

SKIDDING ACCIDENT SYSTEMS MODEL

By

Kenneth D. Hankins

R. T. Gregory

and

Wm. J. Berger

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Definition of Relative Importance of Factors  
Affecting Vehicle Skids

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## DISCLAIMER

The opinions, findings and conclusions expressed in this publication are those of the authors and not necessarily those of the Federal Highway Administration.

## ABSTRACT

The theory introduced in this report is intended to identify the interdependence of factors influencing the skidding accident. The theory proposes that an analysis of accident variables can be made through the selection and quantification of the variables outlined in a Systems Model. The selection and quantification then enables corrective measures to be identified and evaluated.

## SUMMARY

The objective of this study has been the development of a Systems Model to characterize the factors effecting wet-weather skidding. The model identifies and classifies the more significant elements in a skidding incident with particular emphasis given to the highway elements. The model allows each element to be viewed with respect to the total environment and hopefully will lead to a better analysis of specific problem areas in order to correctly formulate effective corrective procedures.

## IMPLEMENTATION STATEMENT

The Systems Model provides the engineer in the field a useful guide which points out many important factors which can contribute to skidding accidents. By illustrating these factors for the engineers' consideration, a variety of potential solutions may be indicated. Future and current work will be and is devoted to quantifying the effects of many of these factors. The Systems Model is necessary for the proper organization of this work. The model allows each element to be viewed with respect to the total accident picture. Ultimately the model may be used as a guide in re-evaluating corrective measures so that the best solution can be identified.

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## INTRODUCTION

The mysteries of wet-weather skidding have concerned highway engineers for a number of years. Similar vehicles influenced by similar environmental and roadway factors do not always have similar reactions. It is apparent that in such cases some subtle variation in factors influencing these interactions made the difference. Researchers are actively collecting data on the elements of wet-weather skidding. The resulting data files are beginning to look impressive, but to be effectively utilized the significance of these data must be fully understood. The challenge for engineers and researchers is to understand the multiplicity of interactions resulting from various combinations of the interrelated elements. The importance of the phenomenon of hydroplaning has been only recently identified. But hydroplaning is only a small part of the overall problem of wet-weather skidding.

The purpose of this study has been to apply systems concepts to the problem of wet-weather skidding. The systems approach was selected because it lends itself to the evaluation of the interaction of variables. The model developed in this study allows for the identification and classification of the factors which influence skidding, but most important, it permits examination of their interaction. Rarely is one isolated element the sole cause of an accident, but two or more interacting elements are very likely. Particular emphasis has been paid to the highway elements of wet-weather driving because of the amenability of these elements to corrective action. However, researchers in other areas of

highway safety can benefit by identifying problem areas of concern.

This systems model is not intended to be a solution to the problem, but is intended to clarify the problem and to place each element in proper perspective, which should serve to identify those areas in which additional research is most needed.



## HIGHWAY

The primary components of a wet-weather accident are: (1) Highway Condition, (2) the Vehicle and (3) the Driver. Superimposed on these major areas are the Meteorological and Physical Environments which affect not just the highway condition but the vehicle and driver as well. (See Figure 1.)

The greatest effort has been concentrated on the Highway Condition where a large amount of data is readily available on the variables related to wet-weather accidents. The Highway Condition variables are grouped into three areas: (1) the Highway Section, (2) the Physical Environment and (3) the Meteorological Environment. (See Figure 2.) Some variables differ only slightly; therefore, criteria were developed to establish their categorization. All variables dealing with geometrics, pavement and communications are included in the Highway Section. By definition, the Highway Section is that portion of the road lying horizontally between the shoulder edges and vertically between the pavement surface and the subsurface bottom. Some of the variables of the Communication System coincide with those of the Physical Environment, but the effects in each case are entirely different. The Physical Environment deals more specifically with an object's size, character, placement and interaction with geometrics.

For example, the variable "guardrail" is included under the Communication System because the guardrail conveys an informal and subtle message to the driver as to the shape of a particular highway section.

