Preliminary Investigation (PI-0148)
Caltrans Division of Research, Innovation and System Information

# Use of Collision Diagramming Systems: Survey of State Practice

*Requested by*
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## Table of Contents

# Executive Summary

## Background

The collision diagrams created by Caltrans' traffic safety investigators support and augment the narrative and quantitative descriptions of a collision. Currently, Caltrans practitioners use Accident Collision Diagram (ACD), MicroStation (Bentley Systems) and other software to create collision diagrams. However, Caltrans is without a service contract to support ACD and this program is obsolete.

Caltrans is seeking information about the commercial collision diagramming systems used by other state departments of transportation (DOTs). This information is expected to inform development of a request for proposal to solicit bids for a commercial collision diagramming system that will replace Caltrans' current systems.

To assist with this information-gathering effort, CTC & Associates conducted an online survey of state DOTs to learn about their experience with commercial collision diagramming systems. The survey questions are provided in Appendix A. The full text of survey responses is presented in a supplement to this report. Contact with selected researchers and the results of a limited literature search supplement the survey results.

## Summary of Findings

This Preliminary Investigation gathered information in three areas:

- Survey of practice.
- Consultation with researchers.
- Related research and resources.

### Survey of Practice

Thirteen state transportation agencies and one university transportation safety research center participated in an online survey distributed to members of the American Association of State Highway and Transportation Officials (AASHTO) Committee on Safety Management. Of these states, only four reported using a commercial off-the-shelf (COTS) system for collision diagramming. Three states use collision diagramming systems that were developed in-house, and seven states do not use a collision diagramming system or tool.

Key findings from survey results are presented below in the following topic areas:

- COTS systems.
- In-house systems.

Supplementing these results is information about collision diagramming products used or suggested by survey participants.

#### Commercial Off-the-Shelf Systems

Of the four transportation agencies that use a COTS system, DOTs in only two states—Iowa and North Dakota—provided details about their agencies' systems. Alabama DOT uses a COTS system but the respondent did not provide details about the product. Representatives from two

Caltrans districts reported using an automated method with ArcMap; a manual method with MicroStation; and Vista Fx (software that is no longer supported by the vendor).

Information about Iowa and North Dakota DOTs' COTS systems is presented below in the following topic areas:

- System description.
- System functionality.
- System implementation and maintenance.
- System assessment and future plans.

*System Description*

Iowa and North Dakota DOTs both use Crash Magic by Pd' Programming, Inc. for collision diagramming, however, North Dakota DOT is planning to discontinue using the software in the near future. Both agencies support a web-based system for agencywide use; Iowa DOT also supports a desktop-based system for individual users. North Dakota DOT customized its COTS product to link it with the agency's crash database and crash codes. User privileges are granted to some Iowa DOT staff; in North Dakota, user privileges are limited to central office staff.

*System Functionality*

North Dakota DOT's system is the more robust of the two systems, supporting 10 of 19 features listed in the survey, while Iowa DOT's system supports six features. Both DOTs' systems:

- Generate custom and standard reports.
- Incorporate geographic information system (GIS) basemaps.
- Map crashes by X,Y coordinates.
- Use a standard set of mapping symbology.
- Assign responsibility for system upgrades or updates to the vendor.

*System Implementation and Maintenance*

Details related to system implementation and maintenance varied between the two agencies. System implementation in Iowa began in 1997 and continued for two to three years. System implementation in North Dakota began in 2009 and continued for six months to one year.

Cost to implement Iowa DOT's system was approximately $60,000. The agency's annual maintenance agreement costs $20,000 and includes access, upgrades, technical support, system administration and system configuration. North Dakota DOT was unable to provide cost information related to system implementation. Annual maintenance costs are $1,000.

Both agency respondents described challenges when implementing updates to their collision diagramming systems. Iowa DOT occasionally experiences technical issues with software updates or database processing changes. In North Dakota, an update that occurred approximately two years ago has prevented the agency from creating visual diagrams showing the number of rear-end, angle and other crashes. However, users are still able to export the desired crashes and automatically create data tables.

