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ABSTRACT

The ultimate goal of the research described in this paper is to develop a set of instructional objectives for driver education courses based on a comprehensive and detailed analysis of the driver's task. There are two phases--first, an analysis of the driver's tasks; second, a set of instructional objectives developed from results of the task analysis. The task analysis is described in this paper. It consists of three activities: (1) the analysis proper--reduction of the driver's tasks into their component behaviors, (2) a criticality evaluation--an attempt to assess the importance of each behavior to safe and efficient driving, and (3) the development of task descriptions--preparation of a booklet containing the results of the task analysis and a criticality evaluation. (Author)

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The Development of Driver Education Objectives Through an Analysis of the Driving Task

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Presentation to
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The Human Resources Research Organization (HumRRO) is a nonprofit corporation established in 1969 to conduct research in the field of training and education. It is a continuation of The George Washington University Human Resources Research Office. HumRRO's general purpose is to improve human performance, particularly in organizational settings, through behavioral and social science research, development and consultation.

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16. Abstract

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Prefatory Note

This paper was presented by Dr. McKnight, Principal Investigator for the research effort described, and Program Director of Research Group 2, HumRRO Division No. 1 (System Operations), at Alexandria, Virginia. Mr. Adams is Project Director for the research.

The paper was given at the October 27, 1970, session of the College Safety Education and Research in Safety Education Divisions of the National Safety Congress at their annual meeting.

The research reported in this paper was part of a set of studies done by the Human Resources Research Organization for the National Highway Traffic Safety Administration. The effort involves the development of a set of instructional objectives for driver education courses.

Publications from this research are *Driver Education Task Analysis, Volume 1: Task Descriptions*, U.S. Department of Transportation report HS 800 367 (HumRRO Technical Report 70-103); and *Driver Education Task Analysis, Volume II: Task Analysis Methods*, U.S. Department of Transportation report in press. Two volumes under preparation will describe the instructional objectives and tests that were developed from the task descriptions.

THE DEVELOPMENT OF DRIVER EDUCATION OBJECTIVES THROUGH AN ANALYSIS OF THE DRIVING TASK

A. James McKnight and Bert B. Adams

Certainly no one needs to be reminded of the controversy that has raged for the past several decades over the role of driver education in public schools. Specifically, does driver education have an enduring impact on the safety and efficiency of people who have received it as they operate their vehicles on the public highways? It is regrettable, most objective authorities will agree, that conclusive judgment on this issue is no closer at the present time than it was when the controversy began.

In a set of studies recently sponsored by the National Highway Traffic Safety Administration, conclusions were almost unanimous that, before we become concerned with the long-term effectiveness of driver education as reflected in accidents and violations, we should see whether present programs achieve the *specific instructional objectives* that have been established. Are students taught what we want them to know; and does the instruction enable them to do what we want them to do? This, after all, is the way other educational programs are evaluated.

Any set of instructional objectives used to evaluate an educational program should, logically, guide the development of the program from the outset. It was the recognized need for a set of acceptable driver education objectives that led to the study herein. The goal was to develop a set of instructional objectives for driver education courses based on a comprehensive and detailed analysis of the driver's tasks. The study has two phases—the first, completed in 1970, was the analysis of the driver's tasks.[1] The second phase, scheduled for completion in early 1971,[2] will attempt to develop a set of instructional objectives from the results of the task analysis. In this paper, the task analysis will be described. There were three activities: (a) the *analysis* proper—the reduction of the driver's tasks into their component behaviors; (b) a *criticality evaluation*—an attempt to assess the importance of each behavior to safe and efficient driving; (c) the *development of task descriptions*—preparation of a booklet containing the results of the task analysis and a criticality evaluation.

