SHRP 2 Request for Proposals

Focus Area: Safety
Project Number: S02
Project Title: Integration of Analysis Methods and Development of Analysis Plan
Date Posted: July 30, 2007

SHRP 2 Background
To address the challenges of moving people and goods efficiently and safely on the nation’s highways, Congress has created the second Strategic Highway Research Program (SHRP 2). SHRP 2 is a targeted, short-term research program carried out through competitively awarded contracts to qualified researchers in the academic, private, and public sectors. SHRP 2 addresses four strategic focus areas: the role of human behavior in highway safety (Safety); rapid highway renewal (Renewal); congestion reduction through improved travel time reliability (Reliability); and transportation planning that better integrates community, economic, and environmental considerations into new highway capacity (Capacity). Under current legislative provisions, SHRP 2 will receive approximately $150 million with total program duration of 7 years. Additional information about SHRP 2 can be found on the program’s Web site at www.trb.org/shrp2.

Safety Focus Area
The SHRP 2 safety research plan includes two tracks: a large field study of driving behavior using volunteer drivers and a sophisticated instrumentation package installed in the volunteers’ vehicles, and a video system to record the movements of all vehicles at specific road sites such as an intersection. The SHRP 2 field studies are intended to support a comprehensive safety assessment of how driver behavior and performance interact with roadway, environmental, vehicular, and human factors and the influence of these factors and their interactions on collision risk, especially lane departure and intersection collisions. The accompanying chart lays out the main projects anticipated. The chart provides a general idea of the flow of work. The exact number, content, and timing of contracts are subject to change.

The in-vehicle driver behavior and crash risk study is shown across the top of the chart, beginning with a Study Design (S05) that leads to data collection starting in 2009 (S07). Project S05, the Study Design, includes the development of a complete data collection system, a field trial of the system, and the management plan for the full in-vehicle study. The Study Design is supported by Project S01 to identify analytic methods to address the research questions and Project S03 to evaluate mobile measurement systems collecting detailed and accurate roadway information in the study areas. This project, S02, will integrate the findings of the S01 projects to produce an analysis plan for the full in-vehicle driver study. The full driver study will be implemented in the third year in three or four study areas with an overall quality assurance and technical coordination contractor (Project S06). Roadway data will be collected in the study areas under a separate project, S04. Multiple analysis projects (S08) are planned to address a wide range of research questions using the data collected.
A second track of research for the SHRP 2 Safety focus area involves site-based video instrumentation and is shown at the bottom of the chart. At this time, only the first project of this track, Project S09, Site-Based Video System Design and Development, is programmed. The purpose of this initial project is to improve the capabilities of existing systems. The Safety Research Plan continues this track with site-based field data collection starting in 2009 under Project S10 and the analysis of the field data in project S11. Execution of this track beyond Project S09 will depend on available funding and on the outcome of Project S09 to improve the capabilities of existing site-based video systems.

**Project Background**

Contracts have been awarded for Projects S05 and S09 and five awards were made under Project S01. Approximate starting dates for these projects are reflected in the chart. The multiple S01 projects will address the development of analytic methods for the SHRP 2 safety field studies, including demonstrations with existing data. The subject of this RFP is Project S02, Integration of Analysis Methods and Development of Analysis Plan.

**Project Objective**

The objective of this project is to integrate the results of the S01 projects and produce an analysis plan for the in-vehicle field studies. This contractor will participate in the Third SHRP 2 Safety Research Symposium in the summer of 2008. All of the active SHRP 2 Safety contractors will participate in this workshop, including the study design contractors and the contractor evaluating roadway measurement systems. This project will take into account the capabilities of the data collection systems and data system design as developed in Projects S03, S05, and S09 and the results of demonstrations of analytic methods from the S01 projects and will integrate this
information to produce an analysis plan for the safety field studies. Finally, the Project S02 contractor will organize, be a principal presenter, and facilitate discussions of the analysis plans developed at the Fourth SHRP 2 Safety Research Symposium in the summer of 2009.