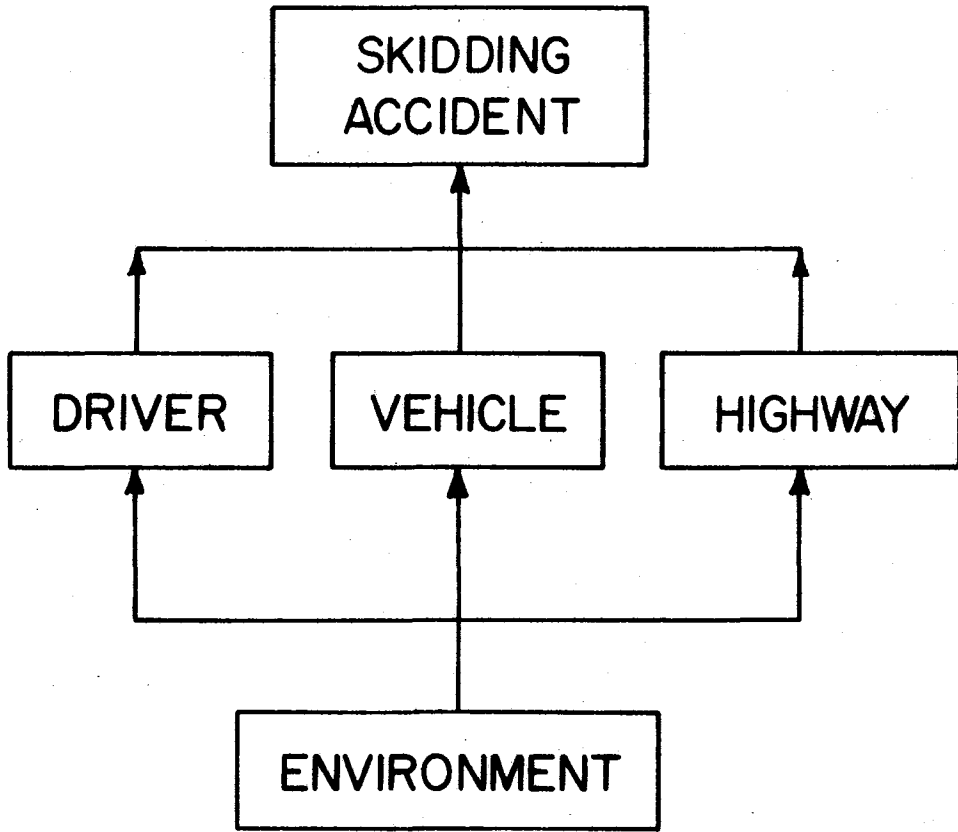


FIGURE 1

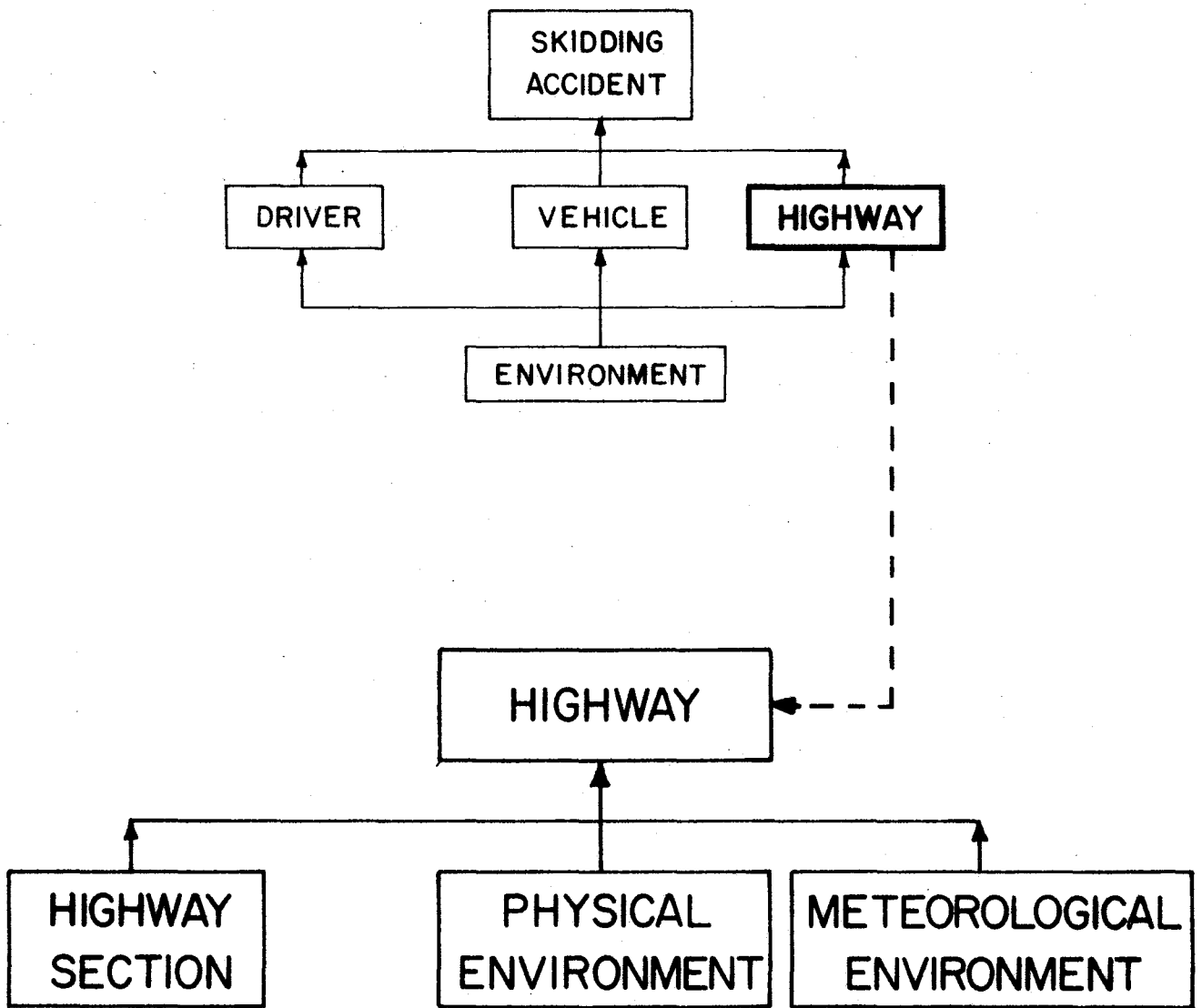


FIGURE 2

Likewise, the guardrail is included under the Physical Environment because, due to the guardrail's size and placement, the driver tends to over-respond to it. In other words, the physical existence of the guard rail elicits an evasive response from the driver.

The Meteorological Environment, as it is discussed, was basically identified by the U. S. Meteorological Agency. This phase of the Highway Condition includes the variables known to constitute all types of weather conditions and interactions.

At this point detailed consideration should be given to the Highway Section and its three major divisions. As has already been stated, the major areas of the Highway Section are: (1) the geometrics of the highway, (2) the pavement and its characteristics and (3) the communication system. (See Figure 3.) In this study the scope of geometrics embraces: a) horizontal alignment; b) vertical alignment; and c) intersections and interchanges. By breaking down the geometrics into these three elements, all aspects of highway design are included. (See Figure 4.) The horizontal alignment is divided into the tangent section and the horizontal curve section. (See Figure 5.) Included in the tangent section are: (1) lane width, (2) diagonal pavement joints, (3) lane transition, (4) shoulders, (5) alignment change and (6) traffic separators. The variables of the horizontal curve section are: (1) degree of curvature, (2) sight distance, (3) curve transition and (4) lane width. The vertical alignment variables include: (1) tangent grades, (2) auxiliary lane and (3) ratio of differential grade to curve length. The intersections and interchanges category is divided into non-channelized and channelized which differ in that the channelized

