakes which in turn caused him to hit his brakes. When he hit his brakes he started sliding and slid into the median. He then in the same continuous act went into the eastbound lanes to the shoulder and was able to steer down the shoulder. He travelled several hundred feet where he eventually jack-knifed. He and his co-driver got out and put out reflectors and tried to warn traffic. A vehicle came up very fast and slid into the trailer. They had been jack-knifed about 5-10 minutes before the collision.

Conclusions:

1) Physical evidence at the scene indicates that Unit #1 was travelling at a minimum speed of approximately 40mph when initially losing control. Statements indicate that Unit #1 was travelling 40mph or more at the time of initial control loss.

2) Statements at the scene indicate that the Plymouth was travelling approximately 65mph just prior to impact. There is no physical evidence to make a pre-impact speed analysis.

3) Evidence at the scene indicates that Unit #1 lost control twice during this incident. The driver once and slid into the median. Then powered out of the median from a complete stop or close to a complete stop and drove under control into the eastbound lanes and down the eastbound south shoulder. Unit #1 then after about 450 feet attempted to cross the eastbound lanes, losing control a second time at a speed of approximately 21mph. This secondary control loss caused the jack-knifing and eventual road blockage.

4) If Unit #1 would have remained at rest or stopped after the first loss of control the collision would not have occurred.

5) If Unit #2 would have been going 32mph or less the collision would probably have not occurred.

6) If the loss of control occurred as the driver of Unit #1 stated, the vehicle would have been going 52mph at initial control loss and the vehicle would have slid off the
south shoulder instead of going straight down the south shoulder. There would also be a
different tire print pattern and a different offtracking pattern than what was observed.
Also the tire acceleration ruts would be absent.

7) The deceased occupants of Unit #2 were not wearing any safety restraint devices and
from their body positioning at pre-impact would most likely have been fatally injured or
seriously injured at any impact speed of 35mph or greater.

8) Both vehicles were in violation of the basic rule in regards to road surface
conditions, however the driving pattern of Unit #1 constitutes Reckless Driving.

9) The log book of William Bell was falsified to the extent that he logs that he was at
Exit 202 at 6:00PM when it reality he 160 miles away at 4:57PM making his log book entry
impossible. No other violations were noted.

10) Results of the urine sample are not available at this time.

Unit #1 was westbound travelling at minimum speed of 40mph which was an excessive speed
for the conditions present. As Unit #1 went to pass witness Gesler, he lost control
on the icy road surface. The Unit then slid into the median where it decelerated to a stop
or a near stop. Approximately 18 feet from the eastside lanes the vehicle spun it’s driver
tires leaving tire rut marks. The Unit then drove across the eastside lanes to the
eastside shoulder and down the eastside south shoulder approximately 300 feet. At this
time the operator then tried to cross the eastbound lanes back to the westbound lanes. As
he attempted to do this he again lost control, jack-knifing and blocking most of the
roadway. By delaying placement of reflectors he nearly caused another collision with
witness Weems Vehicle. Unit #2 was eastbound in the eastbound lanes at a approximate
speed of 65mph. This speed was excessive for the conditions present. Upon perception of
Unit #1 blocking the roadway the operator of Unit #2 hit his brakes and the vehicle
rotated clockwise and collided left side first into the rear of the trailer. The
positioning of the resting heads of the middle left and rear left occupants of Unit #2
were such that the heads directly collided with the frame rail and ICC bumper of Unit #1A.
Unit #2’s speed was such that the vehicle went under the trailer, deflected off the inside
of the ICC bumper and rotated and skidded to its resting location.
Exhibits:

1 - 2 rolls of 36 exposure of 400 ASA color film were taken at the scene and forwarded to the ID bureau for processing.

2 - 2 rolls of film were taken by Trooper Schuening and forwarded to the I.D. Bureau for processing.

3 - 1 urine sample obtained from WILLIAM ARZELL BELL - Forwarded to the Pendleton Crime Lab for analysis.

4 - PUC vehicle examination on Unit #1

5 - 3 1/4 disk obtaining files of TMS measuring.

Action Requested:

Request this report and all other associated reports be forwarded to the Umatilla District Attorneys Office for review regarding possible criminal prosecution against the operator of the Schneider Truck/trailer combination, WILLIAM ARZEL BELL and/or the operator of the Plymouth, DEL ARTHUR STIRLING.