**Tasks**

*Task descriptions are intended to provide a framework for conducting the research. SHRP 2 is seeking the insights of proposers on how best to achieve the research objective. Proposers are expected to describe research plans that can realistically be accomplished within the constraints of available funds and contract time. Proposals must present the proposers’ current thinking in sufficient detail to demonstrate their understanding of the issues and the soundness of their approach to meet the research objective(s):*

**Phase I: Develop a Work Plan for Phase II**

**Task 1: Review the Products of the Current SHRP 2 Safety Projects**

Current SHRP 2 Safety projects include:

Project S01: Development of Analysis Methods using Recent Data  
Five contracts were awarded:  
1) University of Minnesota Center for Transportation Studies  
2) Pennsylvania Transportation Institute  
3) University of Michigan Transportation Research Institute (UMTRI)  
4) University of North Carolina Highway Safety Research Center (HSRC)  
5) Iowa State University Center for Transportation Research and Education (CTRE)

Project S05: Design of the In-Vehicle Driving Behavior and Crash Risk Study  
Contractor: Virginia Tech Transportation Institute (VTTI)

Project S09: Site-Based Video System Design and Development  
Contractor: University of Michigan Transportation Research Institute (UMTRI)

Project S01 Phase I Reports on the conceptual development of the analytic approach are due by the end of 2007. These reports will describe the specific research questions selected, hypotheses formulated, data selected, and analysis planned for Phase II of these projects. The Project S05 contractor will submit a Sample Design Interim Report by the end of 2007. This report will include priority research questions, a general analysis plan that includes collision surrogates, risk measures and analytic methods, and the sample design for selecting geographic areas, drivers, and vehicles for the driving behavior study. A System Design Interim Report from Project S09 will also be available late in 2007. This report will address research questions for the site-based approach and the conceptual approach for data processing and analysis.

The S02 contractor will review the products of the current SHRP 2 safety projects in preparation for the Third SHRP 2 Safety Research Symposium (2008). The objective of the review is to identify the pertinent information relating to the planned data collection, data architecture, data access, and analysis methods to address the priority research questions in the subsequent analysis work plan. The reports described above are not available at this time, but they will be available at the start of this contract. For preparing this proposal, available information on the planned SHRP 2 data collection is included in Attachment 1.

**Product:** material products will go in the subsequent Phase I report.
**Task 2: Third SHRP 2 Safety Research Symposium**

Participate in the Third SHRP 2 Safety Research Symposium that will be organized by the contractor for Project S05: Study Design for In-Vehicle Driving Behavior and Crash Risk Study. This two-day workshop is expected to take place in Washington, D.C., in the summer of 2008; the exact dates will be coordinated with SHRP 2 staff.

The objective of the symposium is to exchange information on implications of the demonstrations of analysis methods conducted under Phase II of the S01 projects for the design of the field studies being conducted by the contractors for Projects S03, S05 and S09 and used in the development of an analysis plan for the field study in Project S02. Workshop participants will include the contractors from all active SHRP 2 safety projects (S01, S02, S03, S05, and S09), SHRP 2 Safety Technical Coordination Committee members, SHRP 2 staff, and possibly other experts. Information from the analysis methods contractors will be used by the S02 contractor to revise the research questions and integrate the results of the S01 projects to produce the analysis plan. This analysis plan will be used for the SHRP 2 safety field studies and by the study design contractors to further refine the data requirements for the instrumentation packages to be used in the field study and to address issues related to data storage, data access provisions, data processing, and quality assurance and control.

**Product:** a compilation of presentations and other materials developed for the Third SHRP 2 Safety Research Symposium along with discussion notes and other information relevant to the S02 project. These products will be included in the Phase I Report (Task 4).

