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RECENT ACCIDENT TYPOLOGY RESEARCH

Recent Research in Developing Accident Typologies

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INTRODUCTION

The identification of Intelligent Vehicle/Highway Systems (IVHS) as a national priority has rekindled interest in collision avoidance. Collision avoidance, however, is much broader than IVHS. Similarly, the topic of this symposium, Human Factors in Highway Safety, is also much broader than IVHS. A positive aspect of this new IVHS interest may be that the seemingly unlimited potential of advanced technology will stimulate us to take a new approach to these issues. Recently, we at UMTRI have been looking at existing accident data to see if new approaches could be developed that would provide information to support the development of advanced technologies for collision avoidance. Such an approach necessarily focuses on the precollision events, which is also the area dominated by human factors. Thus, the Federal Highway Administration felt that even though the original work was intended to address vehicle-based collision avoidance technology, the findings may also be relevant to this conference. The conference break-out groups are organized around four collision types, taken more or less, from a collision typology presented in a recent paper (Campbell, 1991). My presentation here is intended to summarize the development of the typology and provide available accident data on the four collision types that have been selected as the focus for this workshop.

The objective of collision avoidance research is to identify countermeasures that will prevent the collision. Thus, the focus is on the precollision sequence of events to identify opportunities for intervention. There is a problem with using existing accident data for this research because the focus of the accident data elements is primarily on the most harmful event. While this focus is appropriate for the analysis of vehicle crashworthiness, the most harmful event is often *not* the initiating event. Collision-type coding based on the most harmful event can be misleading if one tries to infer the precollision events. The approach that will be described here tries to work around the limitations of existing accident data. The objective is to group collisions with common precollision characteristics.

METHOD

The approach seeks to develop a list of collision situations ranked according to the potential benefits of collision avoidance and a characteristic sequence of events for each. This information will support the identification of opportunities where intervention has the potential to prevent or mitigate the collision and the nature of the required intervention. The steps in the proposed method are summarized below.

1. Define relevant collision situations (types).
2. Rank the collision types by the potential benefits of collision avoidance.
3. Identify contributing factors associated with each collision type.

4. Characterize each collision type in terms of the physical sequence of events leading to the impact.
5. Identify opportunities in the sequence of events where intervention has the potential to prevent or mitigate the impact.

The first issue is to identify the characteristics that will form the basis of the definition of collision types. This choice will be influenced by the collision avoidance countermeasures of interest. For example, the typology that has been suggested was intended to address vehicle-based collision avoidance technology (Campbell, 1991). Consequently, it was presumed that the precollision relative position of the vehicles was fundamental. Once the collision types have been defined, it is useful to rank them in some way. The most obvious ranking is based on prevalence, or how frequently the collision type occurs. The potential benefits of preventing a very common collision situation will be much greater than the benefits of preventing an event that seldom occurs. Other measures may also be considered in ranking the collisions, such as the probability of injury or, perhaps the risk of accident involvement. The next step in developing a comprehensive picture of the collisions to be addressed is to identify driver, vehicle, roadway, and environmental factors that are associated with each collision type. The associated factors provide a description of the environment in which each collision type occurs. The last two steps in the approach address characterizing the physical sequence of events prior to the collision and then examining this sequence to identify opportunities for intervention. This approach is described more fully in the referenced paper (Campbell, 1991). For now, I want to proceed to the definition and selection of the four collision types identified by the organizing committee as the focus of the remainder of this workshop.

SELECTED COLLISION TYPES

In order to determine the precollision situation (as opposed to the orientation at the time of the most harmful impact), the following roadway and traffic flow variables were used to define the typology. The typology shown here has been refined somewhat in an effort to be more responsive to the workshop objectives. The single-vehicle accidents have been classified by object struck; they can then be characterized as on or off the roadway. Also, a distinction between signed and signalized intersections has been omitted here. The distribution of collisions into the categories defined by this typology is shown in the following tabulation from the 1984-86 CARDfile. The tabulations are based on a 5% sample of the three-year CARDfile that includes 55,186 single-vehicle accidents and 124,329 two-vehicle accidents. The tabulation is based on counts of accidents, not on the number of vehicles involved in the accidents.

ACCIDENT TYPOLOGY

Single Vehicle
- Fixed Object
- Pedestrian/Pedacyclist/Animal
- Rollover
- Parked Vehicle

Two-Vehicle Intersection
- Crossing Paths/Same Direction/Opposite Direction
- Both Straight/One or Both Turning

Two-Vehicle Nonintersection
- Same Direction
- Opposite Direction
- Driveway/Parking