TASK ANALYSIS

The HumRRO work is by no means the first analysis of the driving task to be performed. There have been many. However, most have been concerned primarily with the processes that mediate between the driver's sensory inputs—the sights, sounds, and feel of the road—and his outputs, that is, the responses he makes to control the vehicle. Many analyses have provided highly detailed descriptions or models of mediating

[1] McKnight, A. James, and Adams, Bert B. *Driver Education Task Analysis: Vol. I, Task Descriptions,* U.S. Department of Transportation report HS 800 367 (HumRRO Technical Report 70-103, November 1970).

[2] McKnight, A. James, and Adams, Bert B. *Driver Education Task Analysis: Vol. II, Background and Methodology,* U.S. Department of Transportation report in press.

processes, often in precise mathematical terms. These descriptions have often permitted very accurate predictions of the driver's responses to particular constellations of highway variables. However, the driver educator, if he is to prepare students to respond appropriately to the various highway situations they will encounter, must ultimately know what those specific situations and responses are.

One of the oldest ways of identifying the specific behaviors—situation and response—imposed upon an individual is to observe him. However, the extremely varied nature of driving behavior makes direct observation unfeasible. It would be almost impossible to set up an observational scheme that would guarantee that even a majority of the driver's behaviors would be observed within a reasonable period. It is likely that most of the time would be spent witnessing a restricted number of highly repetitive behaviors.

An alternative to observing people behave is to ask them to report on their behaviors through questionnaires or interviews. Again, the extremely varied nature of driving behavior becomes an obstacle. To expect a driver to recall everything he has had to do is unrealistic. Moreover, if the individual administering the interview or questionnaire is himself a driver, it is doubtful that the results of his efforts would prove very enlightening to him.

The approach ultimately selected was analytic rather than empirical. Instead of examining the driver's actual behavior, an analysis was made of the larger system of which the driver is a part in order to identify the specific behavioral requirements imposed upon him. The system which, lacking better identification, we call the "highway transportation system," consists of the driver, the vehicle he drives, the roadway over which they travel, the traffic they encounter, and the natural environment in which it all takes place. It is this system that creates the situations to which the driver must respond.

The specific "system analytic" approach involved four steps—(a) identifying those characteristics of the system that were capable of creating behavioral requirements, (b) identifying the specific behaviors they required, (c) organizing behaviors into an acceptable structure, and (d) analyzing the behaviors into their specific elements.

IDENTIFYING SYSTEM CHARACTERISTICS

Each of the five components of the highway transportation system was examined to identify those specific characteristics capable of giving rise to situations to which a driver must respond. For the driver, this meant physical and mental characteristics, either of a permanent or transient nature, that influence the way in which he must behave. For example, a driver who is fatigued must engage in certain behaviors that are unnecessary when he is fresh and alert. The vehicle's controls and displays clearly influence the responses required of the driver. Moreover, the vehicle is capable of generating behavioral requirements of its own, as, for example, the behavior required to keep it in safe operating condition. The roadway through its variation in vertical and horizontal alignment, lane markings, and various traffic control devices is an obvious source of behavioral requirements. This is true also of the traffic the driver encounters. Finally, the natural environment, with its variation in temperature, weather conditions, and general illumination, is a stronger determiner of driver behavior.

The identification of behaviorally relevant system characteristics was greatly supported by an intensive review of traffic literature including driver education texts, accident statistics, critical incidents reports, engineering studies, behavioral research studies, and operations analyses. The result of this review was a list of nearly 1,000 specific characteristics of the highway transportation system capable of giving rise to situations to which the driver must respond.

IDENTIFYING BEHAVIORS

Having identified behaviorally relevant system characteristics, the next step was to study each characteristic to determine the nature of the situations that could arise and to establish appropriate responses. In many, if not most cases, situations and responses were readily apparent. Few people need to be told the behavioral implications of a traffic light, lane marking, or windshield wiper. However, other characteristics such as a blowout, loss of brake pressure, or an oncoming car traveling in the same lane, are not so well-known, and examination of existing literature was necessary.

