Traffic and Safety Analysis Procedures

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TRAFFIC AND SAFETY ANALYSIS PROCEDURES

FINAL REPORT

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16. ABSTRACT

This report summarizes a review of the procedures used by the Washington State Department of Transportation for manipulating, storing, and analyzing traffic and accident data. The study summarized in this report compared existing WSDOT procedures with those of other states and in the transportation literature. Recommendations were then made for refining the WSDOT procedures that will be included in the Department's new data storage and analysis system known as TRIPS (Transportation Information and Planning Support).

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SUMMARY

This project was performed by the Washington State Transportation Center (TRAC) for the Washington State Department of Transportation (WSDOT). It examined the process the WSDOT Traffic Data Office (TDO) uses for collecting, manipulating, storing and analyzing traffic and accident data. TRAC's review of the Department's existing procedures examined whether WSDOT's methods were cost effective, and whether recent changes in technology and/or innovative analysis techniques might warrant changes in the manner in which these tasks are performed. The primary objective of the study was to determine whether the procedures currently used were appropriate for inclusion in the TRIPS database design, or whether the procedures should be altered before or during the development, programming and implementation of TRIPS. More detail concerning the conclusions and recommendations summarized in this report can be found in the working papers submitted as part of this project and in the final technical report on the review of the safety analyses.

The project found that for the most part, the procedures followed by WSDOT were on a par with or better than the systems used by most other states. However, the WSDOT procedures do have limitations in several areas.

In the area of traffic data, the Department is working well towards implementing the recommendations of the Data Rationalization Study. This will improve the quality of the data available for traffic analyses. The Transportation Data Office already supports the vast majority of computerized traffic analysis packages available today and consequently has the capability to perform any of the traffic analyses that might be requested of it. The quality of traffic data used in these analyses will depend on the individual analysis, the amount of data collection performed within the area of interest, and the data becoming available as a result of the implementation of the Data Rationalization Study.

Possible improvement in the collection, manipulation and storage of traffic information is mostly in the area of data manipulation. The project team concludes that automation should be used to reduce the number of data that require human review. That is, computers should be used to summarize the collected data and print out summary information for review by TDO staff.

If irregularities are found in the summary information, the detailed "raw" data can then be examined for errors and appropriate actions taken. Review of summary statistics in place of raw data should reduce the time needed for data review. It should also improve the quality of the review process by helping to highlight significant errors and by reducing the tedium of this task.

Recommended changes have also been made to the flow and calculation of traffic information specified within the Arthur Andersen TRIPS documentation. These changes center on

- calculating traffic information identified in the Data Rationalization report,
- eliminating on-line storage of some data identified within the Arthur Andersen report that is not commonly used by WSDOT personnel outside of specific TDO staff (e.g., truck weight data), and
- improving the structure of the traffic data file, so that a better understanding of what data are available and how those data can be used is provided to users of traffic information throughout the Department.

For accident data, the project team determined that the Safety Data Branch's (SDB) current emphasis on descriptive statistics is appropriate. The analyses routinely performed by the SDB staff are comparable to those performed by other states, and the SDB's use of microcomputer packages is a cost-effective means of performing these analyses.

A review of current accident analysis literature does indicate that the WSDOT procedures lack the statistical rigor that might be desired. However, upon further analysis, the project team determined that the changes required to improve the statistical validity of these analyses would adversely impact the priority array and priority programming processes, with little consequential benefit to the Department. The project team does recommend that the management of the Department review the basic goals and objectives of its safety analysis function. The project team feels that management should be aware of the choices that are available in the area of accident analyses and how each of those choices impacts other functions such as the priority array process.[1]

Another finding of the project team is that the TRIPS Analysis report produced by Arthur Andersen does not adequately detail the needs of the SDB. The principal finding is that no effort was made by Arthur Andersen to expand the capabilities of the SDB as part of the TRIPS implementation. Specifically, recommendations are made by the project team to

- add variables to TRIPS that are not identified in the Arthur Andersen report,
- provide additional links to other WSDOT data and computers, and
- make better use of existing analysis procedures and software within TRIPS.