*System Assessment and Future Plans*

Both respondents discussed strengths and challenges with their systems. Iowa DOT's tool is a visual aid that helps to determine the amount, type and contributing factors to intersection crashes, such as manner of the crash collision, severity of crashes, vehicle directions and date. However, the system is an intersection-only diagramming tool, and the agency would benefit from a tool that also applied to road segments. In North Dakota, Crash Magic allows agency staff to select desired crashes in ArcMap and then export the information for those crashes into a Microsoft Excel format. However, functionality is impaired by the system update that prevents the agency from creating visual diagrams.

While Iowa DOT does not currently have plans to transition to another collision diagramming system, North Dakota DOT is planning to discontinue using Crash Magic in the near future. Crashes are currently stored in a database and plotted in ArcMap, which recently revised its crash layer to include all the data fields that the agency needs. The data can now be exported directly from ArcMap to Excel, eliminating the need for Crash Magic.

The Iowa DOT respondent suggested that agencies implementing a new system consider ease of use, accuracy, interoperability, vendor responsiveness, initial cost and service fees. The North Dakota DOT respondent recommended continuing to use the agency's current system until the new system has been thoroughly tested and is operating correctly.

In-House Systems

Three states participating in the survey reported on collision diagramming systems that were developed in-house:

*Connecticut*. In early 2019, Connecticut DOT will begin using a web-based, customized collision diagram tool developed by the University of Connecticut Transportation Safety Research Center, which will be responsible for customizing, updating and maintaining the system. The tool is compatible with Esri, can consume other GIS map layers, can be exported to high-quality images and is imbedded in Word. It incorporates GIS basemaps and imports crash data via a crash database connection or crash data service. The tool automatically maps crashes by latitude and longitude. Instead of using prebuilt templates for segments or intersections, the tool uses orthogonal aerial imagery as the base template for a site. The tool can be used in coordination with other diagnosis tools.

Currently authorized users from state and local agencies in Connecticut can access the tool. Consideration is being given to licensing to other states or developing pooled fund projects.

*Ohio*. Microsoft Excel is currently used for most collision diagramming, however, the agency is considering a transition to AASHTOWare Safety Analyst, which is developing an enhancement that is expected to be released in fiscal year 2020.

*South Dakota*. The South Dakota Intersection Crash Diagram Export tool allows users to filter crash data by date, manner of collision, road and light conditions, crash severity and other parameters.

## Consultation With Researchers

We contacted the Safe Transportation Research and Education Center (SafeTREC) at the University of California, Berkeley to learn about the center's use of crash data from the Statewide Integrated Traffic Records System (SWITRS). SafeTREC has developed the

Transportation Injury Mapping System (TIMS), which maps crashes using geocoded California crash data from SWITRS. According to representatives of the TIMS team, SafeTREC does not plan to replace SWITRS with another crash data source in TIMS since SWITRS is the only official statewide collision database, and TIMS aims to serve all of California.

### Related Research and Resources

Two Federal Highway Administration resources provide information about safety analysis tools, including an overview of Safety Analyst. State resources present a range of materials about crash data management systems and safety analysis software. Included in the state resources is guidance from several state DOTs about crash analysis tools and collision diagramming systems, including a 2016 effort to incorporate a collision diagramming application in RoadHAT2, Indiana DOT's safety management tool; a 2013 presentation about South Carolina DOT's collision diagram tool; and access to Iowa DOT's Crash Analysis Tool and New York State DOT's Crash Diagram Tool. Also presented is a sampling of commercial collision diagramming products commonly used in traffic engineering and law enforcement, including Accident Information Management System (JMW Engineering), Collision Data Module (TES Information Technology Ltd.) and Automated Collision Diagrams (Intergraph Corporation).

## Gaps in Findings

The number of survey participants from transportation agencies using COTS systems was limited. Additionally, details provided by survey respondents about these systems were limited. Further attempts to engage with other agencies not responding to the survey could produce useful guidance about other collision diagramming systems and tools.

## Next Steps

Moving forward, Caltrans could consider:

- Following up with Iowa and North Dakota DOTs to learn more about their experiences with Crash Magic.
- Contacting Alabama DOT for information about the agency's COTS system, and contacting Virginia and Washington State DOTs about their interest in obtaining a crash diagram tool in the future.
- Making further attempts to contact nonresponding agencies in a follow-up information-gathering effort.
- Reviewing the collision diagramming software systems and tools presented in this Preliminary Investigation for features and functions of interest to Caltrans.
- Investigating other commercial products not identified by survey respondents that might be of interest to Caltrans.