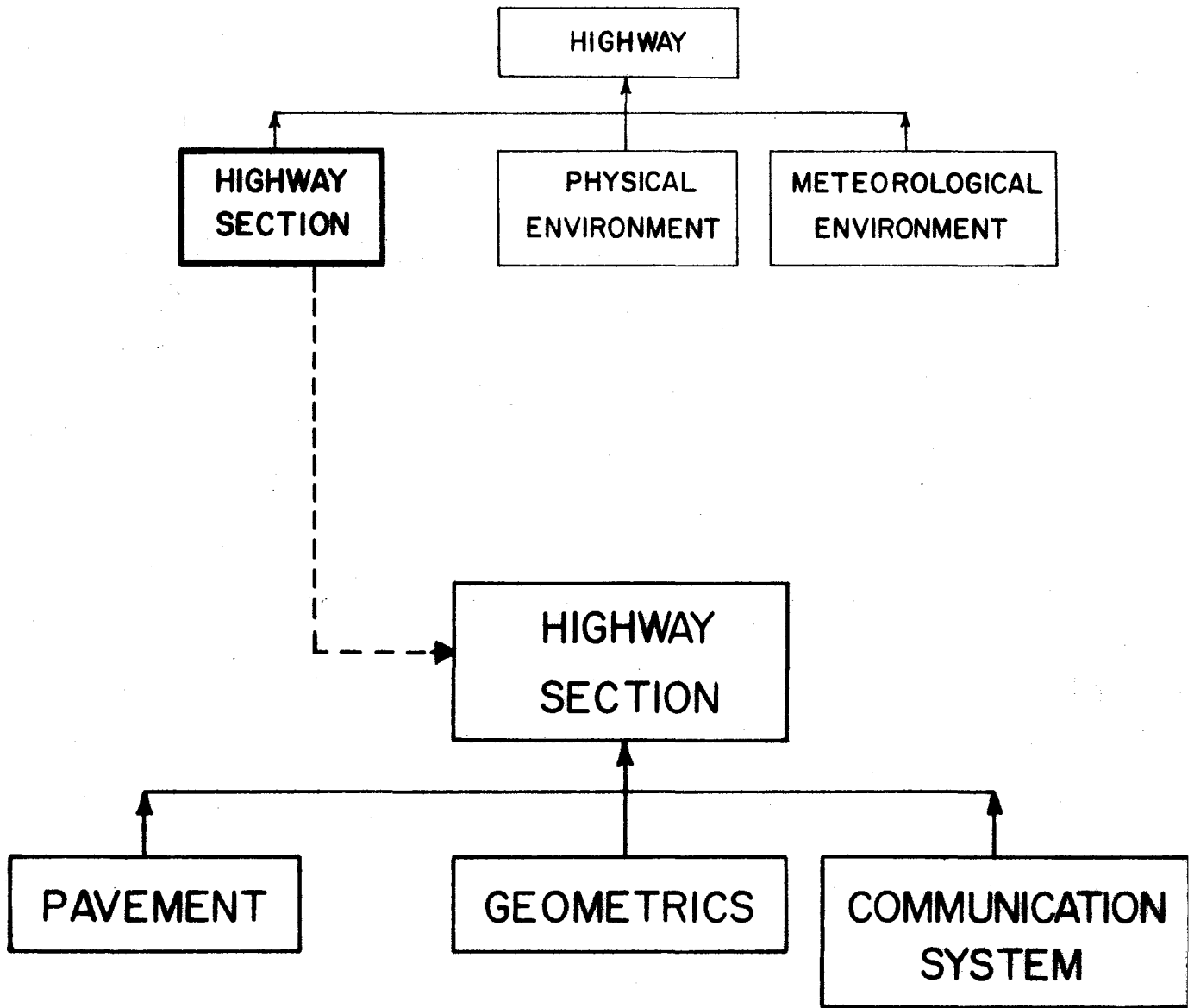


FIGURE 3

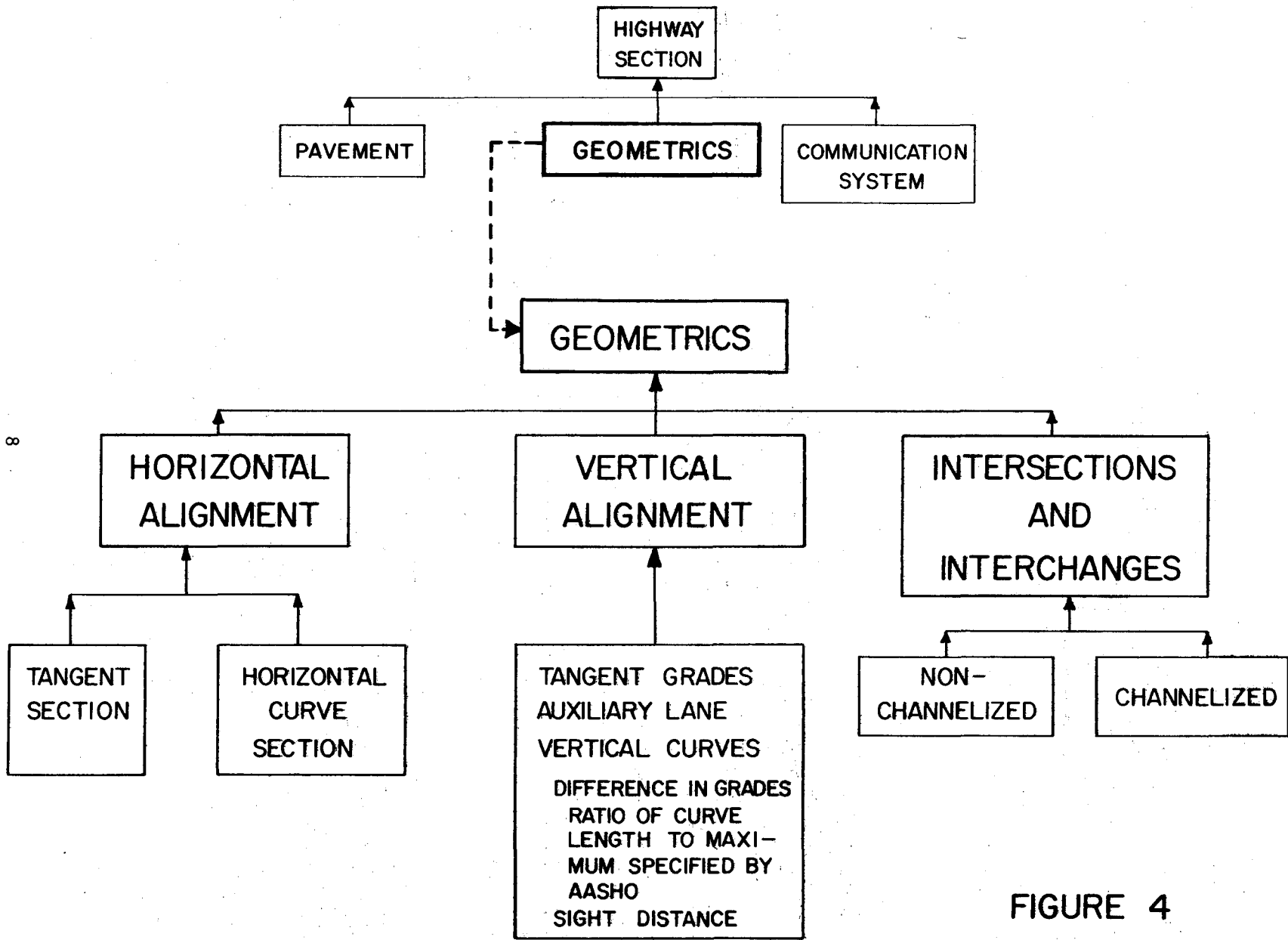


FIGURE 4

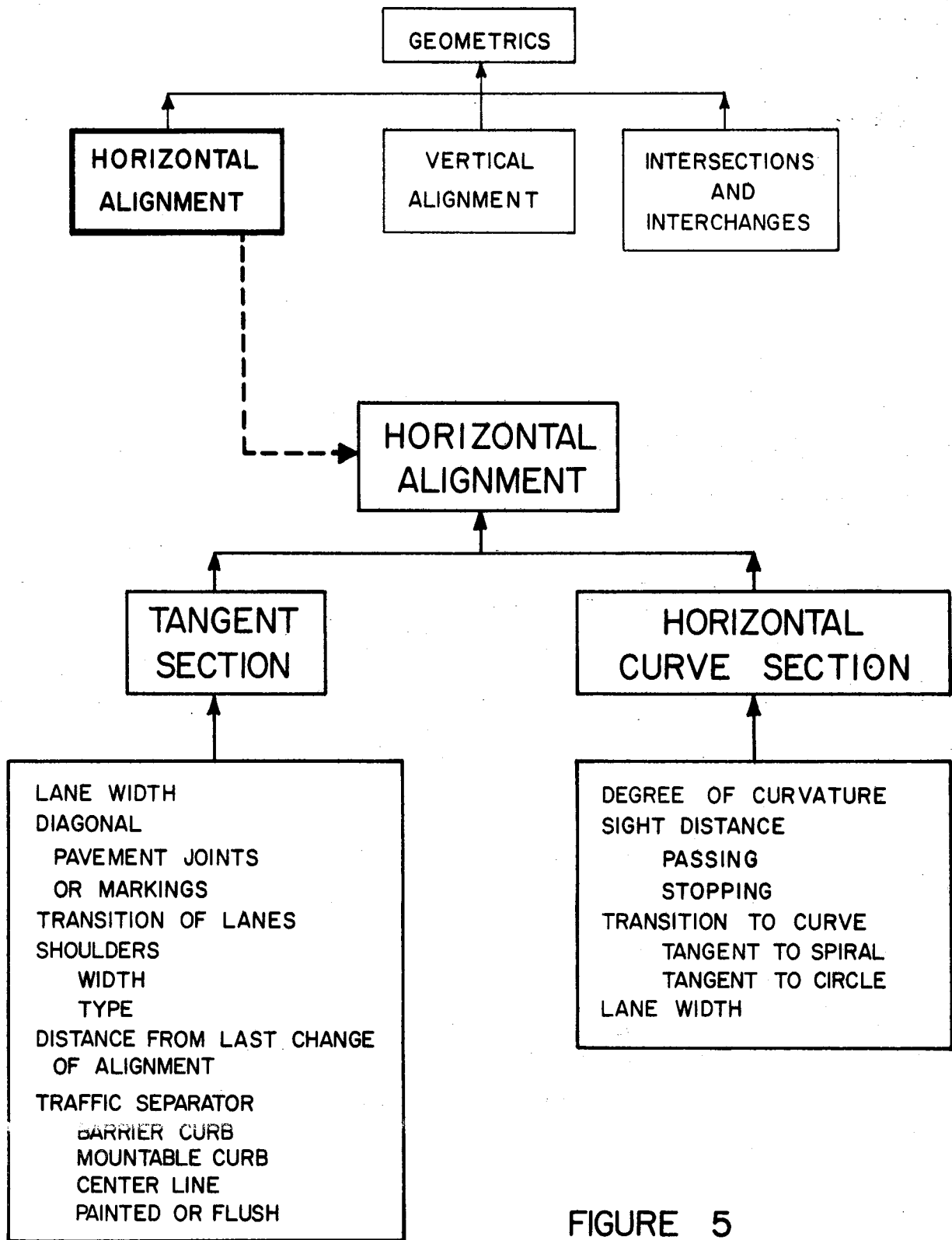


FIGURE 5

section considers transition and channelization type. (See Figure 6.)

The Highway Section is characterized not only by geometrics but also by the pavement proper. Little has been done to document the effects of the pavement variables on wet-weather accidents, but those presently included are: (1) pavement type, (2) texture, (3) friction, (4) cracking, (5) roughness and (6) ponding. Each of these affect the roadway surface to some degree.

The last phase of the Highway Section for consideration is the communication system. Highway communications to the driver are both formal and informal. Formal communication devices are signs, signals and markings; informal messages are conveyed by geometrics, guardrails, delineators and alignment. All of these means of communication influence the driver and their combined effect elicits a response from him. (See Figure 7.)