CASE STATUS:

No Further Investigation
**ROTOR CARRIER ACCIDENT REPORT**

**SCREENING INFORMATION**

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<th>Question</th>
<th>Answer</th>
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<tr>
<td>10.22 COMMERCIAL TRUCK (G.W. 26,000 OR MORE)?</td>
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</tr>
<tr>
<td>HAZARDOUS MATERIAL placard?</td>
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<tr>
<td>COMMERCIAL BUS (DEsigned TO CARRY 16 OR MORE PASSENGERS)?</td>
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<tr>
<td>ANY PERSON SUSTAINING A FATALITY (WITHIN 30 DAYS OF THE ACCIDENT)?</td>
<td>✔</td>
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<tr>
<td>ANY PERSON SUSTAINING INJURIES REQUIRING TREATMENT AWAY FROM THE SCENE?</td>
<td>✔</td>
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<tr>
<td>ANY VEHICLE TOWED FROM SCENE DUE TO DAMAGE OR PROVIDED ASSISTANCE?</td>
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**STORAGE CARRIER NAME**

Schneider National Leasing, Inc.

11861 S. Cottage Grove

**ACCIDENT INFORMATION**

<table>
<thead>
<tr>
<th>Location Information</th>
<th>Details</th>
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<tr>
<td>HIGHWAY NO./STREET NAME</td>
<td>I-84</td>
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<tr>
<td>DIRECTION OF YOUR VEHICLE CIRCLE</td>
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<tr>
<td>DATE OF ACCIDENT</td>
<td>12/31/93</td>
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<tr>
<td>TIME AND DATE &amp; HOURS</td>
<td>5:30 PM</td>
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<tr>
<td>DAY OF WEEK (CIRCLE): MON TUE WED THU FRI SAT SUN</td>
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**CONDITIONS AT TIME OF ACCIDENT**

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<td>ROAD SURFACE CIRCLE ONE</td>
<td>1. DRY 2. WET 3. SNOW</td>
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<td>LIGHT CONDITION CIRCLE ONE</td>
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**VEHICLE INFORMATION**

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</thead>
<tbody>
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</tbody>
</table>

**ARAGO BODY TYPE**

| Van, Flatbed, Tanker, Container, Pole, Dump, Belly-Dump Car Carrier, Livestock, Mobile Home Toter, Passenger, Drop-Box, Garbage, Bulk-Hopper, Mixer, Saddle-Mount Wrecker, Fixed Load, Heavy Haul |

**TOTAL LENGTH OF VEHICLE / COMB**

<table>
<thead>
<tr>
<th>TOTAL WIDTH OF VEHICLE OR CARGO</th>
<th>WEIGHT (Cargo)</th>
<th>WEIGHT (GROSS)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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**COMMODITY INFORMATION**

<table>
<thead>
<tr>
<th>Commodity Being Transported at Time of Accident</th>
<th>Automatic parts</th>
</tr>
</thead>
<tbody>
<tr>
<td>HAS A HAZARDOUS COMMODITY BEEN HAULED?</td>
<td>[ ] YES [ ] NO</td>
</tr>
<tr>
<td>HAZARD CLASS</td>
<td></td>
</tr>
</tbody>
</table>

JC KOPN 239 (7/11/89)
NAME OF YOUR DRIVER: William A. Bell

HOW LONG EMPLOYED AS YOUR DRIVER: 0 YEARS

DRIVING BRIDGE LAST OFF-DUTY PERIOD:

AT TIME OF ACCIDENT, TOTAL HOURS ON DUTY DURING THE PREVIOUS 7 CONSECUTIVE DAYS:

CONDITION OF DRIVER (Circle One): NORMAL

DOES YOUR DRIVER HAVE A MEDICAL WAIVER (Circle Yes or No):

OTHER DRIVER INJURY INFORMATION:

OTHER VEHICLE DRIVER INFORMATION:

OTHER DRIVER INJURY INFORMATION:

ACCIDENT INFORMATION:

DESCRIPTION OF ACCIDENT BY CARREY OFFICIAL:

DID YOUR VEHICLE STRIKE A PARKED VEHICLE?

REMARKS: 2-18-94
DATE AND TIME: 12-31-93  5:16 A.M.
LOCATION ACCIDENT: INTERSTATE 84, MP198.1 EASTBOUND LANES.

NAME-ADDRESS CARRIER: SCHNEIDER TRUCKING COMPANY

NAME-ADDRESS DRIVER: BELL, WILLIAM ARZELL  2680 HIGHLAND APT#812, HIGHLAND, CALIF. (NOT OPERATING VEHICLE AT THE TIME)

DRIVER'S LIC NUMBER: U6149699 ISSUING STATE: CALIFORNIA
TRUCK DESCRIPTION: SEMI TRUCK WITH ILL. LIC. P103676 AND SEMI TRAILER WITH ILL. LIC. 5002635T

PUC NUMBER: NDA 351
ORIGIN & DESTINATION: MICHIGAN TO HILLSBORO, OREGON.
NAME-ADDRESS OF PERSONS KILLED OR INJURED:
#1 - STIRLING, DOLORES ANNE  05 WEST 1200 NORTH, PLEASANT GROVE, UT. DOB. 03-02-38
#2 - STIRLING, DANIEL JAMES  05 WEST 1200 NORTH, PLEASANT GROVE, UT. DOB. 04-26-78