# Detailed Findings

# Survey of Practice

## Survey Approach

Caltrans is preparing to replace the online tools used by its traffic safety investigators to create collision diagrams that support and augment the narrative and quantitative descriptions of a collision. To inform the selection of a new collision diagramming system, Caltrans is seeking information from other state departments of transportation (DOTs) that have experience implementing and using these systems.

To gather this information, CTC & Associates distributed an online survey to members of the American Association of State Highway and Transportation Officials (AASHTO) Committee on Safety Management. Survey questions are provided in Appendix A. The full text of survey responses is presented in a supplement to this report.

## Summary of Survey Results

Fifteen representatives from 13 state transportation agencies and one university transportation safety research center responded to the survey:

- Alabama.
- Arizona.
- California (two responses).
- Connecticut.
- Delaware.
- Iowa.
- Maine.
- North Dakota.
- Ohio.
- South Carolina.
- South Dakota.
- Virginia.
- Washington.
- Wisconsin.

*Note*: The University of Connecticut Transportation Safety Research Center (CTSRC) has developed a web-based, customized collision diagram tool that will be used by Connecticut DOT beginning in early 2019.

Of these states, only four—Alabama, California, Iowa and North Dakota—reported using a commercial off-the-shelf (COTS) system for collision diagramming.

Three states—Connecticut, Ohio and South Dakota—use collision diagramming systems that were developed in-house.

Seven states—Arizona, Delaware, Maine, South Carolina, Virginia, Washington and Wisconsin—do not use a collision diagramming system or tool. Respondents from Virginia and Washington State DOTs are interested in obtaining a crash diagram tool in the future. Current practices of four of the seven states not using a collision diagramming system or tool are summarized below:

*Arizona*. Agency staff occasionally develops crash diagrams using a combination of computer-aided design (CAD) or graphics programs. None of these programs are specific to crashes.

*Maine*. The agency uses MicroStation to draw collision diagrams and has developed the appropriate cell libraries to quickly and efficiently create or update drawings from reports in its crash records system.

*Washington.* Because of limited resources, the agency currently develops collision diagrams without the use of a tool.

*Wisconsin*. Some of the agency's engineering consultants have used crash diagramming tools such as Intersection Magic, but prefer manual methods.

Survey results are presented below in three topic areas:

- COTS systems.
- In-house systems.
- Related resources

## Commercial Off-the-Shelf Systems

Of the four states that use a COTS system, only two—Iowa and North Dakota—provided details about their agencies' systems. The Alabama DOT respondent did not provide additional information about the agency's system. Two Caltrans districts reported on their systems:

*District 1*. Staff uses an automated ArcMap method and a manual MicroStation method.

*District 3*. The district uses Vista Fx software with an added module that performs automated collision diagramming. (Note: This software, initially provided by Trimble and later by Visual Statement, Inc., is no longer supported.)

Information about the COTS systems described by respondents from Iowa and North Dakota DOTs is presented below in the following topic areas:

- System description.
- System functionality.
- System implementation and maintenance.
- System assessment and future plans.

System Description

Iowa and North Dakota DOTs both use Crash Magic by Pd' Programming, Inc. for collision diagramming. While the information provided by the North Dakota DOT respondent in this report describes the agency's current system, the respondent noted that the agency is planning to discontinue using Crash Magic in the near future (see **System Assessment and Future Plans** on page 10).

Both agencies support a web-based system for agencywide use; however, the Iowa DOT respondent noted that the agency's system, Iowa Crash Analysis Tool, doesn't use Crash Magic consistently as patches are updated. In addition to the web-based system, Iowa DOT supports a desktop-based system for individual users. North Dakota DOT also customized its COTS product; according to the agency respondent, the vendor collaborated with agency information technology (IT) staff to link the product with North Dakota DOT's crash database and match up

various crash codes, such as manner of collision, so that Crash Magic would export the correct values.

Both agencies also maintain a unique type of licensing. In Iowa, some DOT staff members have individual user privileges. The web-based crash data tool allows use of collision diagramming for all users. Because North Dakota DOT is a centralized agency with limited staff, its license is for one district and is only used by staff in the agency's central office.