**Task 3: Frame and Prioritize Specific Research Questions**

Identification and prioritization of research questions has been addressed by SHRP 2 committees and the current contractors. The S02 contractor will take on responsibility for this process of refining the research questions for Safety research in SHRP 2. A starting point for this proposal is a summary of research questions developed by technical committees for the in-vehicle field study that is included as Attachment 2.

The goal of this project is to produce analytic approaches that can be applied to the larger data sets that will be produced by the field studies. Two central issues for the planned analysis of the in-vehicle field study are the statistical relationship of surrogate measures of collisions (conflicts, critical incidents, near-collisions, or roadside encroachment) with actual collisions, and the formulation of exposure-based risk measures using these surrogate measures.

Specific research questions of interest to SHRP 2 relate the interaction of driver behavior/performance for specific roadway design and operation characteristics to changes in the risk of road departure and intersection crashes. Candidate factors include, but are not limited to:

- Driver factors: age and gender, speed, driver errors, inattention, distraction, fatigue, impairment, and perhaps driving characteristics such as aggressive or non-aggressive driving styles that might be characterized from measured driving performance such as speed on curves, deceleration levels on intersection approach, or gap acceptance.
- Roadway factors: edge-marking, rumble strips, lane width, shoulder type and width, curvature, grade, signing and sight distance.
• Intersection factors: signal versus signed, intersection configuration, signal timing, traffic volumes, and sight distance.
• Environmental factors: light condition, weather, and pavement quality condition.
• Vehicle factors: vehicle type (car, SUV, van), antilock braking systems, cruise control use, handling characteristics (including roll stability), and wheelbase.

Specific research questions address the possible relationship of the factors listed above and others, either independently and/or in combination, with lane-keeping performance and road departure or with intersection safety indicators. The expected capabilities of the data collection system, based on the Task 2 work, should be taken into account. Proposals are not expected to address all the questions/issues posed, but rather should address a process and criteria for refining the research questions available from the Third SHRP 2 Safety Research Symposium and for prioritizing these questions. Examples may be used to illustrate the proposed approach.

**Product:** a revised and prioritized set of research questions to be addressed by the subsequent plan for the analyses of SHRP 2 Safety data in the S08 and S11 projects. Material products will go in the subsequent Phase I Report.

**Task 4: Phase I Report**

A Phase I report should be prepared to present the results of the research conducted in Tasks 1 through 3. The Phase I report should include a revised and prioritized set of research questions to be addressed in analyses of the data gathered in the in-vehicle field study. The Phase I report should address the ability of the anticipated SHRP 2 safety data set to address each of the priority research questions.

The Phase I report should identify specific priority research questions that can be addressed with data from the SHRP 2 in-vehicle field study. The report should indicate how specific priority research questions might be grouped together into several work plans. Each work plan should address groups of questions closely related by topics or requiring similar data reduction and analysis approaches or needing similar research skill sets. Upon approval by SHRP 2, the work plans recommended by the research team in the Phase I report will be prepared in Task 5.

The Phase I report should identify specific priority research questions that cannot be addressed with data from the in-vehicle field study, but can potentially be addressed with data from a site-based study. The data requirements and research approaches to answer these questions with site-based studies will be addressed in Task 6.

The Phase I report should identify any specific priority research questions that cannot be fully addressed with data from the in-vehicle field study, as currently planned, and that are also not appropriate for consideration in a site-based study. The report should recommend any changes in the plan for the SHRP 2 in-vehicle driving study that could provide data to make evaluation of such questions feasible.

**Product:** a Phase I Report is due no later than six months after contract award.

**Phase II: Work Plans**

Contractors cannot proceed with Phase II unless and until approval is given by SHRP 2. One month is allocated for the Phase II approval by SHRP 2.
Task 5: Develop an Analysis Plan for SHRP 2 In-Vehicle Field Study

An analysis plan should be developed to obtain answers to the specific priority research questions that can be addressed with data from the in-vehicle field study. The analysis plan should consist of a series of work plans recommended in the Phase I report and approved by SHRP 2. These work plans will be developed, but not executed, in Project S02. Each work plan should be sufficiently self-contained that it could, if desired, be executed in a future project independently of the other work plans (i.e., specific work plans may be executed by different research contractors).