As previously mentioned, some of the communication elements are also parts of the Physical Environment, but their roles differ with respect to each classification. In the environment the existence of a physical object affects the driver and his manipulation of his vehicle; these effects are a function of the proximity of the object to the roadway and the vehicle as well as the speed of the vehicle and the expectations of the driver. Such physical objects might be vegetation, bridges and utility structures, roadside development, other traffic, curbs, and bridge and guardrails. Their relationship to the roadway may cause a driver to avoid them with exaggerated maneuvers which simultaneously create potential accident hazards. (See Figure 8.)



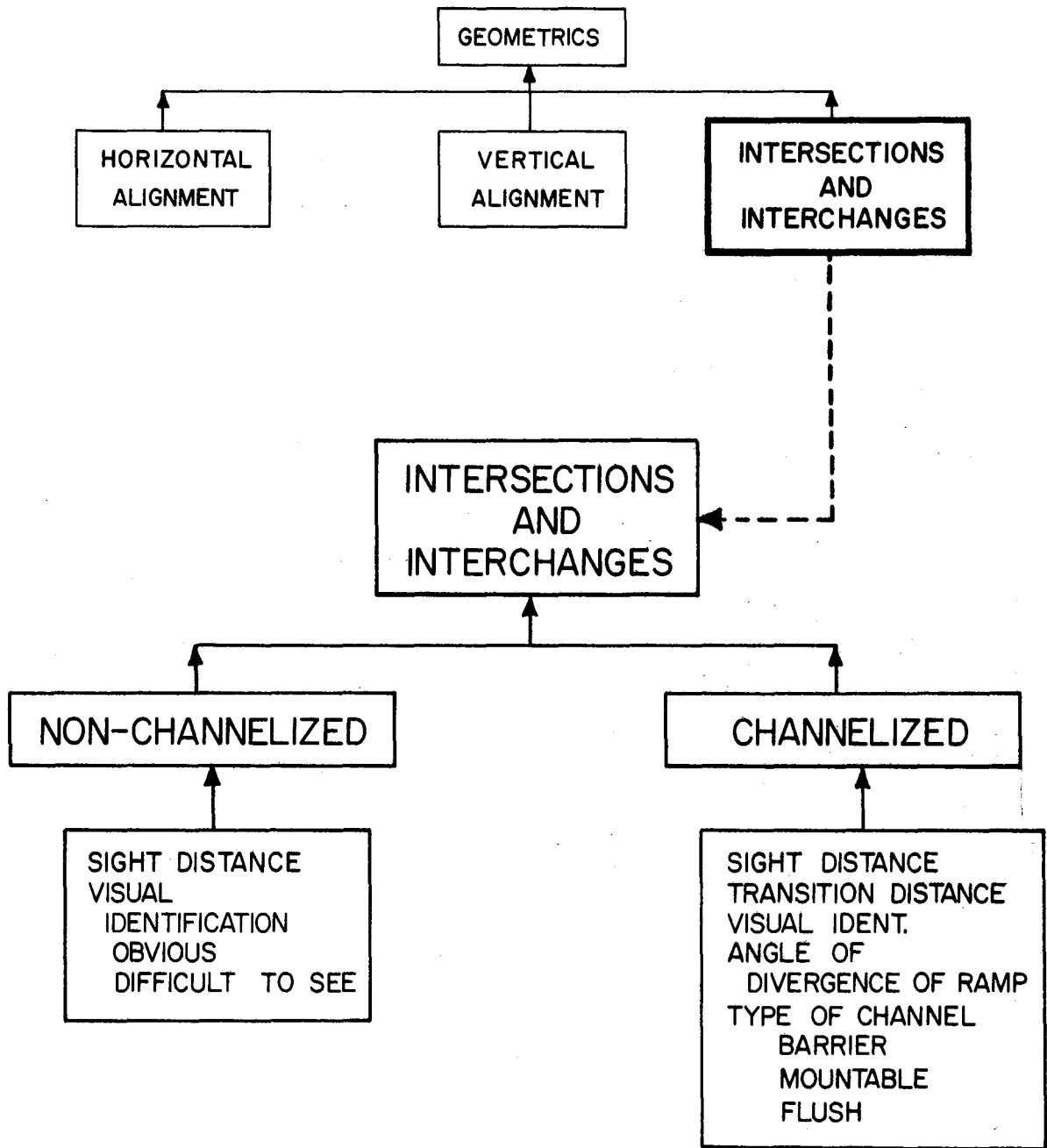
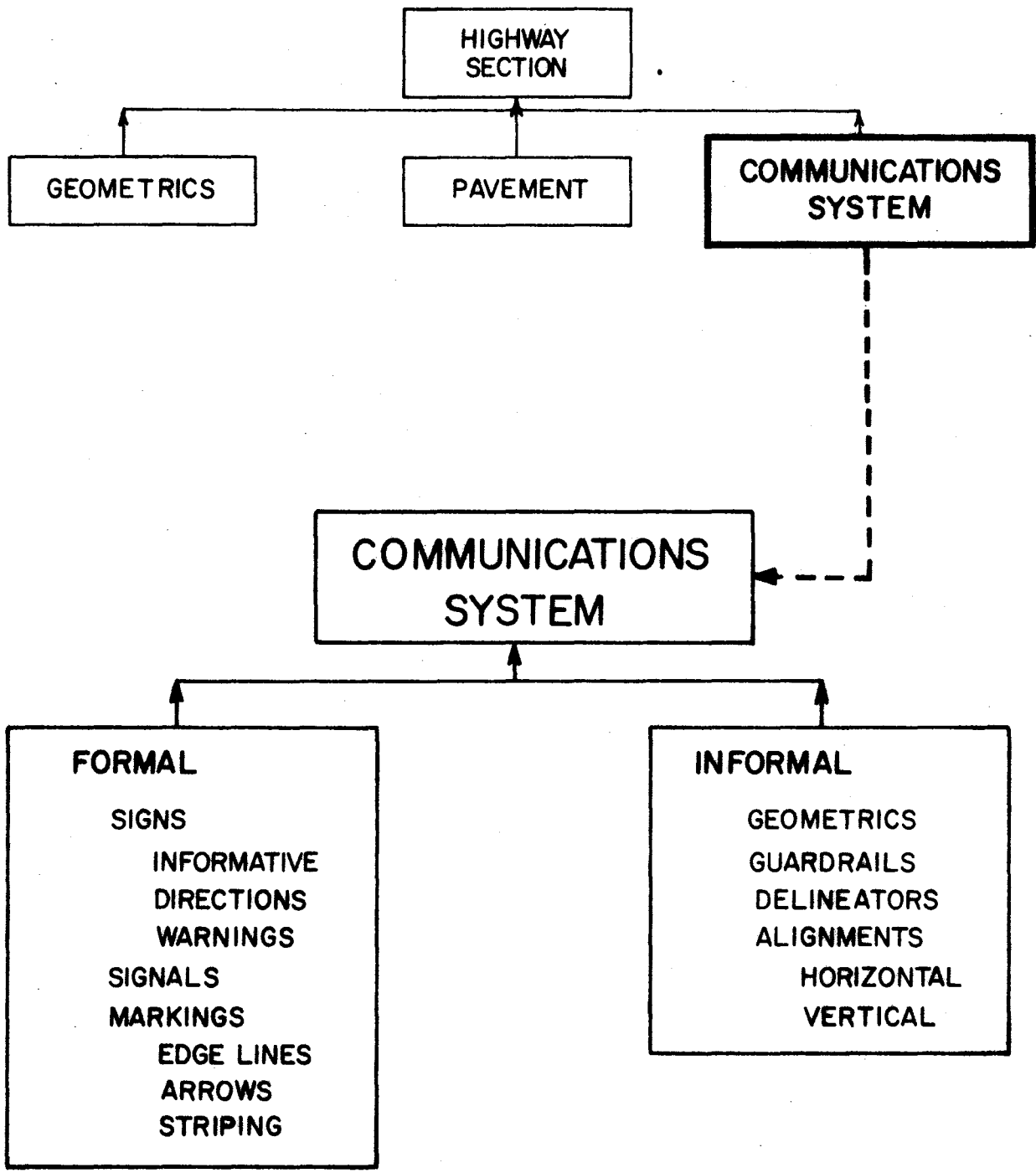