Neither agency provided documentation related to their systems.

The table below summarizes the systems used by Iowa and North Dakota DOTs.

**Collision Diagramming System Description**

| | Iowa | North Dakota |
|---|---|---|
| **System Name** | Iowa Crash Analysis Tool | N/A |
| **COTS Product and Vendor** | *Crash Magic*<br>Pd' Programming, Inc. | *Crash Magic*<br>Pd' Programming, Inc. |
| **System Type** | • Web-based.<br>• Desktop-based. | • Web-based.<br>• Customized COTS product: Link with agency's crash database. |
| **Licensing** | • Individual user privileges.<br>• Access to all users. | One district: Used by agency's central office staff only. |

System Functionality

Respondents were asked to indicate which of 19 features were supported by their collision diagramming systems. North Dakota DOT's system was the more robust of the two systems, supporting 10 of the 19 features. Iowa DOT's system supported six features. The Iowa DOT respondent noted that the agency also updates crash data weekly by manually uploading an XML file to the system.

Survey responses are summarized in the following table.

| Collision Diagramming System Features and Functions | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| State | System | Exports Data to Excel | Generates Custom Reports | Generates Standard Reports | Incorporates GIS Basemaps | Maps Crashes by X,Y Coordinates | Provides Prebuilt Templates for T-Type Intersections | Provides Prebuilt Templates for X-Type Intersections | Reads to and From External Databases | Standard Set of Mapping Symbology | Upgrades/System Updates Provided by Vendor |
| **Iowa** | Crash Magic | | X | X | X | X | | | | X | X |
| **North Dakota** | Crash Magic | X | X | X | X | X | X | X | X | X | X |

Neither system supported the following features:

- Compatible with Google Earth (either current day or past dates).
- Exports data to Word.
- Exports geographic information system (GIS) basemaps.
- Imports data via a text file or via an Excel file.
- Maps crashes by node.
- Provides prebuilt templates for ramps.
- Provides records management functions.

System Implementation and Maintenance

In addition to describing aspects of their systems, respondents provided details related to system implementation and maintenance. The table below summarizes survey responses.

| Collision Diagramming System Implementation and Maintenance | | |
|---|---|---|
| | **Iowa** | **North Dakota** |
| **System Name** | Iowa Crash Analysis Tool | N/A |
| **COTS Product and Vendor** | *Crash Magic*<br>Pd' Programming, Inc. | *Crash Magic*<br>Pd' Programming, Inc. |
| **Implementation Date** | 1997 | 2009 |
| **Time to Implement** | 2 years to less than 3 years | 6 months to less than 1 year |

| Collision Diagramming System Implementation and Maintenance | | |
|---|---|---|
| | **Iowa** | **North Dakota** |
| **Implementation Cost** | Approx. $60,000 | N/A |
| **Annual Maintenance Costs** | Annual maintenance/service agreement: $20,000* | $1,000 |
| **Ongoing Service Contract** | Yes* | No |
| **Frequency of System Updates** | As required by vendor | As required by vendor |
| **Responsibility for System Updates** | Vendor | Vendor and DOT IT staff |

* Includes access, upgrades, technical support, system administration and system configuration.

*Challenges Related to System Updates*

Respondents were asked to describe any challenges their agencies experienced when implementing updates to their collision diagramming systems. Iowa DOT occasionally experiences technical malfunctions with software updates or database processing changes. The North Dakota respondent reported that since an update approximately one or two years ago, the agency has not been able to create crash diagrams (visual diagrams showing the number of rear-end, angle and other crashes). However, users are still able to export the desired crashes and automatically create data tables.

System Assessment and Future Plans

When asked to assess their agencies' overall collision diagramming systems, both respondents briefly described their systems' key strengths and challenges, which primarily related to functionality. They also both reported that their systems had not been challenged in court. The following summarizes survey responses in the following topic areas:

- Benefits and challenges.
- Future plans.
- Recommendations for implementing a new system.