Each work plan prepared in Task 5 should be capable of being executed with data expected to be available from Projects S04, S06, and S07. The work plans prepared in Task 5 will be candidates for execution in Project S08. The work plans prepared in Task 5 may, collectively, have funding requirements that exceed the anticipated funding level for Project S08 both because future funding availability may change and to provide an opportunity for SHRP 2 to make choices among candidate work plans.

Each work plan should be presented in sufficient detail so that it can be understood and executed by researchers other than the authors of the work plan. Each work plan should address all required elements of the research including, as appropriate, problem formulation, hypotheses to be tested, measures of effectiveness (dependent variables), evaluation factors (independent variables), data requirements, sampling approaches, data reduction methods, recommended data base structure, model formulation, statistical analysis, model validation, and documentation of results. The recommended approaches to each of these elements should be fully explained and justified. Each work plan should anticipate potential pitfalls in the research and recommend how these pitfalls should be avoided. The research approaches should consider both engineering and human factors/driver behavior models, as appropriate. The recommended study duration and levels of effort and funding for each work plan should be stated. The products of this project will support the development of the S08 RFP and will provide reference material for prospective S08 bidders. (See Special Note 2.)

Bidders may propose analytic activities that might be necessary to support the work plan development. Such activities might include, for example, analysis of existing data to estimate the exposure or expected sample of collisions and/or surrogates for subsets associated with specific research questions based on driver subgroups or specific road environments. And in cases where appropriate sample data are available and where the methods have not been completely tested in Project S01 or in other research, bidders may consider conducting additional pilot analysis in Task 5 to support the work plan. Other analysis activities/methodology development to support the work plan may also be considered, such as the problem of establishing the relationship of surrogates to crashes. If key data reduction and analysis methods cannot be tested in Project S02 because actual data from Projects S04/S06/S07 are needed for testing, then the work plan prepared in Task 5 should be structured with a two-stage approach, including an initial pilot study to fully test the data reduction and analysis methods before the primary study begins.

Product: an analysis plan, including a series of self-contained work plans, to address priority research questions with data from the in-vehicle field study. The analysis plan should be incorporated in the final report to be prepared in Task 8.
Task 6: Identify Potential Analytic Applications for the Site-Based Data
A secondary task is to consider what analytic approaches would be needed to address specific priority research questions in site-based work. This may involve analytic approaches that are considered for the in-vehicle field study in Task 5 or other analytic approaches that are specifically applicable to site-based studies. This activity is necessarily of limited scope since the site-based field study anticipated in Project S10 is not currently funded. This task will produce a section for the Task 8 Final Report that assesses the suitability of the analytic approaches described in Task 5, or other approaches considered, for analysis of the site-based data. An analysis work plan for the site-based study is not required of this project.

Product: assessment of potential analytic approaches for the site-based study. Material products will go in the subsequent Final Report (Task 8).

Task 7: Fourth SHRP 2 Safety Research Symposium—Summer 2009
The Project S02 contractor will organize, be a principal presenter, and facilitate discussions at the Fourth SHRP 2 Safety Research Symposium. This two-day workshop is expected to take place at the Keck Center in Washington, D.C. in the summer of 2009; the exact dates will be coordinated with SHRP 2 staff.

The primary objective of this symposium is to present and discuss the analysis plans developed in this project. The priority research questions will be reviewed, as well as the planned data collection, data archive and data access to support the analysis work plan. Workshop participants will include the contractors from all active and completed SHRP 2 safety projects (S01, S02, S03, S05, and S09), SHRP 2 Safety Technical Coordination Committee members, SHRP 2 staff, and possibly other experts.