Finally, the project team is convinced that additional effort is needed (and resources committed) to ensure that the data stored in TRIPS are kept current. Concerns are already surfacing that the roadway portion of TRIPS will not be able to maintain data accuracy without additional resources because of changes in

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[1]A more in-depth examination of the basic issues that should be presented to Department management, the possible analysis and reporting systems for dealing with those issues, and the implications of the use of each of those potential systems is presented on pages 43 and 46, 63, and 64 of the technical report for this project, entitled *Traffic and Safety Procedures: Project Report on the Safety and Accident Procedures*, April 1988.

roadway characteristics that are not reported to the TDO. Similarly, the accident analysis section relies on several data sources (most notably the locator log) to help improve the validity of accident characteristic and locations data. These sources are aging rapidly and are not currently budgeted for improvement. The project team therefore recommends that additional resources be provided for maintenance of the data that are being placed in TRIPS.

CONCLUSIONS AND RECOMMENDATIONS

As noted above, the project team found that, for the most part, the existing WSDOT procedures were consistent with the practices of most other state transportation departments. The majority of recommendations made by the project team concerns revisions to the preliminary description of data storage, flow and manipulation within TRIPS. Recommendations listed below are divided into separate sections on traffic and accident data.

TRAFFIC DATA

Conclusion. Many of the TDO's present data collection/manipulation problems are caused by variations in the format of the output produced by equipment that the TDO uses, but that is made by different manufacturers. These differences result in additional effort for interpreting output, the need to reformat data for later use in various analyses, and a slower than necessary error checking process.

Recommendation. Provide an input/output system within TRIPS that will produce consistent, easily read outputs regardless of which type of counter (GK, Golden River, etc) and counter function (volume, vehicle classification, speed) is being used.

Conclusion. The current data storage process requires too much manual review and manipulation of data.

Recommendation. As part of the TRIPS development effort, increase the automation of the traffic data edit function by providing summary information to allow quicker and easier review of input information.

Conclusion. TRIPS needs to be easy to use and clear about which items can be used for which analyses.

Recommendation. Add on-line files for seasonal factors, axle correction factors, vehicle classification factors and PTR AADT information. Carefully label this information in the report generation process and TRIPS user's documentation so that WSDOT staff understand its uses and limitations.

Conclusion. The TDO already maintains the necessary analytical software for performing any necessary traffic analyses.

Conclusion. The WSDOT as a whole lacks direction in performing traffic analyses, particularly in the areas of what data are available, when additional data should be collected, who should perform the analyses, and which reviews of the data should be performed.

Recommendation. Communication and cooperation between the TDO, the Districts and the Materials Laboratory need to be improved. This improved communication should extend beyond the development of the new Traffic Forecasting Guide.

Conclusion. The Arthur Andersen TRIPS Analysis Report has a number of significant errors.

Recommendation. WSDOT MIS should continue with the Traffic Design developed in conjunction with this project. TRIPS procedures not included in the original Arthur Andersen report include seasonal factoring procedures, calculation of seasonal factors and axle correction factors, smoothing traffic volumes, and a procedure for estimating the annual VMT on the state highway system.

ACCIDENT DATA

Conclusion. Accident data are collected cost-effectively, but the WSP form does not provide sufficient information about vehicle classification and the second harmful event.

Recommendation. The WSDOT should request that the report form be modified to include better vehicle classification information and a category for the second harmful event in an accident.

Conclusion. Location information included on the accident reports often does not provide sufficient information by itself to accurately locate accident sites.

Recommendation. The WSDOT should fund updating of the locator log to a level of roughly $25,000 and 0.5 FTE per year.

Conclusion. Additional safety analyses of significant value to the Department could be gained by providing SDB access to historical appurtenance and roadway information.

Recommendation. Historical roadway information may be accessed through TRIPS through several different programming techniques. This function needs to be built into the Safety portion of TRIPS. Access to appurtenance data requires close cooperation between the WSDOT maintenance division and the TDO. The project team recommends that the TDO, Maintenance and MIS sections explore the possible ways this could be done and how the benefits of attaching the appurtenance system to TRIPS relate to the cost of performing the necessary system development.

Conclusion. The analysis techniques used by the SDB are comparable to, or better than, those used by other states. However, they do have statistical limitations. The changes required to improve the statistical validity of these analyses will adversely affect a number of other WSDOT procedures, notably the priority array and priority programming functions.