*Benefits and Challenges*

The respondent from Iowa DOT noted that the agency's tool is a visual aid that helps to determine the amount, type and contributing factors to intersection crashes, such as manner of the crash collision, severity of crashes, vehicle directions and date. In North Dakota, Crash Magic allows the agency to export information from its previous crash database. DOT staff can use Crash Magic to select desired crashes in ArcMap and then export the information for those crashes into an Excel format.

These systems are not without challenges. Iowa DOT's system is an intersection-only diagramming tool, and the agency would benefit from a tool that also applied to road segments. The system's generic intersection template shows a 90-degree, four-legged, undivided crossing and does not show intersection control. It also does not allow inclusion of a basemap or

imagery. The North Dakota respondent reiterated the result of an update within the past two years that prevents the agency from creating crash diagrams (Users are still allowed to export the desired crashes and automatically create data tables.)

*Future Plans*

The North Dakota DOT respondent noted that the agency is planning to discontinue using Crash Magic in the near future. Crashes are currently stored in a database and plotted in ArcMap. Recently the crash layer in ArcMap was revised to include all the data fields the agency needs, and the data can now be exported directly from ArcMap to Excel. Since the agency has Excel templates that automatically tally various statistics, such as crash types, it no longer needs to see the most common crash type patterns visually on a crash diagram. The DOT also no longer needs a middle program to export crash information into Excel.

Iowa DOT does not currently have plans to transition to another collision diagramming system.

*Recommendations for Implementing a New System*

When asked to share recommendations with other agencies that are preparing to implement a new collision diagramming system, the Iowa DOT respondent suggested the agencies consider the following factors:

- Ease of use.
- Accuracy.
- Interoperability.
- Vendor responsiveness.
- Initial cost.
- Service fees.

The North Dakota DOT respondent recommended continuing to use the agency's current system until the new system has been thoroughly tested and is working correctly.

## In-House Systems

Three states—Connecticut, Ohio and South Dakota—use systems that were developed in-house. Information provided by survey respondents about these systems is summarized below.

*Connecticut*. Connecticut DOT currently uses MicroStation to manually draw collision diagrams following certain common formats. The University of Connecticut Transportation Safety Research Center (CTSRC) has recently developed a web-based, customized collision diagram tool that Connecticut DOT will begin using in early 2019. The tool is part of the Connecticut Roadway Management System, an enterprise-level safety management system developed during a multiyear project to implement the six-step highway safety management process: network screening, diagnosis, countermeasure selection, economic appraisal, project prioritization and safety effectiveness evaluation.

The collision diagram tool is one of the tools in the diagnosis module. It is customized based on Connecticut DOT's practice and allows modifications as needed (CTSRC is responsible for customizing, updating and maintaining the system). Authorized users from state and local agencies can access the tool. Consideration is being given to opening the application

to other states; conversations have begun about licensing or pooled fund projects for these opportunities and long-term maintenance.

The collision diagram tool is compatible with Esri (but users do not need to install Esri products), can consume other GIS map layers (for example, Connecticut DOT uses a statewide orthogonal aerial imagery), can be exported to high-quality images and is imbedded in Word. It incorporates GIS basemaps and imports crash data via a crash database connection or crash data service. The tool automatically maps crashes by latitude and longitude. On the initial load, crashes are symbolized by types and are clustered if their locations are close. Users can then modify the symbols and clusters, and move crashes as necessary by viewing individual crash details (such as a police officer's crash diagram at the scene and crash narratives) within the tool. Prebuilt templates for segments or intersections are not provided; instead, the tool uses orthogonal aerial imagery as the base template for a site. The tool can be used in coordination with other diagnosis tools, such as viewing site conditions through street views, to get a more complete picture of the site and crash experience history.

*Ohio.* The agency currently uses Microsoft Excel to complete most collision diagramming. The agency is considering a transition to AASHTOWare Safety Analyst, which is developing an enhancement that is expected to be released in fiscal year 2020.

*South Dakota*. The agency has developed the South Dakota Intersection Crash Diagram Export tool for collision diagramming. The tool allows users to filter crash data by date, manner of collision, road and light conditions, crash severity and other parameters. See **Related Resources** below for information about this tool.

## Related Resources

Information about collision diagramming products used or suggested by survey participants is provided below.