Frequently, system characteristics in combination with one another will require behaviors over and above what each characteristic alone requires. Examples of such "interacting" characteristics are snow on a hill, meeting an oncoming car at night, or following another car when the driver is extremely fatigued. The only way to identify such behaviors was to examine system characteristics in pairs. With close to a half-million such pairs, some simplification was required. We examined combinations of characteristics at the level of 40 major categories to determine which combinations were likely to create additional behaviorally relevant situations. The internal components of an automobile, for example, did not seem likely to interact with the characteristics of the driver.

The number of interacting characteristics is not limited to two. For example, the behavior involved in driving up a *snow*-covered *hill* will vary depending on presence or absence of other traffic. This meant examining combinations of three characteristics, with the same simplification described earlier. This process could have been continued to any number of characteristics in combination. However, as the number of characteristics increased, the number of combinations giving rise to additional unique behaviors decreased sharply. Beyond four characteristics, the situations became too specific and occurred too infrequently to warrant serious consideration.

ORGANIZING BEHAVIORS

The result of the analysis of system characteristics was a list of over 1,000 specific driving behaviors. In order to make the list usable, behaviors were grouped into tasks, that is, behaviors that either were directed toward a particular outcome (e.g., "passing," "parking") or dealt with the same general situation (e.g., "night driving," "responding to road surface instructions"). On-road tasks were grouped into three categories: *basic control tasks*—those relating to control of vehicle; *general driving tasks*—those that occur any time the car is being driven; and *situational tasks*—those representing responses to specific situations encountered, further subdivided according to the system characteristics that define the system. Off-road tasks were also grouped into three areas—pre-trip, maintenance, and legal responsibilities. A list of tasks is shown on the following pages.

ON-ROAD BEHAVIORS

Task Number	
	Basic Control Tasks
11	Pre-Operative Procedures
12	Starting
13	Accelerating
14	Steering
15	Speed Control
16	Stopping
17	Backing Up
18	Skid Control
	General Driving Tasks
21	Surveillance
22	Compensating for Physical Limitations
23	Navigation
24	Urban Driving
25	Highway Driving
26	Freeway Driving
	Tasks Related to Traffic Conditions
31	Following
32	Passing
33	Entering and Leaving Traffic
34	Lane Changing
35	Parking
36	Reacting to Traffic
	Tasks Related to Roadway Characteristics
41	Negotiating Intersections
42	On-Ramps and Off-Ramps
43	Negotiating Hills
44	Negotiating Curves
45	Lane Usage
46	Road Surface and Obstructions
47	Turnabouts
48	Off-Street Areas
49	Railroad Crossings, Bridges and Tunnels, Toll Plazas
	Tasks Related to the Environment
51	Weather Conditions
52	Night Driving
	Tasks Related to the Car
61	Hauling and Towing Loads
62	Responding to Car Emergencies
63	Parking Disabled Car
64	Roadside Servicing
65	Pushing and Towing

OFF-ROAD BEHAVIORS

Task Number	
	Pre-Trip Tasks
71	Planning
72	Loading
73	Use of Alcohol and Drugs
74	Maintaining and Accommodating Physical and Emotional Condition
	Maintenance Tasks
81	Routine Care and Servicing
82	Periodic Inspection and Servicing
83	Repairs Car Subsystems
	Legal Responsibilities
91	Driver and Car Certification
92	Post-Accident Responsibilities

ANALYZING THE BEHAVIORS

After all the driving behaviors had been organized for the tasks, it was necessary to continue the analytic process in order to identify the specific behavioral elements involved. A behavioral element included a description of the specific response, the physical objects toward which the responses were directed, and any cues that initiated, guided, or terminated the behavior. The attempt was made to be as specific as possible. For example, "checks traffic behind" would not be sufficiently behavioral. "Looks in the rearview mirror and observes cars behind" is more precise. Similarly, terms such as "hazards" or "traffic pattern" were not considered sufficiently precise to serve as cues. Even the term "car ahead" would be too broad if it were the tail lights of the car to which a driver was to respond.