Recommendation. No significant changes are recommended in the safety analysis procedures. The project team believes that the costs to the Department of altering the procedures do not warrant the minor improvements in statistical validity that would be gained.

Recommendation. The project team does recommend that the SDB slightly modify the existing accident evaluation process by including simple cost estimates

for common safety improvements and by increasing the number of years of accident data used in the "before" evaluation phase. The cost estimates should be developed with the assistance and review of the maintenance section.

Recommendation. It is also recommended that the WSDOT management review the goals and objectives of the Department's accident analysis process to ensure that the correct emphasis is placed on safety analyses, given their relationship to other WSDOT work.

Conclusion. The Arthur Andersen analysis of TRIPS Safety requirements has several flaws. TRIPS needs to easily and inexpensively produce datasets for use in the existing analytical software.

Recommendation. In addition to providing for access to historical appurtenance and roadway data and the potential changes in the WSP accident report form, TRIPS needs one basic, menu driven inquiry process that allows a novice user to request accident information for either printed output or use later in a computerized analysis. This inquiry process is described in detail in the technical report on safety analyses submitted as part of this project.

Recommendation. The TRIPS Safety design should also include connections to the mapping capabilities of the WSDOT Intergraph system and be able to interact with the automated collision diagram process being worked on by Ron Cihon, currently on fellowship from WSDOT at the University of Washington.

INTRODUCTION

The Washington State Department of Transportation is currently implementing the Transportation Information and Planning Support (TRIPS) data collection and analysis system. The objectives of TRIPS are

- to develop a central, integrated database of information about the state highways, and
- to provide a core around which an expanded road network database system can be built.

As part of the design and implementation of TRIPS, the Transportation Data Office asked the Washington State Transportation Center (TRAC) to examine the process the TDO uses for collecting, storing, and analyzing its traffic and accident information, as well as the information collected and the processes proposed in Arthur Andersen's TRIPS Analysis Report.

This summary describes the key findings of TRAC's effort. TRAC's review of the Department's existing procedures examined whether WSDOT's methods were cost effective, and whether recent changes in technology and/or innovative analysis techniques might warrant changes in the manner in which the Department performs its traffic and accident data collection, storage and reporting. The primary objective of the study was to determine whether the procedures currently being followed were appropriate for inclusion into the TRIPS database design or whether the procedures should be altered before or during the development, programming and implementation of TRIPS.

REVIEW OF PREVIOUS WORK

Several studies done for WSDOT and for the nation as a whole have had a significant impact on the data collection and processing requirements and capabilities of the Department. Of particular interest are the Data Rationalization Study performed by TRAC and the TRIPS System Reports performed by Arthur Andersen and Co. Following a brief description of these two projects, a summary of the findings of the literature search and telephone contacts with other states is provided.

The Data Rationalization Study reviewed the amount, location and style of traffic data collected by the TDO. It recommended basic changes in the manner in which data were collected, how those data were to be factored and used, and how the factored data should be made available to the Department as a whole.

The TRIPS reports produced by Arthur Andersen were the initial steps in the development of a complex database system designed to simplify and speed access to traffic, roadway and accident data by persons within the Department. These reports described the consultant's view of how data should flow within the database system, what data should be stored, and what analyses and reports need to be produced by the computer system.

TRAFFIC

Literature on the manipulation and storage of traffic information was difficult to find. This subject is not "glamorous" and most papers dealing with the traffic data concern either analytical software (NETSIM, SPF, etc.) or the development of large-scale database systems similar to TRIPS (e.g., RMS in Pennsylvania). The specifics of how the data manipulation is actually performed are rarely discussed outside of basic engineering texts. As a result, the project team called a number of state DOTs, to discuss the procedures used by those DOTs. The

answers received most frequently were "we do that all by hand," or "we don't know what this computer program does, we just run it."

The project team was able to obtain a copy of the CALTRANS Traffic Manual, which explained the process CALTRANS uses for extrapolating between count locations. CALTRANS uses a combination of linear interpolation and a historical traffic profile (to show discontinuities). Most other states use either a straight linear interpolation process, or hold volumes constant for sections of highway and provide counts (or manual estimates) for each section.