Multiple States

**Crash Magic Online**, Pd' Programming, Inc., 2018.
http://www.pdmagic.com/crashmagiconline/
Crash Magic Online is the browser-based version of Crash Magic. The vendor describes the legacy version of Crash Magic as "[t]he most widely used crash records analysis tool on the market today." *From the web site*: Crash Magic (CM) is a graphic display and data summary package designed for use in safety management systems for analysis of crash data. CM is interactive, offering detailed collision diagrams, data retrieval, crash summaries, statistical output, and user specified graphic displays. CM provides traffic safety specialists and law enforcement officials an exceptional tool for identifying crash patterns, high crash locations, and maintenance and operational concerns.

**ArcMap**, Environmental Systems Research Institute, Inc., undated.
http://desktop.arcgis.com/en/arcmap/
*From the web site*: ArcMap has been the primary application used in ArcGIS Desktop for mapping, editing, analysis, and data management. … ArcMap represents geographic information as a collection of layers and other elements in a map view. There are two primary map views in ArcMap: the data view and the layout view.

The data frame provides a geographic window, or map frame, in which you can display and work with geographic information as a series of map layers. The layout view provides a page view where map elements (such as the data frame, a scale bar, and a map title) are arranged on a page for map printing.

**MicroStation**, Bentley Systems, Inc., undated.
https://www.bentley.com/en/products/brands/microstation
*From the web site*: With MicroStation, you can easily view, model, document, and visualize projects of any size or complexity. Use MicroStation to deliver projects smarter. With proven MicroStation technology, you can confidently take on any design, construction, or operations project.

Iowa

**Iowa Crash Analysis Tool (ICAT),** Iowa Department of Transportation, 2019.
https://icat.iowadot.gov/
This web site provides access to Iowa DOT's crash analysis tool.

Ohio

**AASHTOWare Safety Analyst**, American Association of State Highway and Transportation Officials, undated.
http://www.safetyanalyst.org/
*From the web site*: Safety Analyst is a set of software tools used by state and local highway agencies for highway safety management. Safety Analyst implements state-of-the-art analytical procedures for use in the decision-making process to identify and manage a systemwide program of site-specific improvements to enhance highway safety by cost-effective means. … The diagnosis tool includes a capability to generate crash summary statistics and collision diagrams, to conduct statistical tests for particular sites, to identify predominant collision patterns, and to determine whether those collision patterns represent higher-than-expected frequencies of particular collision types. The diagnosis tool includes a basic collision diagramming capability. The Safety Analyst software can also interface with commercially available collision diagramming software packages, which provide more interactive capabilities and options.

South Dakota

**South Dakota Intersection Crash Diagram Export**, South Dakota Department of Transportation, undated.
http://intersectioncrashdiagram.sd.gov/
This web site provides access to South Dakota DOT's collision diagramming tool.

Wisconsin

**Intersection Magic**, Pd' Programming, Inc., undated.
http://www.pdmagic.com/im/
*From the web site*: Intersection Magic is an MS Windows based PC application for crash records analysis. It generates automated collision diagrams, pin maps of high accident locations, high accident location lists, frequency reports, presentation graphics (such as crashes by time of day or month of year) and much more.

# Consultation With Researchers

Safe Transportation Research and Education Center (SafeTREC), part of the University of California, Berkeley is tasked with reducing transportation-related injuries and fatalities through research, education, outreach and community service. SafeTREC has developed the Transportation Injury Mapping System (TIMS), which maps crashes using geocoded California crash data from the Statewide Integrated Traffic Records System (SWITRS).

In an email conversation with SafeTREC, we inquired about the use of SWITRS data and the possibility of replacing SWITRS with another crash data source in a new application of TIMS. According to representatives of the TIMS team, SafeTREC does not plan to replace SWITRS with another crash data source in TIMS since SWITRS is the only official statewide collision database, and TIMS aims to serve all of California.

# Related Research and Resources

The documents and resources below present national and state tools and practices related to automated collision diagramming software. Citations are presented in the following topic areas:

- National resources.
- State practices.
- Commercial products.

## National Resources

**SafetyAnalyst**, Federal Highway Administration, September 2006.
https://www.fhwa.dot.gov/publications/research/safety/06124/06124.pdf
This brochure presents an overview of Safety Analyst, including each of the six software modules in this toolkit that "help transportation agencies analyze the safety performance of specific sites, suggest appropriate countermeasures, quantify their expected benefits, and evaluate their effectiveness."