SHRP 2 will provide the meeting facility and pay the costs associated with hosting the event, such as travel for invited participants and any food. The Project S02 contractor will develop the agenda and invite selected speakers in consultation with SHRP 2 staff.

Product: a compilation of presentations and other materials developed for the symposium along with questions, comments and other relevant information from attendees that may be of interest to the SHRP 2 staff, technical committees and current or future contractors. These products will be included in the subsequent Final Report (Task 8).

Task 8: Final Report
The contractor will prepare a final report documenting the activities of Tasks 1-7. The report will include the materials called for in each task, including the work plans developed in Task 5. A draft report is due at the end of month 16; the final revised version is due at the end of month 19.

Deliverables
1. Papers, presentations, and/or summary materials prepared for the Third Safety Research Symposium in Task 2—summer of 2008
2. Phase I Report in Task 4—end of month 6
3. Draft Final Report prepared in Task 8—end of month 16
4. Papers, presentations, and/or summary materials prepared for the Fourth SHRP 2 Safety Research Symposium in Task 7—summer of 2009
5. Final Report—end of month 19
Meetings
1. Quarterly meetings with SHRP 2 staff, two in Washington, DC and the rest at contractor’s facility starting with a kick-off meeting in the first month.
2. Two (2) interim meetings with the TCC in Washington, DC; Irvine, CA; or Woods Hole, MA
4. TRB Annual Meeting January 2009 in Washington, DC.
6. Three additional SHRP 2 contractor meetings, in either Blacksburg, VA or Ann Arbor, MI—dates to be determined.

Special Notes:
Note 1: The Research Plan, Item 4 of the proposal, shall be limited to no more than 35 pages.

Note 2: The S02 contractor is not precluded from bidding on Project S08, or any other SHRP 2 safety project.

Funds Available: $425,000

Contract Period:
Phase I: 6 calendar months from contract start date
Phase II: Begins approximately 7 calendar months after Phase I begins and goes on for 12 calendar months from notice to proceed on Phase II.
Phase I and II: 19 months

Responsible Staff: Kenneth L Campbell, kcampbell@nas.edu, 202-536-5187

Authorization to Begin Work: April 2008, estimated

Proposals (20 single-bound copies) are due not later than 4:30 p.m. on September 18, 2007

This is a firm deadline, and extensions simply are not granted. In order to be considered, all 20 copies of the agency's proposal, accompanied by the executed, unmodified Liability Statement must be in our offices not later than the deadline shown, or they will be rejected.

Delivery Address
PROPOSAL-SHRP 2
ATTN: Neil F. Hawks
Director, Strategic Highway Research Program 2
Transportation Research Board
500 Fifth Street, NW
Washington, DC 20001
Phone: 202-334-1430
Liability Statement
The signature of an authorized representative of the proposing agency is required on the unaltered statement in order for SHRP 2 to accept the agency's proposal for consideration. **Proposals submitted without this executed and unaltered statement by the proposal deadline will be summarily rejected.** An executed, unaltered statement indicates the agency's intent and ability to execute a contract that includes the provisions in the statement. Here is a printable version of the Liability Statement (pdf). A free copy of the Adobe Acrobat PDF reader is available at http://www.adobe.com.

General Notes
1. Proposals will be evaluated by SHRP 2 staff and Expert Task Groups (ETGs) consisting of individuals collectively very knowledgeable in the problem area. Selection of an agency is made by the SHRP 2 Oversight Committee, based on the recommendation from SHRP 2 staff and the ETG. The following factors are considered: (1) the proposer’s demonstrated understanding of the problem; (2) the merit of the proposed research approach and experimental design; (3) the experience, qualifications, and objectivity of the research team in the same or closely related problem area; (4) the proposer’s plan for participation by disadvantaged business enterprises—small firms owned and controlled by minorities or women; and (5) the adequacy of facilities.