In most cases, the states contacted expressed a desire for additional automation of the data processing tasks but feared that the loss of human review could jeopardize the quality of the data. No state had software that actually automated the entire process of converting machine counts to usable estimates of AADT. Staff directly involved in the data collection effort tended to have a strong suspicion of the accuracy of counts reviewed by automated techniques, while staff from upper management levels tended to have a more optimistic outlook on this type of data manipulation.

ACCIDENT

A considerable amount of literature has been recently written in the area of accident analyses. Among the more important of these are the *Accident Research Manual*, by F.M. Council, Highway Safety Center, Chapel Hill, N.C., FHWA/RD-80/016, and an NCHRP synthesis report, *Highway Accident Analysis Systems*, by Charles Zegeer. The accident literature useful for this project centers on two subject areas. One is the review and development of accident analysis techniques, and the other is the development of integrated information systems that allow the expansion of accident analysis capabilities.

The literature is uniform in its criticism of many commonly performed accident analyses, particularly the before/after type used by WSDOT for its FHWA

Safety Countermeasures Effectiveness Evaluations. The criticism is based on the lack of statistical confidence associated with most before/after studies. The literature points out that the statistical tests used in these analyses are often subject to considerable error as a result of "side-effects" that are not controlled by the study design. Examples of these error-causing "side-effects" are regression to the mean and the impact of non-controlled variables on the outcome of the analyses (e.g., the impact of seat belt laws on a study of the severity of injuries associated with run-off-the-road crashes).

The literature points out a number of more "statistically correct" methods for performing these analyses. These methods always entail more direct control of the experiments through use of some type of control group in the selection of sites for inclusion in the study. This improves the validity of the study results but restricts the selection of safety improvement sites, since some sites must remain "hazards" in order to serve as control locations during the study. The literature does indicate that these control sites may result in some increase in the Department's tort liability.

Other literature provides an excellent overview of the make up of integrated highway information systems (e.g., *Introduction to Comprehensive Computerized Safety Record Keeping Systems*, Transportation Research Circular 293, Washington, D.C., 1985). The thrust of this section of literature is to emphasize the advantages of integrating various related databases.

For the most part, the integration of statewide databases in Washington was addressed in the study *An Assessment of the Current Traffic Safety Records Systems in Washington State* by the Washington State Traffic Safety Commission in February 1986. This project described the steps necessary for the creation of a Comprehensive Computerized Safety Record keeping System (CCSRS) in Washington. Such a system would combine files from WSDOT, the Department of Licensing, the Department of Motor Vehicles and a number of other sources. While this system has its advantages, various political, jurisdictional and legal

constraints have restrained the implementation of this report's findings. The project team did, however, take into account the intent of this effort when developing recommendations for TRIPS accident records and functions.

PROCEDURES

This project was approached in nine tasks as follows:

- literature review,
- interviews with other states' officials,
- review of WSDOT traffic analysis needs,
- analyze potential techniques (traffic),
- recommend analysis techniques (traffic),
- review of WSDOT accident analysis needs,
- analyze potential techniques (accidents),
- recommend analysis techniques (accidents), and
- produce summary report.

The initial task was a literature search, which primarily examined previously published material on the analyses and data collection and manipulation that need to be performed by WSDOT. The project team also searched for software to be used with or in place of existing procedures. The second task of the project consisted of telephone interviews with other state officials to determine if they were using procedures or software not discussed in the published literature..

Tasks 3 through 5 and 6 through 8 were similar, except that the first three tasks examined the traffic data collection and manipulation procedures and the last three tasks examined accident data collection and manipulation procedures. Tasks 3 and 6 reviewed WSDOT needs. Tasks 4 and 7 analyzed the techniques used by WSDOT and compared them to the techniques used by other state's and those discussed in the literature reviewed in Task 1. In Tasks 5 and 8, the project team developed the conclusions and recommendations presented in the technical reports and in this paper. Task 9 produced this summary report.

DISCUSSION

This section discusses the findings of the project team and provides background to the conclusions and recommendations presented earlier in this paper. This section is divided into two parts, one on traffic issues and one on accident issues.