FIGURE 6



**FIGURE 7**

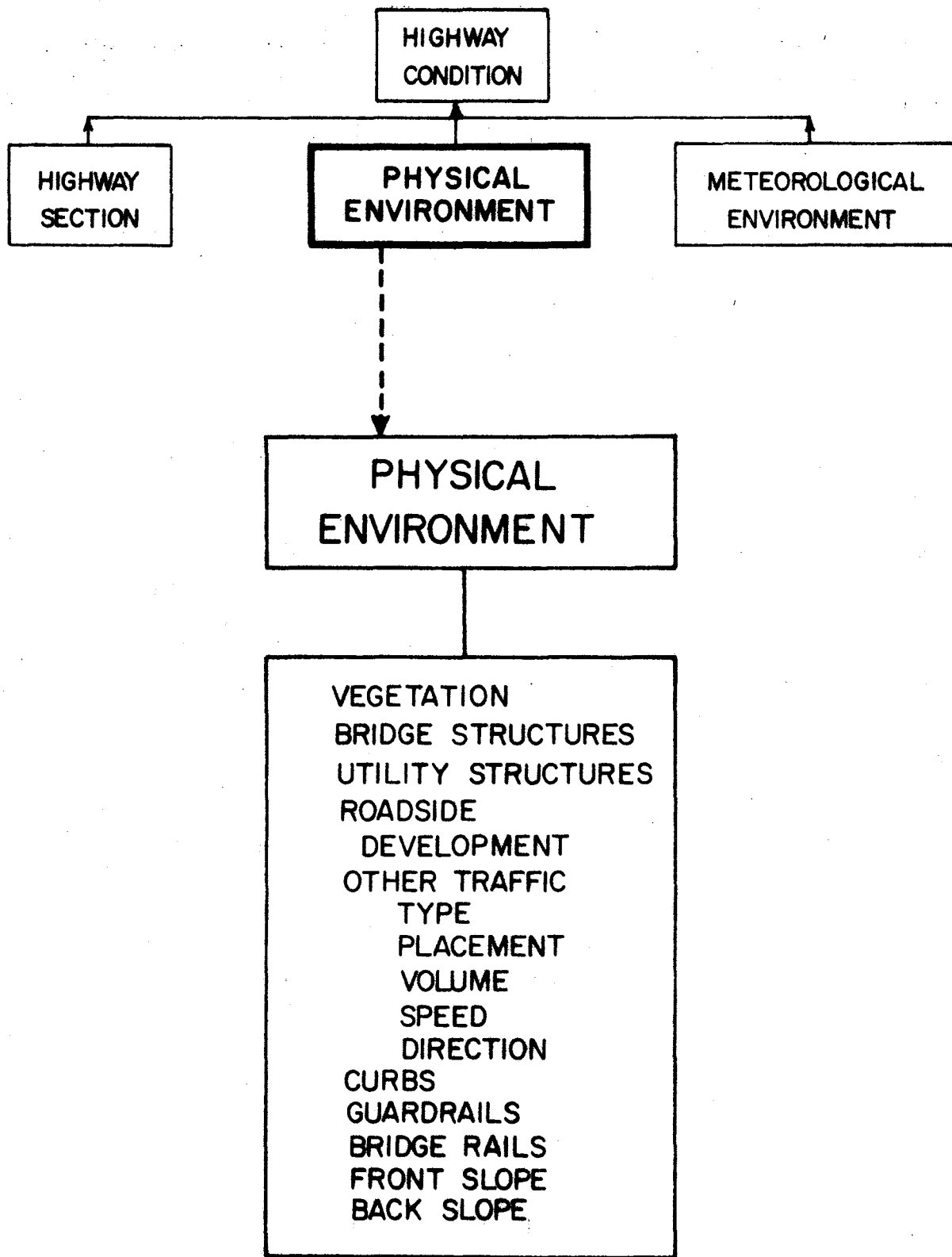


FIGURE 8

The Meteorological Environment is one over which the driver has little control, and apparently little is known about the effect of many of its elements on a skidding accident. This environment is composed of precipitation, light, atmosphere, visibility and other less significant elements which interact with the highway, the vehicle and the driver. Precipitation may be the predominant element, and it varies with regard to type, intensity, duration, accumulation and antecedent precipitation (the amount or lack of precipitation preceding existing conditions). The atmospheric condition is determined by the temperature, humidity, cloud cover, wind and antecedent temperature. The elements of light and visibility are closely integrated with the main difference being that visibility concerns types and amount of light, while light itself concerns the kind, direction and intensity of light. (See Figure 9.)