2. Any clarifications regarding this RFP will be posted on the SHRP 2 Web site (www.TBR.org/SHRP2). Announcements of such clarifications will be posted on the front page and, when possible, will be noted in the TRB e-newsletter. Proposers are advised to check the Web site frequently until August 15, 2007, when no further comments will be posted.

3. According to the provisions of Title 49, Code of Federal Regulations, Part 21, which relates to nondiscrimination in federally assisted programs, all parties are hereby notified that the contract entered into pursuant to this announcement will be awarded without discrimination on the grounds of race, color, religion, sex, national origin, or disability.

4. The essential features required in a proposal for research are detailed in the Manual for Conducting Research and Preparing Proposals for SHRP 2. **Proposals must be prepared according to this document, and attention is directed specifically to Section IV for mandatory requirements. Proposals that do not conform to these requirements will be rejected.**

5. The total funds available are made known in the project statement, and line items of the budget are examined to determine the reasonableness of the allocation of funds to the various tasks. If the proposed total cost exceeds the funds available, the proposal is rejected.

6. All proposals become the property of the Transportation Research Board. Final disposition will be made according to the policies thereof, including the right to reject all proposals.

**IMPORTANT NOTICE**

Potential proposers should understand that the research project described herein is tentative. The final content of the program depends on the level of funding made available. Nevertheless, to be prepared to execute research contracts as soon as possible after sponsors’ approvals, the Strategic Highway Research Program is assuming that the tentative program will become official in its entirety and is proceeding with requests for proposals and selections of research agencies.
Attachment 1: Planned SHRP 2 Data Collection

Requests for Proposals are available for prior SHRP 2 projects at the link below.

http://www.trb.org/shrp2/SHRPII_ProjectDescriptions.asp

The RFP for Project S05 includes a complete description of the desired capabilities for the in-vehicle driver behavior study. The list of candidate data elements below is taken from the RFP.

- Trip time and distance traveled
- Steering wheel angle (position, velocity)
- ABS/ESC status or activation
- Individual wheel speeds (can infer ABS/ESC/ wheel lock / loss of control)
- Longitudinal speed, acceleration
- Lateral acceleration
- Yaw rate
- Brake actuation
- Brake pedal force
- GPS (latitude, longitude, speed, heading, and clock synchronization)
- Cruise control state
- Turn signal, lights, wipers, horn
- Throttle position
- Air bag status
- Number of occupants in vehicle
- Seatbelt usage
- On cell phone (cell phone RF detector)
- Physiological Measures (wireless EKG, GSR, etc.)
- Video (driver face, forward view, instrument panel, and rear view)
- Lane edge sensing and lane position
- Headway and range rate
- Wide-angle sensors to detect cut-ins in front
- Tailway and range rate
- Lateral proximity sensors
- Weather, illumination
- Ambient temperature
- Road temp (estimate of roadway mu (coefficient of friction))
- Traffic density measure
- Use location to link with roadway characteristics (curvature, grade, lane width, shoulder type and width, etc.)
- Traffic signal state
- Vehicle performance and handling characteristics
- Inventory of vehicle-based equipment (cell phones, radio, navigation, etc.)
- Real-time events to be flagged (if any)
- Consider driver-only audio

Information on the desired roadway characteristics is included in the Project S03 RFP.
The 100-Car Naturalistic Driving Study was recently completed by the Virginia Tech Transportation Institute (VTTI). This study is perhaps the closest in terms of data collected to the planned SHRP II driving behavior study. A sophisticated and unobtrusive instrumentation package was installed in the vehicles of about 100 volunteer drivers for a period of one year. The instrumentation recorded a wide array of numeric and video information sampled at 10 HZ whenever the vehicle was operating. Vehicles operated in the heavily urban Washington DC and Northern Virginia area. Data were collected on over 43,000 hours of driving covering about 2 million miles. Crashes, near-crashes and incidents were identified, where an incident required an evasive maneuver that was less severe than a near-crash. Reported events included:

- 15 police-reported crashes
- 67 non-reported crashes (some producing no damage)
- 761 near-crashes, and
- 8,295 incidents

In addition, a sample of about 20,000 non-events (6 second intervals with no crash, near-crash or incident) was analyzed to produce the same summary data as for the events above. The analysis included manual review of the driver face video to assess driver behavior such as inattention and fatigue.