The most prevalent collision type is the single-vehicle, fixed-object impact. These collisions occur off the road, and leaving the roadway is the initiating event. Since this is true of most single-vehicle rollover accidents as well, these two collision types have been combined and designated as Group III, Run-off-the-Road, of the selected collision types for this workshop. The Run-off-the-Road group represents 18% of all police-reported accidents. The other three collision groups selected are all two-vehicle accidents. Group I combines two situations that usually result in a rear-end collision. These are the nonintersection collisions between two vehicles initially traveling in the same direction and collisions of two vehicles at an intersection when both are traveling in the same direction, but neither intends to turn. Together, this two types form Group I, Rear-End, and represent 22% of all accidents. Group II is composed of two other intersection collision types. These are collisions between two vehicles on the crossing legs of an intersection when both intend to go straight through the intersection and collisions between two vehicles traveling in opposite directions through an intersection when one or both intend to turn. These two intersection collision types represent 19% of all accidents. The last group, Group IV, Head-On, represents only about 4% of all police-reported accidents. However, the probability of fatality is much higher for this collision type: it accounts for about 20%

of fatalities. In combination, the four collision groups selected for this workshop represent about 63% of all police-reported accidents. The four selected collisions groups are summarized in the following table.

SELECTED COLLISION GROUPS

I.	Rear-End	22%
	Nonintersection/same direction	11%
	Intersection/same direction/both straight	10%
II.	Intersectional	19%
	Crossing paths/both straight	13%
	Opposite direction/one or both turning	7%
III.	Run-off-the-Road	18%
	Fixed object	16%
	Rollover	3%
IV.	Head-On	4%
	Nonintersection/opposite direction	4%
	Intersection/opposite direction/both straight	1%
	TOTAL	63%

ASSOCIATED FACTORS

The factors that affect the driver, vehicle, roadway, and environment vary for the different collision types. Once collisions have been grouped, as in the above typology, the next step is to identify the factors associated with individual collision types. Drawing from previous work, driver age, gender, and impairment (alcohol); lighting (day/night); and road surface condition (snow or ice) were examined for association with the selected collision groups. The association of each these factors with each of the four selected collision groups is described in the following sections.

Group I, Rear-End. Note from the distribution of accidents in the collision typology that the percentage of rear-end accidents is about equal between the two types selected: 10% intersection, same direction both straight and 11% nonintersection, same direction. However, the general environment is different in that the intersection collisions are predominantly in urban areas, whereas the nonintersection collisions are predominantly rural. The percentage of these accidents associated with the factors identified above is summarized in the following table:

ASSOCIATED FACTORS: REAR-END GROUP

Alcohol	7%
Darkness	10%
Snow or ice	7%
Excessive speed with low friction	8%

The percentages for the first three factors shown--alcohol, darkness, and snow or ice--are essentially the same as the percentages observed for all two-vehicle accidents. Thus, none of these factors shows any significant association with the rear-end collision group.

However, excessive speed with low roadway surface friction is coded for this group about twice as often as for all two-vehicle accidents, 8% versus 4%, respectively. Overall, none of the factors listed above was coded for 75% of the rear-end group. In addition, no particular associations were observed with age or sex. Previous researchers have identified "inattention" as a contributing factor in rear-end collisions, but without more detail this characterization does little to expand on the essential nature of this collision group.

Group II, Intersectional. Group II also combines two collision types from the typology. The first of these, crossing paths, both straight, is about twice as large as the second, with about 13% of all police-reported accidents as compared with the opposite-direction, turning type of accident, with 7%. The associated factors will be examined separately for these two subsets of Group II.

The associated factors for the intersection, crossing paths, both straight collision type are summarized below.

ASSOCIATED FACTORS: INTERSECTIONAL GROUP--CROSSING PATHS, BOTH STRAIGHT

Alcohol	5%
Darkness	7%
Snow or ice	6%
Signal	35%
Sign	46%

Like the rear-end group, alcohol, darkness, and slippery roads are not overrepresented in this group and are not factors in a significant percentage of these accidents. However, the distribution between signed and signalized intersection is of interest. Significant percentages of these collisions occur with both types of control.

A review of police accident reports for samples of accidents from this group at signed as compared with signalized intersections revealed some interesting differences. At the signalized intersections, nearly all of these accidents were the result of a driver's entered the intersection against a red light. There was no strong pattern in the age of these drivers, although there was some overrepresentation of older drivers. The situation was much different at the signed intersections. Here there were two distinct subsets. In approximately 45% of these collisions, a driver failed to stop at the sign, proceeding into the right-of-way of the other driver. Forty-five percent of the drivers that failed to stop were under the age of 25, a very strong overrepresentation of this age group. In contrast, the other subset (41% of the collisions at signed intersections) was characterized by a driver's first stopping at the sign and then proceeding into the right-of-way of the other vehicle. Sixty-nine percent of the drivers that first stopped and then pulled out in front of another vehicle were over age 60--again a very strong overrepresentation of this age group and a very different kind of error.

Associated factors for the opposite-direction, turning, collision type are summarized below.

ASSOCIATED FACTORS: INTERSECTIONAL GROUP--OPPOSITE DIRECTION, TURNING

Alcohol	6%
Darkness	8%
Snow or ice	2%
Signal	49%
Sign	8%

The predominant factor here is that nearly half of these collisions occur at signalized intersections and very few at signed intersections. A review of police accident reports indicates that the most common situation is one in which a vehicle makes a left turn across the path of the other. Age distributions were examined for the turning driver as compared with the driver going straight through. About 19% of the turning drivers were over 56, while only 9% of the drivers going straight through were over 56. The older drivers are overinvolved as the turning driver by about a factor of 2, but they still make up only 20% of the offending drivers. Clearly this error is not limited to the older driver.