TRAFFIC ISSUES

The majority of technical findings for this project on traffic data manipulation and analysis were submitted as a series of working papers to the TRIPS development team working on the TRIPS Traffic Design. After it received comments from the involved TDO and MIS staff, the MIS TRIPS design team used the information in these draft papers to refine the TRIPS design. Final versions of the working papers were not produced, since these papers were superceded by the TRIPS working documents. The most significant issues discussed in the working papers are presented below.

Reformatting Traffic Data

The WSDOT uses a variety of devices to collect "raw" traffic information (i.e., data that have not been factored for seasonality and/or axle correction). These devices have been purchased over a number of years, and consequently a number of manufacturers are represented in the WSDOT equipment inventory. The newer counters have more capabilities than the older counters, and each counter type has its own unique method for outputting data collected from the field.

As long as the data are used by hand, the differing output formats are not a problem. The user simply reads the printed output table and selects the numbers he/she needs for the analysis. In essence, the person using the data is capable of reformatting the printed data into a form of the user's choosing.

Computers are not that "intelligent" and usually require that data to be used by the computer be entered in one or more "standard" formats. These formats are developed during the design and implementation of the computer system. Consequently, the data WSDOT collects from the field must be reformatted into a consistent style for insertion into TRIPS. If this format is not achieved automatically, manual entry of the data is necessary, and manual entry of data is not cost effective.

After the data have been output from the data collection equipment, WSDOT personnel must review them to ensure that the counting equipment functioned correctly. This is currently a manual process. The data reviewer examines the output data for signs of equipment breakdown or other abnormalities and discards those data determined to be in error. The review of data for error is a highly subjective process. It would be possible to automate this review, but a sufficiently "smart" computer program probably could not be cost effectively developed to perform the task. This is because the human reviewer takes a very wide variety of factors into account when performing the review (e.g., what person placed the counter, whether those counters have been malfunctioning lately, what the expected traffic volume is on that road, whether that road has unusual traffic patterns such as high nighttime traffic levels, etc).

While the computer is not really capable of replacing the human review of data, it can be used to simplify and speed the review process. It is well within the computer's capability to provide the data to the human reviewer in a summarized format that makes the data review faster and easier to perform, less tedious, and more reliable. Currently, the WSDOT staff review the raw data, often to the level of 15 minute or hourly traffic counts. The project team believes that if the data were provided in a summarized form (for example, daily traffic volumes with peak directional splits and volumes) the process of data review would be significantly speeded up. By looking at the key summary data, the staff could determine whether

the counts were reasonable. If the counts were not reasonable, the raw data could then be reviewed to find the cause of the unusual numbers. If the data were reasonable, the count could be sent through the factoring process without the need to look at the detailed raw count information.

Using this method, WSDOT staff would only need to review the detailed raw numbers for those counts that indicated that the counting equipment might have failed. The vast majority of the data would not require this level of detailed review and would therefore be more quickly entered into the database.

Clarity of Traffic Estimates

When the project team reviewed the needs of the WSDOT, they discovered that few users of the traffic data understood what data were available and what limitations should be placed on the data that were available. For instance, many engineers require estimates of Average Annual Daily Traffic (AADT) for design purposes. In many cases, engineers simply took AADT values from the Annual Traffic Report, even when an actual traffic count had not been made near that location for over four years. While such data might be accurate, their use for design purposes is suspect. Other data in the Annual Traffic Report are sufficiently accurate for use in design calculations.

The project team concluded that TRIPS needs to be structured in such a manner that an engineer or technician using the system is aware of

- what data are available,
- what data are not available,
- what each piece of data could be used for, and
- how data not on TRIPS could be obtained (i.e., how to get raw data, how to request special traffic counts, how to get assistance from TDO staff, etc.).

Specific attention needs to be placed on the development of the TRIPS reports and inquiry screens so that accurate impressions of the available data are given to

WSDOT users. It is also important for TRIPS to make available for general use a number of the files maintained by the TDO. These include summary tables of PTR information, tables of seasonal factor estimates and axle correction information.

Improved communication is also necessary between the TDO and the various users of traffic information within the Department. Staff moving into positions within the Districts, the Materials Lab and other WSDOT offices need to be trained in the availability of traffic data, who to contact when data not in TRIPS are required, and what type of lead time is required to acquire data not currently in the database system. The TDO then needs to respond to those needs and provide the additional data required in the time frames allowed.