**Road Safety Data Program Toolbox**, Federal Highway Administration, undated.
https://safety.fhwa.dot.gov/rsdp/
This clearinghouse of information provides resources in four categories: manage, analyze, collect and research. The "Analyze" section provides information about "state-of-the-art safety analysis tools" that can be used "to inform decisions in the safety management, planning, programming and project development processes. This section offers information about the use, strengths, limitations and data requirements of traditional and state-of-the-art methods. These analysis tools can help agencies get the biggest bang for their dollar."

## State Practices

### Florida

**Florida Traffic Safety Portal: Common Crash Data Systems**, Florida Department of Transportation, August 2018.
https://fdotewp1.dot.state.fl.us/TrafficSafetyWebPortal/HomePostDetail.aspx?id=934
*From the introduction*: Several crash data systems with query functions exist for interested users. The most common data systems in Florida include but are not limited to (1) the FIRES (Florida's Integrated Report Exchange System) by the FLHSMV (Florida Department of Highway Safety and Motor Vehicles), (2) the CAR (Crash Analysis Reporting) system by the FDOT (Florida Department of Transportation), (3) the SSOGis (State Safety Office Geographic Information System) web-based map by FDOT, and (4) Signal Four Analytics by the GeoPlan Center at UF (University of Florida) with the Florida TRCC (Traffic Records Coordinating Committee).

**"District 7 Web Crash Data Management System and Study Tracking,"** Anthony Chaumont, Tindale Oliver, *Florida Transportation Data Symposium*, October 2014.
http://www.fdot.gov/statistics/symposium/2014/CrashDataMgmtSystem.pdf
This vendor presentation provides an overview of Florida DOT's crash data system, Web Crash Data Management System (WebCDMS).

**Standardization of Crash Analysis in Florida**, Albert Gan, Kirolos Haleem, Priyanka Alluri and Dibakar Saha, Florida Department of Transportation, March 2012.
https://ftp.fdot.gov/file/d/FTP/FDOT%20LTS/CO/research/Completed_Proj/Summary_SF/FDOT_BDK80_977-10_rpt.pdf
*From the abstract*: This project attempts to identify the existing crash analysis practices, problems and needs in Florida in order to help move Florida in the direction of standardizing its crash analysis methods and tools. Standardization of crash analysis procedures in Florida would ensure that the crash analysis practices are up to the national standards and are applied consistently throughout the state. It would further permit other cost-saving opportunities, such as statewide training.
….
In addition to the surveys, three geographic information systems (GIS) currently in use in Florida for crash data retrieval and analysis, including the Web Crash Data Management System (WebCDMS), the Traffic Safety Analysis Tool (TSAT) and the Signal Four Analytics (S4), were reviewed to learn about their features and capabilities. Further, state-of-the-art crash analysis methods and tools, including the Highway Safety Manual (HSM), SafetyAnalyst and Interactive Highway Safety Design Model (IHSDM), were also reviewed, and recommendations were provided.

### Indiana

**Updating RoadHAT: Collision Diagram Builder and HSM Elements**, Andrew P. Tarko, Mario Romero, Jose Thomaz, Jorge Ramos, Afia Sultana, Raul Pineda and Erdong Chen, Indiana Department of Transportation, January 2016.
https://pdfs.semanticscholar.org/4b69/c9c101158ffe91f300b1c85ba017b1380a19.pdf
*From the abstract*: In order to minimize the losses resulting from traffic crashes, Indiana developed its road safety management methods before the Highway Safety Manual and the SafetyAnalyst became available. The considerable cost of replacing the Indiana current practice with the safety management based on the Highway Capacity Manual prompted the Indiana DOT to continue using its own safety management tools. This study includes two related but distinct

components: (1) comparison of the HSM-based and Indiana methods of safety management, and (2) development of a Collision Diagram Builder (CDB) to improve current Indiana safety management tools.
….