Wherever quantitative standards of performance could be validly established, they were included. Unfortunately, such standards are difficult to obtain in driving owing to their dependence on the specific situation involved. For example, the driver's maximum acceptable delay in responding to an amber light at an intersection would depend, among other things, on his speed, his distance from the light, and the anticipated duration of the amber cycle.

CRITICALITY EVALUATION

The result of the task analysis was a set of specific driving behaviors numbering approximately 1700, grouped into a hierarchy of tasks, subtasks, and so on. The next major step in the analytic phase of the project was to evaluate the criticality of each behavior. Such an evaluation is needed to help driver educators establish realistic priorities when developing instructional objectives.

It was immediately apparent that any evaluation of behavior criticality would have to be judgmental. The relationship between each specific driving behavior and the overall needs of the transportation system are far too complex, and data bearing upon the relationships are far too sparse, to offer any hope of establishing precise, quantitative expressions of criticality. The goal of the evaluation process therefore became one of obtaining judgments that would provide the closest possible estimate of the true criticality of each behavior. The evaluation process involved (a) the collection of empirical data to be used in guiding judges, (b) the selection of an evaluation method that would produce reliable results, (c) the administration of the evaluation, and (d) the analysis of results.

COLLECTION OF CRITICALITY DATA

Of course, the judgment of any person concerning the criticality of driving behavior is, to a great extent, a function of his own individual experience. This experience, no matter how "expert" a person may be, is bound to be somewhat limited. One way to improve judgments of criticality was to provide each evaluator with all the information that could be obtained concerning the relationship of specific behaviors to the needs of the highway transportation system. Such information included data bearing on the system consequences of behaviors, for example, accident statistics, data on human performance and error, and data concerning the frequency with which the various behaviors are acquired.

One of the most valuable forms of criticality data describes behavioral antecedents of accidents. Unfortunately, little of such information is available. However, highly detailed descriptions of actual accidents are on file at the National Highway Traffic Safety Administration and at Cornell Aeronautical Research Laboratories. The project staff examined 1,000 of these reports to identify behaviors in three categories: (a) *preventive*—behaviors that might have prevented an accident situation from arising, (b) *defensive*—behaviors that might have enabled the driver to avoid being placed in an accident situation, and (c) *evasive*—behaviors that might have allowed an individual to escape an impending accident. The results of this study, supplemented by information gathered from the U.S. Army, were added to the inventory of criticality data.

SELECTING AN EVALUATION METHOD

Two questions arose in selecting an evaluation method—whether to have judges rate or rank the behavior, and what sort of rating or ranking to use. In a small pilot examination, different approaches were compared. The results favored the ranking process, but a problem with this approach was that each judge could rank only a limited number of behaviors at a time—25 was believed to be a maximum. The question was how to interlock the rankings so that an estimate of each behavior's relative position within the entire population of 1500[3] behaviors could be obtained. The decision was made, again aided by the pilot study, to compile groups of 25 behaviors drawn at random from all of them. Each behavior would be ranked five times in five different groups of behaviors. The assumption was that the mean of the five rankings would provide a reasonable approximation to the relative position of the behavior in the total population.

ADMINISTERING THE EVALUATION

The evaluation was performed by 100 highway safety specialists representing the areas of driver education, enforcement, licensing, traffic safety programs, and fleet safety. Each evaluator received three randomly drawn groups of 25 behaviors and a set of directions and a booklet of task descriptions that contained the results of the task analysis along with the information bearing on task criticality described earlier. All but

[3]For the evaluation process, the number of behaviors was reduced from 1700 to 1500 by combining those behaviors which were part of an integral process and which, it was believed, should be evaluated as a group.

seven of the evaluators returned completed rankings. The only consequence of the missing rankings was that some behaviors were ranked four rather than five times.