ACCIDENT ISSUES

A final technical report for the accident section of this project has been delivered by the project team. Because the current schedule for the development of TRIPS safety indicated that the TRIPS development effort was not ready for consideration of the TRIPS safety design issues, the project team determined that it was better to produce a document expressing the concerns of the project team that the TRIPS development staff could reference when appropriate than to provide only working documents, as was done for TRIPS traffic. The issues discussed in the technical report on accident and safety data are presented below.

Changes to the WSP Accident Report Form

Because the WSP collects traffic accident data as part of its routine duties, to recommend major changes in the manner in which accident data are initially collected would be unreasonable. However, minor changes in the report form are possible and can be achieved with relatively little cost to the Department.

Because of the growing number of heavy vehicles and the severity of accidents that involve heavy vehicles, the safety of these vehicles is becoming a significant issue within the Department. In order to evaluate the safety implications

of these vehicles, the Department will require better data than currently exist. The data include better estimates of the number of trucks using the highway, their configuration, and the number of accidents involving heavy vehicles of different configurations.

Ongoing changes in the manner of data collection and the level of traffic volume data collected should improve the estimates of heavy vehicle volumes. Heavy vehicle accident data must also be improved. The most cost effective way to collect these data is to include vehicle types on the accident report form. The data then need to be correlated back to the available volume data.

For these reasons, vehicle classification data should be included on the accident report form. The data should be collected in the same categories used by the Department, so that they can be readily compared with WSDOT data. Further, assistance should be given to the WSP officer filling out the report so that the accuracy of the classification information can be ensured. The project team recommends that this be done in the form of silhouettes of the types of vehicles that fit into each category.

The second change recommended for the accident report form is that it include additional information on the number and type of objects struck during a collision. While this type of data does not have the high profile given improved truck classification data, it would provide a significant improvement in the analysis capabilities of the Department. It would allow more detailed examination of the effects of different appurtenances on highway accident severity and would allow more complete accident analysis.

In both of these cases, the requested changes to the accident report form may require additional space on the form. The project team determined that space for these questions can be included without eliminating other report information. The Traffic Records Committee will need to determine how these requested changes can be accommodated with respect to data required by other agencies.

Historical Roadway and Appurtenance Information

WSDOT maintains both historical roadway information and appurtenance data in some fashion at this time. Neither type of data is readily available or currently usable within safety analyses.

Historical roadway data could be used in a variety of analyses. In particular, it would allow the correlation of accidents and roadway configuration information. This should result in more effective design information and would most likely save WSDOT funds by decreasing highway expenditures. Access to historical roadway information simply needs to be facilitated within TRIPS. While the historical information is stored within the TRIPS structure, the existing analysis documents do not indicate the types of links necessary to inexpensively access and utilize this information.

Obtaining appurtenance data will be a more difficult and expensive undertaking for safety analyses. Data are not stored in a manner accessible from TRIPS, and the data are not maintained in a sufficiently accurate state for use within the safety process.

TDO staff could gain access to this information for use in accident analysis by 1) including appurtenance data as part of TRIPS, 2) accessing it as needed at the same time the location information is coded for WSP, or 3) creating a separate file maintained by the TDO.

The inclusion of appurtenance data in TRIPS would make the integration of the data with accident information relatively easy. It would also require that someone take responsibility for maintaining the accuracy of the appurtenance information by seeing that maintenance actions were regularly included as updates to the file. To include this effort in TRIPS would require additional systems development work on the part of WSDOT MIS. It would also require some additional staff to maintain the data. Additional benefits would be available to the maintenance division if it were to include this type of information under TRIPS, but

it is not clear whether the requirement for the data within maintenance is sufficient to justify the cost of the system's development. Accurate cost estimates of development and maintenance of such an addition to TRIPS are beyond the scope of this project.

A video log system and other existing records could possibly be used to manually determine appurtenance type data during coding of the accident information for WSP. However, the picture on the current video logging system is not sufficiently clear to perform this task alone, and the extra time necessary to do this would be excessive. With access to the maintenance database and the video log, the TDO staff might be able to determine the required information. This option is staff intensive and most likely the most expensive in the long term. It would likely require at least one additional FTE (and possibly more) within the accident coding area of the TDO. This staff requirement might be reduced some if higher quality video logging equipment were used (e.g., laser disk media storage allowing random access to pictures, and multi-camera recording, allowing better pictures of structures on each side of the road), or if computer-aided graphics (e.g., straight line diagrams) could be produced from existing data.