All of these previously discussed elements and their variables make up the total highway condition. And they directly or by way of an interaction affect the driver's perception and actions and the vehicle-highway interaction.

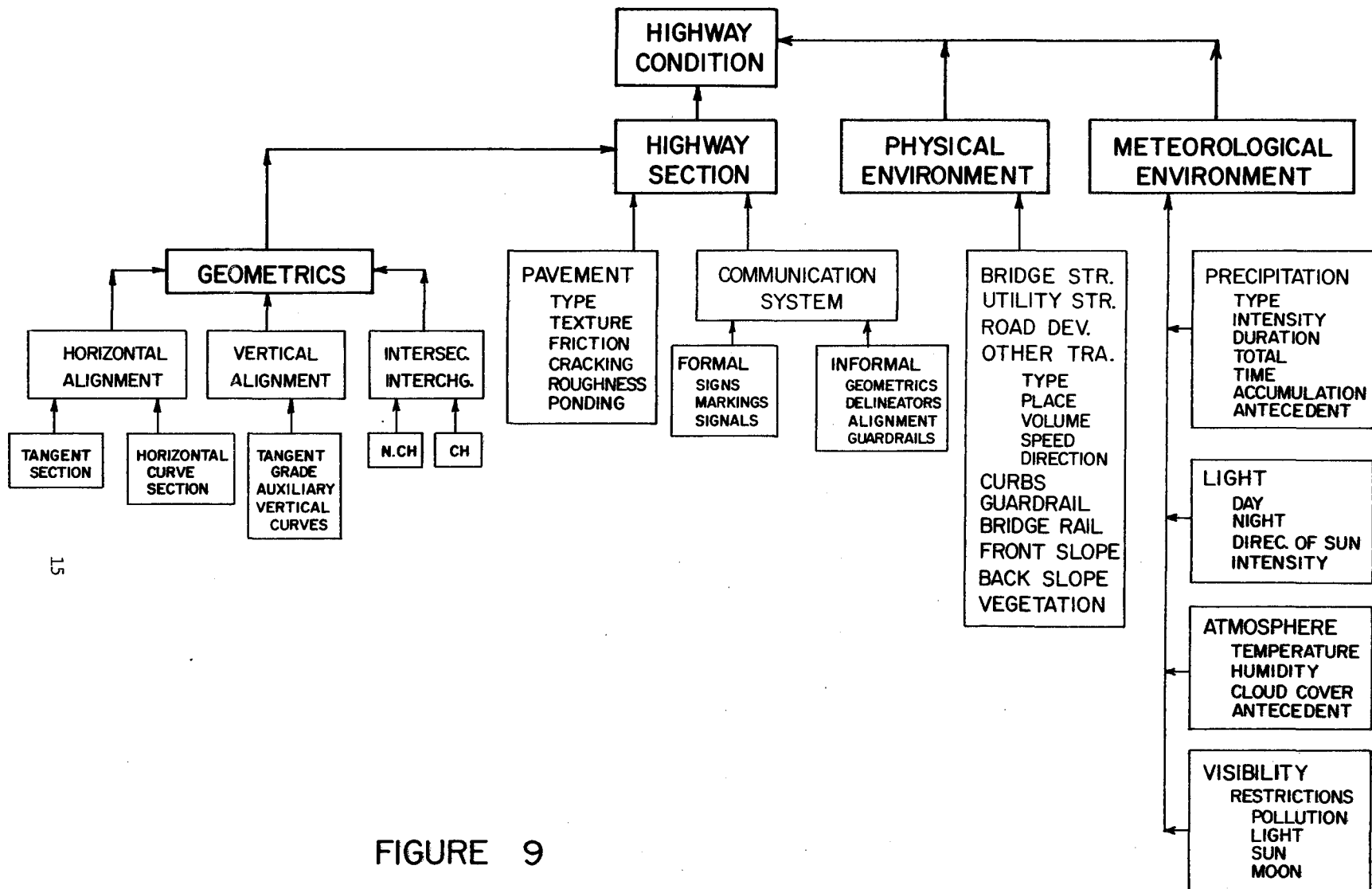
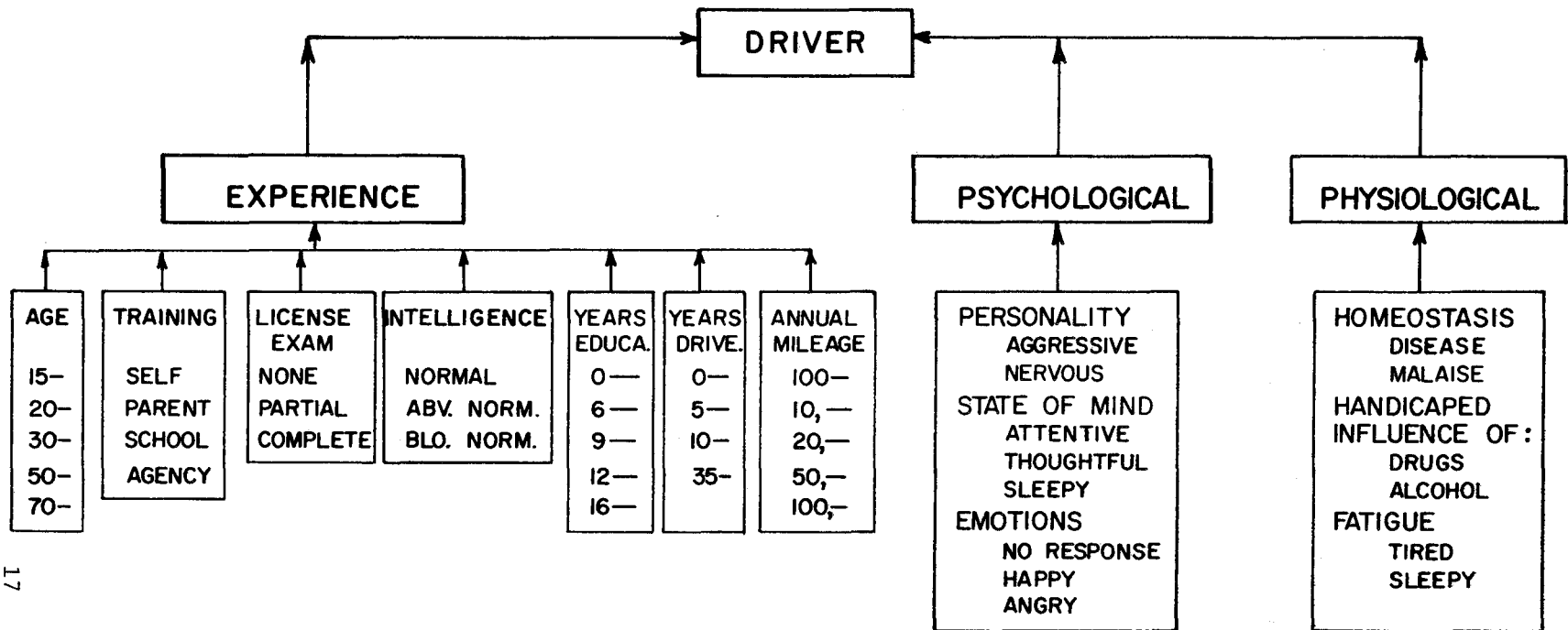