Group III, Run-off-the-Road. The largest single category of the typology, 16% of all police-reported accidents, is the single-vehicle, fixed-object impact. Single-vehicle rollover accidents represent another 3% of all accidents. Running off the roadway precedes each of these collisions. The associated factors for this group are quite striking. The environmental factors demonstrate a predominance of rural roads at night, with slippery road surfaces in 17% of these accidents. With regard to the driver, this collision type is prevalent amoung young men. Alcohol impairment is indicated for about one-quarter of these drivers. The associations of these factors are summarized in the following table. Here is a group that includes almost 20% of all police-reported accidents and is apparently a consequence of social factors that shape young male driving behavior.

ASSOCIATED FACTORS: RUN-OFF-THE-ROAD GROUP

Rural	70%
Age 16-25	50%
Male	70%
Alcohol	26%
Darkness	39%
Snow or ice	17%
Excessive speed with low friction	16%

Group IV, Head-On. This group also shows some overinvolvement of young, male impaired drivers, but not nearly to the same extent as in the previous group. Here, if the impaired drivers are omitted, there is no overinvolvement by age or sex among the remaining drivers. Slippery roads play a larger role, 21% more in this group than in any of the previous groups, although excessive speed is identified less often than in the ran-off-road accidents. Perhaps the limited visibility in situations producing slippery roads is a factor in these collisions. It should also be noted that 50% of the accidents in this group did not involve any of the factors identified in the table below. While there is clearly some overinvolvement in this collision type with both degraded drivers and a degraded environment, this collision often occurs with both "normal" drivers and driving conditions.

ASSOCIATED FACTORS: HEAD-ON GROUP

Alcohol	15%
Darkness	19%
Snow or ice	21%
Excessive speed with low friction	10%

CONCLUSIONS There are inherent problems with using existing accident data to study collision avoidance in general and the role of human factors in particular. First, there is the problem that existing data provide little information on the precollision situation or events. Additionally, there is the problem that the perceptions, decisions, and actions of the human leave little evidence from which to infer the influence of these factors. However, I am not inclined to dismiss the study of accidents as a way to expand our current understanding of the role of the driver in collision avoidance. Since accidents are *the* event we wish to prevent, it seems necessary to focus part of our attention there.

A related issue is the notion that there is a difference between "normal" driving and driving behaviors that result in accident involvement. It is easy enough, after the fact, to identify particular actions, or lack of action such as "inattention," on the part of the involved driver as the "cause" of the accident. But so far, such information has not been particularly useful in preventing, or reducing, drivers' tendencies to make these errors. If "normal" driving is considered to be error free, or accident free, or something that is simulated in a laboratory, or controlled experiments on the road, then there would seem to be some question as to what this has to do with accidents. Real driving often seems to be quite tolerant of occasional driving errors, or less-than-optimal performance. If the objective is to prevent accidents, then it would seem necessary to try to determine whether there are situations, meaning the combination of the driver's performance and all of the other pertinent factors that define the driving environment at that moment, that have a significantly elevated risk of accident involvement. The opportunities for collision avoidance would seem to come from an understanding of the demands in those situations. These demands may or may not be similar to the demands in the relatively low-risk situations that make up the vast majority of our driving experience.

Rather than abandon the study of accidents, I think it is necessary to work backwards from the collision to the precollision events. It is my hope that this workshop will conclude that the study of accidents needs to be expanded to better address the precollision events in order to provide a bridge between the accident and events that elevated the risk of accident involvement. Such information would seem to be important to prioritizing human factors research areas for the purpose of collision avoidance. I would urge the working groups to review their problem statements as they are being developed to ask what has been assumed about the accident experience. What is the assumed precollision sequence of events? What are the assumed physical mechanisms responsible for each event? What has been assumed about the role of the driver in the sequence of events? I believe that the research proposals should include a verification of the specific aspects of the assumed precollision sequence of events that form the basis for each human factors research area identified. My concern is that a human factors research agenda will be based on intuitive definitions of the problem as opposed to the actual highway experience.

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BREAK-OUT SESSION REPORTS: RESEARCH PROBLEM AREAS

REAR-END COLLISIONS

REAR-END COLLISIONS -- 1

Title: Definition, Measurement, and Control of Driver Attentional Impairment in Specific Traffic Situations
Problem: Inattention (including difficulty with divided attention, allocation of attention, multitask performance) is considered a leading contribution to rear-end collisions. Conditions that impair a driver's attention include those that are temporary (adaptation, fatigue) as well as those due to functional deterioration. We currently lack a definition of what constitutes attentional impairment, ways of measuring it, or means of controlling it.
Objectives: (1) Undertake dynamic laboratory simulation studies systematically varying conditions