PREPARING INDICES OF CRITICALITY

An index of criticality was obtained for each behavior by averaging the four or five rankings assigned to that behavior. Before averaging, ranks were transformed to normalized scores with the mean of zero and a standard deviation of 10. Resulting criticality scores ranged from -20 for a 25th-ranked behavior to +20 for a first-ranked behavior.

To determine the degree of agreement among the evaluators, an analysis of variance was performed on the 1500 criticality indices, using as an error term the variation among judges evaluating the same behavior. The differences among means were highly significant. An inter-class correlation of .82 indicates a high degree of agreement among the judges.

PREPARATION OF TASK DESCRIPTIONS

The final step in the task analysis program was the preparation of task descriptions containing (a) the behavior descriptions resulting from the task analysis, (b) the criticality indices resulting from the evaluation process, and (c) various items of supporting information gathered through the literature review, including the criticality data furnished to the task evaluators. Two sample pages from the task descriptions are shown at the end of this paper. They represent one portion of the Subtask "decides whether to pass" of Task 32: Passing.

The first of the two sample pages appears as a left-hand page in Driver Education Task Analysis: Volume I, Task Descriptions. The various elements in the task description appear at the left center. Each behavioral element is assigned a code number; it appears at the far left. The results of the criticality evaluation are displayed along the right-hand margin. The number represents the mean criticality value, scores ranging from -20 to +20. It is apparent that all the passing behaviors shown are quite critical. The "x's" are merely a graphic display of the same information; the greater the number of "x's" the more critical is the behavior. Where several behaviors in a sequence have the same level of criticality, the numerical and graphic display is provided only once. For example, in the sample page, all the behaviors between 32-121 and 32-123 had a mean criticality value of 15.

The second of the two sample pages appears as the right-hand page in the task description. It contains various items of information related to those behavioral elements whose code numbers are indicated along the left margin. These elements were also indicated by the appearance of an asterisk (*) following the behavior description. The nature of the information provided is indicated by the placement of the "x" in the column at the left. The abbreviations are as follows:

- PI - *Performance Information*. Information which describes characteristic driver performance.
- PL - *Performance Limits*. Information which describes limits of driver capability.
- CR - *Criticality*. Information bearing upon the criticality of driver behaviors, as described in an earlier section.
- SK - *Skills*. Information which describes complex perceptual, motor, or intellectual processes.
- KN - Knowledge. Information which might play a role in enabling or motivating students to perform the behavior.

The contents of the right-hand page are not intended as an organized body of information, but rather as individual items of relevant information of potential interest to users of the task descriptions.

Task 32: Passing *

		Criticality	
32-1	DECIDES WHETHER TO PASS (TWO- OR THREE-LANE ROADS)		
32-11	Looks along roadside for passing control signs *	5	X X X X
32-111	Does not pass if "no passing" zone is indicated or has been indicated previously (see 21-2, Surveillance or Traffic Controls)	12	X X X X X
32-112	May pass if sign indicates end of "no passing" zone *		
32-12	Observes lane markings	10	X X X X
32-121	Does not pass if left side of lane is marked by the following:	15	X X X X X
32-1211	One or two solid lines		
32-1212	Solid line to the right of broken line		
32-122	Determines that passing is permissible if left side of lane is marked by the following:		
32-1221	Broken line		
32-1222	Broken line to the right of solid line		
32-1223	No markings		
32-123	Does not anticipate end of "no passing" zone *	5	X X X X
32-13	Observes roadway ahead		
32-131	Identifies passing limitations including the following *	13	X X X X X
32-1311	No passing zone *		
32-1312	Hill		
32-1313	Curve		
32-1314	Intersection *		
32-1315	Bridge or tunnel		
32-1316	Railroad crossing		
32-1317	Pedestrian on edge or shoulder of two-lane roadway *		
32-132	Judges available passing distance *	15	X X X X X
32-133	Judges lead vehicle relative to speed *		
32-1331	In accelerative pass, judges lead vehicle speed from car speed *	12	X X X X X
32-1332	In flying pass, judges lead vehicle-car closing rate *	14	X X X X X
32-134	Judges available passing time *		