FIGURE 9

## DRIVER

The driver portion of the systems model is the most difficult of all to evaluate because the driver's psychological and physiological states are difficult to determine. The latter would require a physical examination, and even then not all the condition variables could be determined. The variables of physiology concern homeostasis, handicaps, the degree of drug and alcohol intake, and fatigue. The psychological variables, such as personality, state of mind, and emotional state are also difficult to identify accurately because they are in a constant state of change. The most easily determined area considered under the driver section is that of experience. Most of the variables of one's experience are matters of record. For instance age, training, license examination, intelligence, level of formal education, years of driving and annual mileage are all on file or can be established by routine examination. (See Figure 10.) All of these variables affect the driver's perception and ultimately his overt actions. The sum total of these interactions affects the probability of an accident.



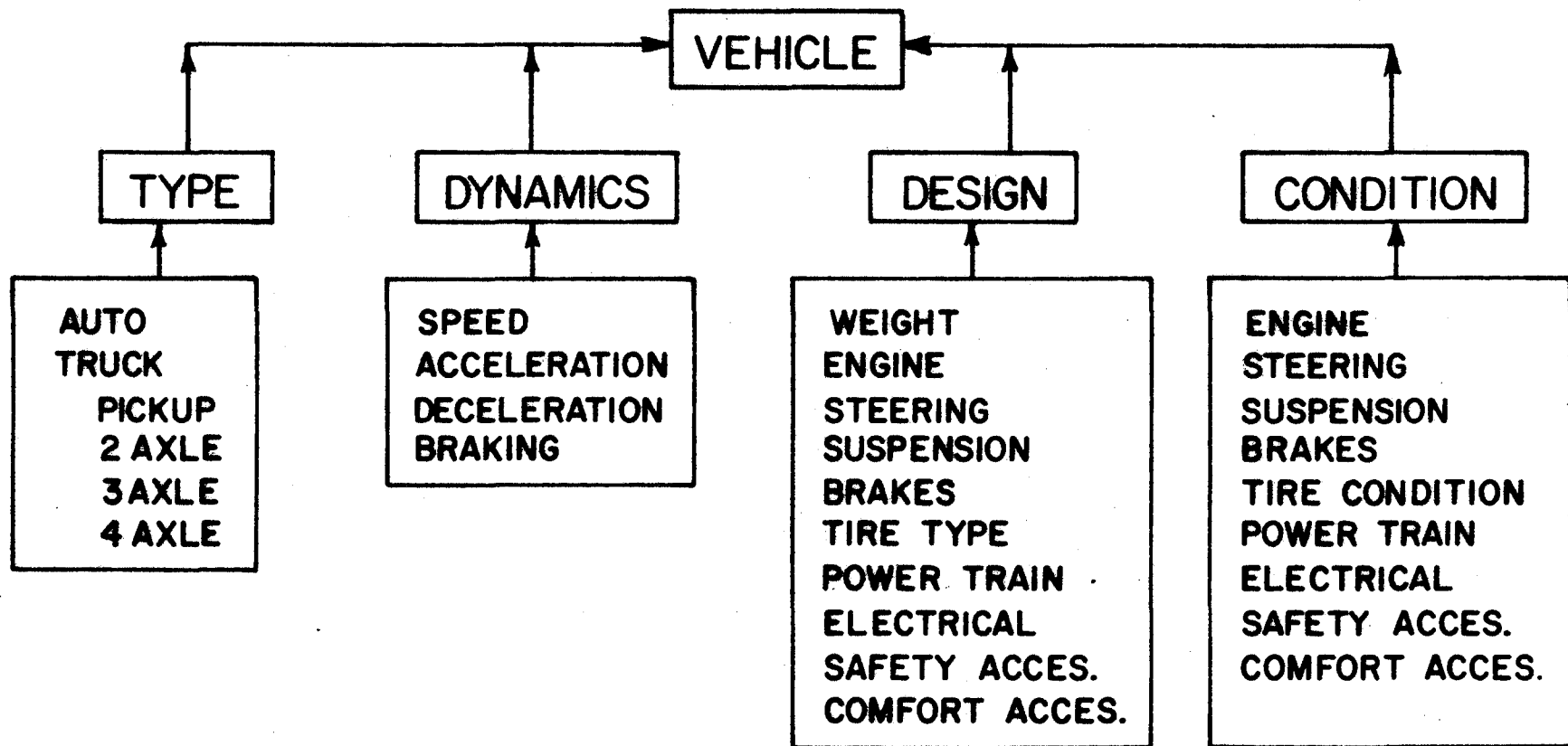
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FIGURE 10

## VEHICLE

The last major area of concern, which affects the driver's perception and physical actions and interacts with the highway, is the vehicle. The vehicle is a machine with distinct characteristics which limit its performance and capabilities. The dynamics of vehicular machines vary, such as acceleration, speed, braking and deceleration capacities. The design of vehicles differs greatly with regard to weight, engine, suspension, brakes and power train, among other things. And last of all, a vehicle's condition or state of repair varies significantly and influences its performance. (See Figure 11.) All of these elements interact to determine the composite vehicle condition. Then the vehicle interacts and responds mechanically to the highway and to the driver and thereby influences the outcome of an accident.