Several reports address the 100-Car Naturalistic Study conducted by VTTI
An Overview of the 100-Car Naturalistic Study and Findings by VTTI

The main report on the 100-car study. April 2006 (about 500p)

A subsequent analysis of the 100-car study also by Virginia Tech on driver inattention, April 06 (also about 500p)
Attachment 2: SHRP 2 Priority Research Questions

Overall question: Study the relationship of multiple factors or descriptors (human, vehicle, roadway and environmental) to the risk of collisions and casualties. This will involve observing, recording and studying data related to driver behaviors (e.g., lane keeping, speed choice, gap acceptance), driver descriptors (e.g., age, gender, driving experience, fatigue level, attention level), vehicle descriptors (e.g., vehicle type), roadway and traffic descriptors (e.g., curvature, speed limit, shoulder type and width, traffic density) and environmental descriptors (e.g., light level, weather). Basic questions will concern how driver behavior is affected by driver, vehicle, roadway and environmental descriptors and how changes in driver behaviors are related to crash risk under various vehicle, roadway and environmental conditions. While the study can involve many crash types and situations, attention will be given to crashes involving lane departures and crashes at intersections.

Specific questions, by major area:

1) Crash surrogates: define crash surrogates that occur more frequently than crashes, that exhibit behaviors or circumstances similar to those observed in crashes (face validity), and that are operationally observable in the data. Validate that these surrogates predict higher crash risk than “normal” driving. Candidates include “near-crashes” or incidents, lane departure, sudden braking or headway reduction, short headway at intersections, etc. If necessary, develop analytic methods for extrapolating from surrogates to crashes.

2) Exposure and relative risk: how often, and under what circumstances, do drivers do X. X could be many things such as speed more than 10 mph over the posted limit, violate lane edges, tailgate, leave less than 1 sec headway at an intersection, fail to wear safety belts, talk on their cell phone, look at their rearview mirrors, ... How does X affect the risk of crashes or other crash surrogates (relative risk: crash risk with / crash risk without)?

3) External roadway/environmental descriptors: how is driving behavior X and crash risk affected by external descriptors A, B? External descriptors include anything outside the vehicle, so include both permanent (all highway and environmental features: rumble strips, lane width and markings, curvature, road surface, roadside hardware, etc.) and transitory (weather, light conditions, traffic flow, adjacent vehicles, etc.) features. This area includes countermeasure evaluation of existing features (e.g., effect of rumble strips). Particular attention will be given to roadway descriptors related to lane-departure crashes (e.g., run-off-road crashes, head-on crashes) and crashes at intersections.

4) Vehicle descriptors: how is driving behavior X and crash risk affected by vehicle descriptors C, D? Vehicle descriptors include vehicle type, controls, handling characteristics, etc. This area includes countermeasure evaluation of existing features (e.g., ACRS).

5) Human descriptors: how is driving behavior X and crash risk affected by driver descriptors E, F? Driver descriptors include both “permanent” descriptors (age, gender, driving experience, crash record) and transitory descriptors (fatigue, mental state, cell phones, other distractions, etc.).
In each of areas 3-5, explore the mechanisms by which the descriptors affect driving. As appropriate, study interactions of descriptors: for example, how does the effect of a distraction (cell phone) vary under different conditions (highway characteristics, vehicle ACRS, driver fatigue)?

6) **Broad issues:** as appropriate, use the information and results from the previous areas to shed light on today’s and tomorrow’s key traffic safety issues such as reducing crashes involving speeding or young drivers, high-speed congestion conditions, or increasing the safety belt use of part-time belt users.