Code Number	P I	P L	C R	S K	K N	O	
32				X			In 1968, there were approximately 10,000 fatal passing accidents
32-11						X	Abiding by signs, lane markings, and other passing limitations is a legal requirement in most states
32-112		X					(EX) More passing opportunities are accepted when drivers are forewarned 500 feet from the start of the passing zone and given the length of the passing zone (193, p. 124)
32-123		X					Nearly half of drivers violate the end of a "no passing" zone on a two-lane roadway (131, p. 32)
32-131				X			Driver's disregard of roadway limitations to passing was noted in at least 7 out of 1000 accident reports received (HumRRO)
32-1311		X					Nearly 25 percent of drivers violate the beginning of a "no passing" zone (131, p. 32)
							(EX) Drivers were able to judge variables involved in completing a pass within the passing zone. Few drivers initiated passes that could not be completed in time without additional acceleration; few declined to pass when two seconds or more margin existed (81, p. 16)
32-1314						X	It is dangerous and illegal to pass at an intersection owing to the possibility of encountering unexpected vehicle maneuvers, including the following: (a) lead vehicle suddenly attempts a left turn; (b) lead vehicle is forced to the left by traffic entering from the right; (c) on two-lane roads, traffic may enter the left lane without looking, not expecting to encounter oncoming traffic there
32-1317						X	If the pedestrian is on the right, the vehicle ahead may swerve left and force the car off the left side of the roadway. If the pedestrian is on the left, driver could possibly face the alternative of hitting the pedestrian or sideswiping the vehicle being passed (198, p. 5)
32-132		X					(EX) Drivers consistently underestimated the required overtaking and passing distance. Negative errors increased with speed. At 50 miles per hour, over three-fourths of the estimates were considered dangerous (145, p. 42)
32-133		X					The greater the speed, the less likely the driver of an overtaking car is to accept a given passing distance (047, p. 3)
32-1331						X	By attaining a stable headway between the car and the vehicle ahead, the driver matches the speed of the lead vehicle
							When the lead vehicle's velocity is 50 miles per hour, approximately 750 feet are required to complete the pass (28, p. 168)
32-1332						X	A flying pass is one with the original speed of the passing car greater than the speed of the vehicle being passed This type of pass requires great sight distance ahead (201, p. 144)
		X					(EX) Drivers adequately respond to speed and distance cues that determine the validity of a flying pass decision - car speed, car-vehicle ahead closing rate, distance of each from the end of the passing zone, and the distance headway between the car and the vehicle ahead (145, p. 51)
32-134						X	Judgment of passing time is based on driver's judgment of passing distance and closing rate
		X					While driver's ability to judge closing rate is quite limited, he responds appropriately to passing distance and the speed of the vehicle ahead (193, p. 34)

P I | P L | C R | S K | K N | O

SUMMARY

The results of the task analysis, while directed to the needs of driver education, are of potential interest to anyone whose work demands an understanding of the tasks imposed on the driver. Each individual information user would be required to process the contents of the task description in fulfillment of his own individual needs. For example, a simulator manufacturer would wish to analyze at far greater detail the sensory components of each task. However, because of their comprehensiveness, the task descriptions should provide a broad platform on which to work and should provide each practitioner with some assurance that he is taking adequate account of the full range of demands placed upon the driver. Moreover, the criticality indices, while decidedly judgmental, constitute at least a consensus that should permit the establishment of priorities that are not entirely arbitrary.

The task descriptions developed from the research should be viewed as a beginning. If the tasks imposed on the driver do not change over time, our understanding of them will certainly do so. To accommodate extensions and revisions of the task analysis, the task descriptions have been entered on magnetic tape to be used in conjunction with a tape-operated typewriter. It is our hope that this facility for rapid and economical updating of the task analysis will be fully utilized in the future.