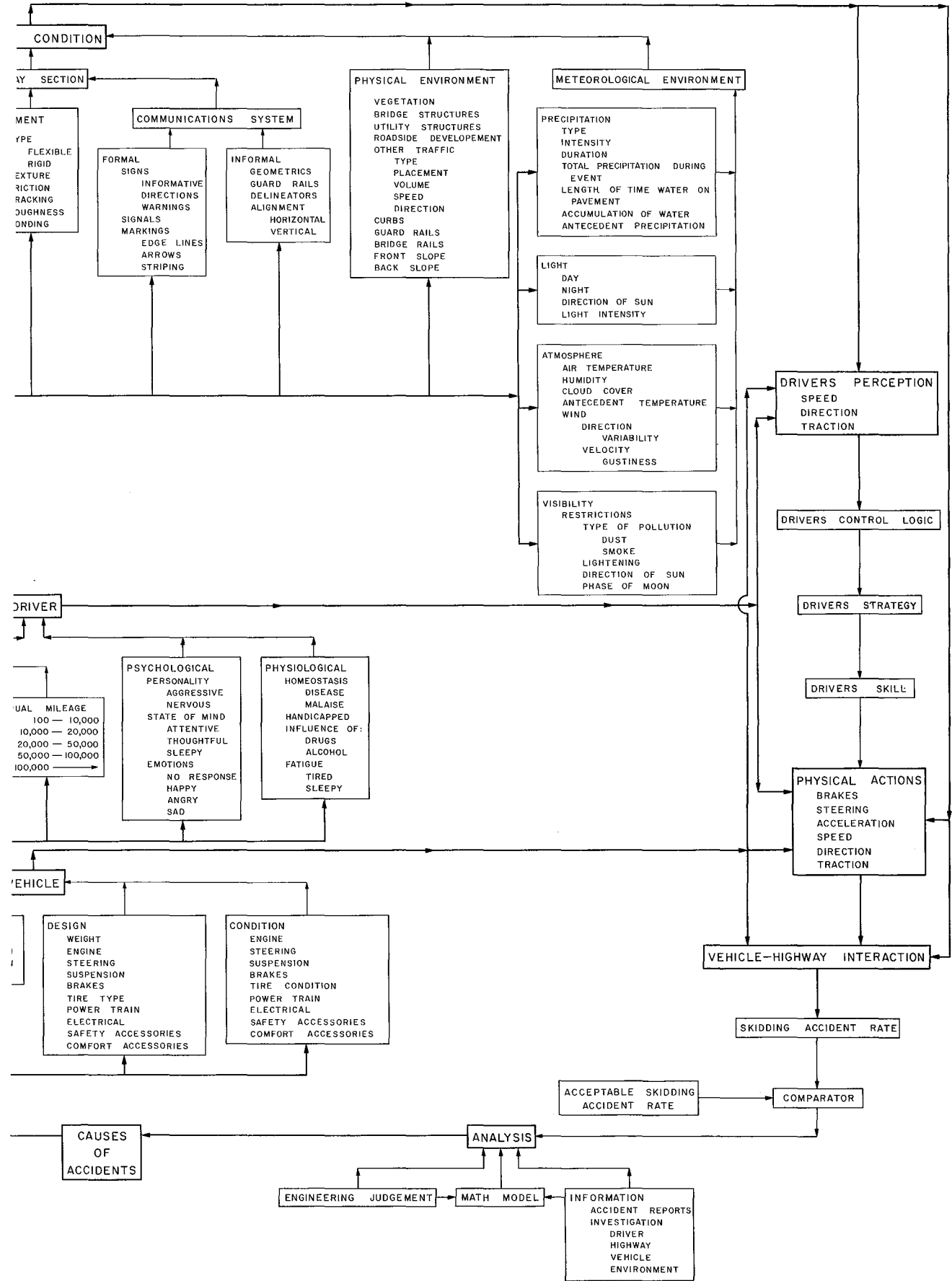
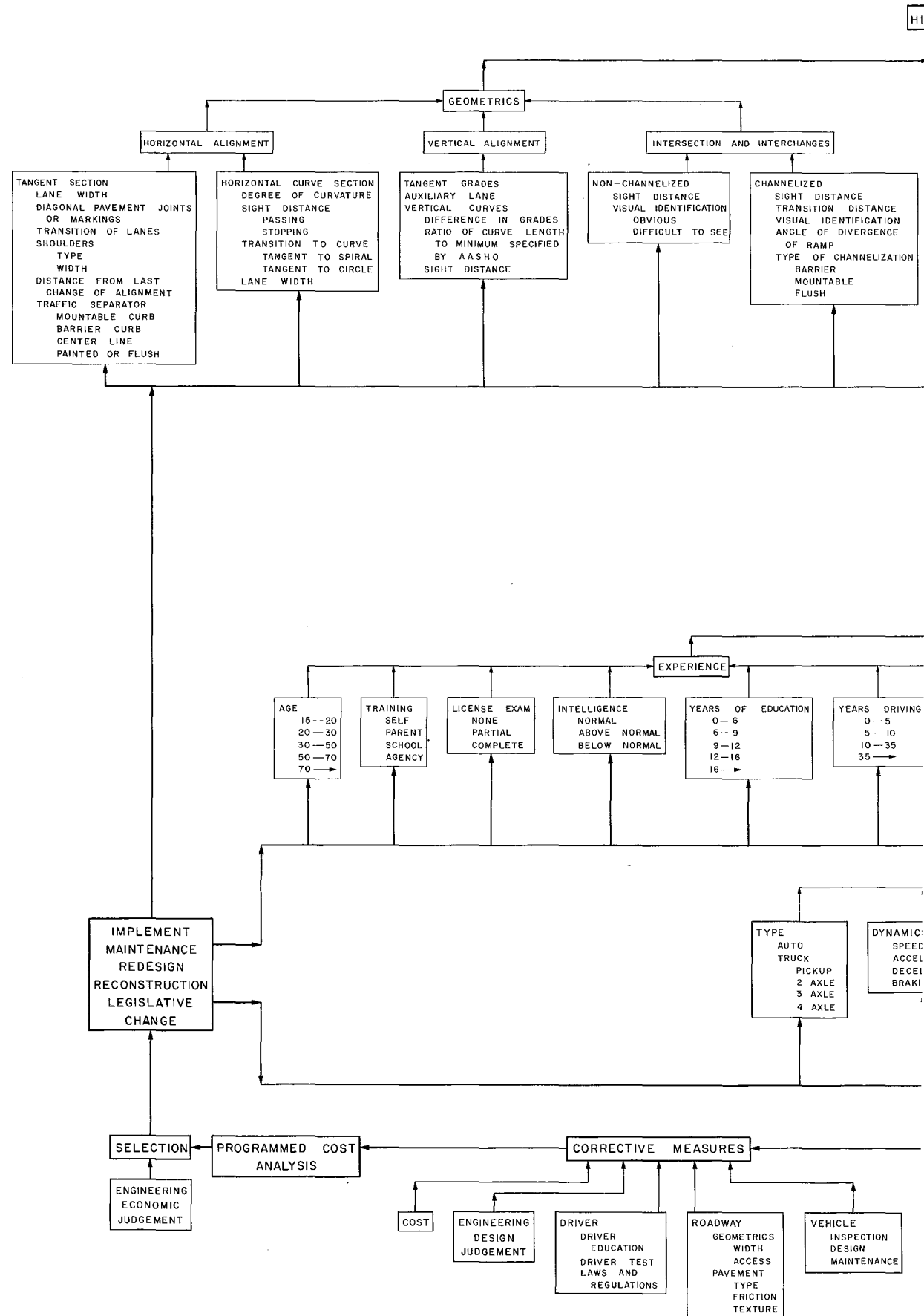


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FIGURE II

## ANALYSIS

At this point the Highway, the Driver, and the Vehicle have been identified and proposed as having an effect on the probability of a skidding accident. In its present form, the mathematical model can be used in combination with engineering judgment and information on the variables within the three major elements to determine the apparent causes of an accident. These apparent causes then become the basis for the determination of corrective measures. The proposed corrective measures could then be evaluated by engineering and economic considerations. A cost analysis should be concerned primarily with the long term cost and cost benefit of each corrective measure rather than with just the initial cost. A selection from the corrective measures available is made and fed back into the skidding accident loop. (See Figure 12.) Thus the loop is closed and an evaluation and re-evaluation program begins in order to find the best possible solution.



## CONCLUSION

The Systems Model outlined here should not be regarded as a solution to the problem of wet-weather skidding accidents but should be viewed as a description of the total event from which a solution may be sought. This Skidding Accident Systems Model contains most of the known variables which contribute to such accidents, and it is the intent that through the use of this model new areas of needed research will be identified that will improve the accuracy of the model. An effort has been made to keep the model flexible so that it may be supplemented and updated with new research findings.