The final option would be to create a file similar to the locator log. This file would contain a listing of appurtenance information maintained by the TDO. It would require roughly $100,000 to develop initially and would need periodic updates costing between $25,000 and $100,000 per biennium to maintain.

Location Data For Accidents

Location coding for accident data is performed by the WSDOT. The accuracy of the coding information is primarily dependent on the completeness and accuracy of the accident report form and the ability of the TDO staff to estimate the milepost of that location data. To perform this task, the TDO staff uses the "accident locator log," a file containing the milepost locations of roadside landmarks to correlate the accident description with state route mileposts.

The accident locator log is quickly aging, and no resources are currently set aside to maintain that file. The project team believes that until a better method of locating accidents is developed through research (a variety of new technologies show promise but will not be available in the near future), this file needs to be maintained. While a complete update of the locator log would require roughly 2 FTE and $100,000, a partial update (roughly $25,000 and 0.5 FTE per year) would be more cost effective and would be more consistent with the fiscal constraints of the Department.

Safety Analysis Procedures

The existing procedures followed by the Department fulfill the vast majority of the Department's and FHWA's needs. However, the project team recommends some adjustments to the existing process. These include improving the cost information used in the safety project evaluation effort and increasing the number of years of data that are used in the evaluation procedures.

Of equal importance is the need for WSDOT management to be aware of the goals and objectives of the safety analyses currently being performed, since these impact the selection of analysis techniques. Currently, the Department uses the safety analysis process to determine problem locations, to evaluate the relative success of safety improvements, and to provide descriptive statistics about the accident profile of the state highway system. The current procedures perform these tasks quite well.

Some of the literature reviewed presented the opinion that more emphasis should be placed on examining the cause and effect of specific safety improvements. To perform this type of detailed accident analysis would require that the Department change the orientation of its safety program. Department management needs to be given this choice. If new directions are desired, the TDO safety branch can restructure its analysis capabilities to provide that type of information.

TRIPS Safety Analysis

A variety of limitations were discovered in the existing analysis documentation for the TRIPS safety database. In particular, the project team believes that a single, basic inquiry/report process can meet the vast majority of users' needs without the need for many of functions described in the original documentation.

By including a menu system to answer the questions presented below and then producing the appropriate database inquiry, TRIPS could provide data for almost all required uses (outside of specialized analyses, for which other software already exists) while maintaining the ease of use necessary to ensure the system's use by the entire Department. Questions that should be asked by the menu system include the following:

- Are the results to be a printed report, or should they be a computer file to be used by an analysis package?
- Should summaries of the data be included in the output (i.e., the total number of accidents within the section and/or the total severity of those accidents)?
- What variables should be included in the output?
- What variables will control the selection of accidents in the query (SR/MP, accident type, fatalities, etc.)?
- What years of data should be included in the response?
- What is the priority of the request (immediate response requested, overnight response is acceptable, etc)?

Other responses might be added to this request by TDO or other Department staff. In addition, TRIPS could produce estimated job costs before the job was executed to assist the user in determining whether the requested job's benefits were exceeded by the cost of the computer time.

IMPLEMENTATION

The recommendations described previously in this paper can be split into three primary categories:

- short-term actions,
- important liaison activities, and
- long-term activities and reviews.

SHORT-TERM IMPLEMENTATION

First in the short term is the development of the TRIPS traffic system. Work on this area of TRIPS has already begun, and the recommendations of this project have already been taken into account in the TRIPS Traffic Design documentation.

Other than the development of TRIPS, the recommendations for the traffic section are primarily based on the need for improving communication between the TDO and the rest of the WSDOT. Part of this improvement in communication should come as part of the changes in the traffic forecasting process just beginning, but a specific effort needs to be made within the TDO to ensure clear lines of communication and cooperation between the TDO and other parts of the Department.

For short-term implementation in the accident section, the Safety Data Branch (SDB) should obtain simplified costs for common "safety improvements" from maintenance. This effort should entail

- determining the standard types of "safety projects,"
- collecting capital, operating and maintenance costs for these types of improvements from other WSDOT divisions,
- analyzing those cost data, and
- developing single cost/unit or average cost estimates that can be used in the existing evaluation process.