BRIEF DESCRIPTION OF DAMAGE-ALL VEHICLES:
#1 98 FLY. VOYAGER VAN WITH UTAH LIC. 817 EFF/EXTENSIVE DAMAGE TO LEFT SIDE AND REAR
#2 THE ABOVE LISTED SEMI TRUCK/VERY MINOR DAMAGE TO THE LEFT REAR OF TRAILER

BRIEF DESCRIPTION ON HOW OCCURRED: UNIT #2 HAD EARLIER JACKNIFED AND CAME TO REST WITH THE TRACTOR IN THE MEDIAN AND THE TRAILER BLOCKING BOTH EASTBOUND LANES. THE DRIVER AND CO-DRIVER WERE OUT OF THEIR UNIT AND HAD PUT OUT REFLECTORS AND WERE ATTEMPTING TO FLAG TRAFFIC WHEN UNIT #2 CAME UPON THE SCENE. UNIT #2 HIT HIS BRAKES, SKIDDING INTO THE END OF THE TRAILER, TEARING THE SIDE OF THE VAN OPEN AND KILLING BOTH PEOPLE IN THE TWO BACK SEATS.

SR. TPR. POWELL
SP PENDLETON
EOT *** *** ***
## APPENDIX G

### THEORETICAL FOUNDATIONS OF MOTOR CARRIER SAFETY RESEARCH

<table>
<thead>
<tr>
<th>YEAR PUBLISHED &amp; SOURCE TITLE</th>
<th>AUTHORS</th>
<th>THEORETICAL FOUNDATION</th>
<th>ASSOCIATED DISCIPLINE*</th>
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<tbody>
<tr>
<td>1964 The Logistics &amp; Transportation Review</td>
<td>Corsi, Fanara, &amp; Roberts</td>
<td>N/A</td>
<td>Public Policy</td>
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<tr>
<td>1967 Insurance Institute for Highway Safety</td>
<td>Jones &amp; Stein</td>
<td>N/A</td>
<td>Public Policy</td>
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<td>1967 Journal of the Transportation Research Forum</td>
<td>Beilock &amp; Capelle</td>
<td>N/A</td>
<td>Economics</td>
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<td>1968 Journal of the Transportation Research Forum</td>
<td>Beilock &amp; Capelle</td>
<td>N/A</td>
<td>Public Policy</td>
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<td>1968 American Journal of Public Health</td>
<td>Stein &amp; Jones</td>
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<td>Public Policy</td>
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<td>Blevins &amp; Chow</td>
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<td>Dacoff</td>
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<td>1968 Transportation Journal</td>
<td>Corsi, Fanara, &amp; Jarrell</td>
<td>N/A</td>
<td>Comparative Public Policy</td>
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Figure 16: Theoretical Foundations Of Motor Carrier Safety Research

Continued next page
<table>
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<th>YEAR PUBLISHED &amp; SOURCE</th>
<th>TITLE</th>
<th>AUTHORS</th>
<th>THEORETICAL FOUNDATION</th>
<th>ASSOCIATED DISCIPLINE*</th>
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<td>Transportation Safety in an Age of Deregulation</td>
<td>Chow</td>
<td>N/A</td>
<td>Economics</td>
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<td>Bruning</td>
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<td>1969</td>
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<td>Jovanis, Chang, &amp; Zabaneh</td>
<td>N/A</td>
<td>Public Policy</td>
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<td>1992</td>
<td>Accident Analysis &amp; Prevention</td>
<td>Moses &amp; Savage</td>
<td>N/A</td>
<td>Public Policy</td>
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<td>1993</td>
<td>The Logistics &amp; Transportation Review</td>
<td>Kraas</td>
<td>Economic Regulation</td>
<td>Economics</td>
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<tr>
<td>1993</td>
<td>The Quarterly Review of Economics &amp; Finance</td>
<td>Traynor &amp; McCarthy</td>
<td>Economic Regulation</td>
<td>Economics</td>
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<td>1993</td>
<td>Transportation Research Record</td>
<td>Lin, Jovanis, &amp; Yang</td>
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<td>1994</td>
<td>Accident Analysis &amp; Prevention</td>
<td>Moses &amp; Savage</td>
<td>N/A</td>
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<tr>
<td>1994</td>
<td>Great Lakes Center for Truck Transportation Research</td>
<td>Moses &amp; Savage</td>
<td>N/A</td>
<td>Public Policy</td>
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</tbody>
</table>

Continued next page
Where no theoretical foundation was clearly specified or definitively applied by the author(s), I have taken the liberty of stating which associated discipline should have been relied upon for the theoretical foundations based on the content of the article.
BIBLIOGRAPHY


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