A simple manual (or spreadsheet) should then be developed to assist SDB staff in including these cost estimates in future safety evaluations when real data are not available.

The SDB should also revise its existing safety evaluation spreadsheets or consider acquiring an evaluations package so that it can include additional years of accident rate information in the predictive section of the evaluation spreadsheet.

Both of these improvements should improve the benefit/cost analyses that are included in the FHWA Safety Project Evaluation Reports. While these changes may not directly impact which improvements are applied to hazardous locations, they should both result in more representative evaluations of the impacts of WSDOT's safety improvements. Given the statistical limitations of the before and after study, these modest improvements should allow WSDOT to provide the best analyses possible to FHWA, short of restructuring the entire safety improvement process.

LIAISON WORK

The recommended actions of the report will require a significant amount of liaison work between the Safety Data Branch and a variety of other groups, both within and outside of the WSDOT. This work will be required to refine the design of the systems currently planned so that the accident analysis function will improve in the manner expected. These liaison activities will include the following:

- working with WSDOT MIS on the TRIPS design,
- working with WSP on revisions to the accident report form and other WSP activities,
- working with the WSDOT cartography section on the map display of accident location data,

- working with WSDOT maintenance sections and Districts to gain access to appurtenance data, and
- continuing to pursue the automation of collision diagram plotting.

Without continuous liaison activity, the likelihood that the recommendations in these areas will be realized is remote.

Work with WSDOT MIS will be particularly important because some significant changes and additions to the work done by Arthur Anderson are recommended in this report. Liaison with MIS will be necessary to determine which of the requested changes are feasible, how those changes will interact with each other, and how the necessary programming efforts can be prioritized.

Unlike the TRIPS effort, in which MIS will not proceed without SDB liaison, WSP will most likely revise the accident report form with or without further input from WSDOT. While the recommended changes to the accident form have already been submitted to WSP, without continued action by WSDOT, WSP may underestimate the value of these requested changes and additions. Wholehearted WSDOT liaison efforts will ensure the proper consideration of Departmental recommendations and may also allow WSDOT to comment on WSP's review of other changes suggested by various researchers and agencies.

Work with the cartography section should be pursued to improve the presentation of accident data. While such improvements may not result in improvements to the quality of the accident analysis, they will help improve the perceived quality of those analyses and strengthen the impact of presentations of those results.

Finally, a specific effort should be made to understand the needs and workings of the automated collision diagram process Ron Cihon is currently developing while he is on fellowship at the University of Washington. The automated collision diagram process should provide substantial improvements and

savings to the Department, but it will need to interface with TRIPS and potentially other WSDOT databases.

Access to appurtenance data can be considered part of the TRIPS development process, but it will also entail a significant degree of liaison work between the SDB and those persons who acquire and maintain the appurtenance data. Maintenance and other Department personnel have something to gain from these potential analyses, and an effort must be made to inform them of the possibilities in this area and compare those benefits to the cost of maintaining these data in an appropriate form.

LONG-TERM PROJECTS

The above liaison work is necessary in the immediate future because of its impact on the functioning of the TRIPS accident process and the importance of the analyses that it impacts. The work to be done in this section is of lesser importance to the WSDOT or will require a longer time frame to complete.

The most important of the long-term implementation efforts is the need for upper WSDOT management to review the Department's accident analysis goals. The project team believes that descriptive analyses are sufficient to meet WSDOT's needs. If the management's opinion is otherwise, steps need to be taken to restructure the Department's entire accident analysis and safety improvement processes.

A second long-term implementation project is the gradual improvement of the location information used in identifying accident sites. Because simple remedies are not currently available for solving location problems, the SDB should remain observant of the developments in the area of automatic vehicle identification (AVI) and automatic vehicle location (AVL) but not immediately press for application of these new technologies. (For example, the Seattle Police Department is currently investigating the implementation of computers in its patrol cars. Several police

jurisdictions already have satellite based vehicle locators on their vehicles.) Should WSP decide to utilize such technologies for better fleet management and/or faster trooper assistance, the SDB could then support the use of those systems to improve the accuracy of location information.