A second major component of the study was to improve the current Indiana safety management tool, RoadHAT2, by developing a computer application facilitating preparation of a so-called collision diagram. These diagrams are an important element of safety audits. They are not used frequently due to a considerable time required to build collision diagrams. The developed application reduces this time from one or two days to an hour or less. The application also provides additional tools for analyzing and visualization of crash patterns. A developed CDB User Manual introduces the user to the tool and provides examples to help the user get familiar with the application.

## Iowa

**"Collision Diagram Software Compatibility with Iowa Accident Database,"** Duane E. Smith, Jeff Gerken and Phil Mescher, *Crossroads 2000: 1998 Transportation Conference Proceedings*, 1998.
https://intrans.iastate.edu/app/uploads/2018/03/216collision.pdf
*From the abstract*: The Center for Transportation Research and Education (CTRE), an Iowa State University center, completed an evaluation [of automated collision diagram products]. This paper presents the findings. An automated collision diagram program quickly and accurately generates a graphic of intersection accident history. Limited human resources can concentrate on the safety analysis and not on manually generating collision diagrams resulting in a more efficient safety analysis program. The Iowa DOT was interested in software packages compared to the requirements. Fourteen packages were initially identified by CTRE. … Comparing to the requirements, Intersection Magic, distributed by Pd' Programming, was the program that the Iowa DOT selected for their collision diagram package. The software displays accident history in graphical formats and uses filters to segregate graphics for specific inquiries. This allows the evaluator the opportunity to look at different types of accidents and see if there are trends that warrant further evaluation. The Iowa DOT is in the process of comparing the results from Intersection Magic with previously generated diagrams and developing a program for implementation in field offices.

## Minnesota

**Minnesota Department of Transportation Traffic Safety Analysis Software State of the Art**, Jeffrey von Brown, Michael Martello and Reginald R. Souleyrett, Minnesota Department of Transportation, February 2011.
https://www.lrrb.org/pdf/201110.pdf
*From the abstract*: The Minnesota Department of Transportation is working on developing a replacement product for the Transportation Information System (TIS), a mainframe database management system whose purpose is the maintenance, retrieval and reporting of roadway and railway data, including roadway accident or crash data. The TIS is capable of data management, data queries and producing reports. Ultimately, the core functionality of the existing TIS will need to be recreated in a new environment that interacts with a new TIS platform that will include modern traffic safety or crash analysis tool functionality. The objective of this research was to identify and assess existing crash analysis software tools currently being used in other states and to identify safety analysis capabilities that should be considered when replacing the existing TIS.

## Missouri

**907.5 S-HAL**, Engineering Policy Guide, Missouri Department of Transportation, November 2015.
http://epg.modot.org/index.php/907.5_S-HAL
*From the introduction*: The HAL Manual (Identification, Analysis and Correction of High-Crash Locations) was re-titled S-HAL (Safety Handbook for Locals). The First Edition of the HAL Manual was published in 1975. The S-HAL allows local, non-MoDOT agencies to

- Develop a traffic record system (Chap 2)
- Perform network screening (Chap 3)
- Using safety analysis tools (Chap 4)
- Implementing safety improvements (Chap 5)
- Conduct road safety audits (Chap 6) and
- Additional resources (Chap 7).

## New York

**Crash Diagram Tool (CDT) User Manual**, Version 1.0, New York State Department of Transportation, August 2015.
https://www.dot.ny.gov/divisions/operating/osss/highway-repository/Crash%20Diagram%20Tool%20User%20Manual%20v1.0.pdf
*From the introduction*: The New York State Department of Transportation (NYSDOT) Crash Diagram Tool (CDT) is a web-based application that provides tools for making crash diagrams. A good accident diagram can help you document your accident.

The CDT works in concert with the New York State Accident Location Information system (ALIS). In order to use the CDT, you need to be logged into ALIS. Also, you need to use ALIS to create a table of the accidents you would like to diagram in the CDT. This accident event table gets imported into the CDT where you can edit the symbols to categorize the accidents and also to add shapes and text.

**Accident Analysis Toolbox**, New York State Department of Transportation, undated.
https://www.dot.ny.gov/divisions/operating/osss/highway/accident-analysis-toolbox
The web site includes traffic engineering procedural manuals, traffic engineering crash analysis forms and various accident statistics.

## North Carolina

**Traffic Engineering Accident Analysis System (TEAAS)**, North Carolina Department of Transportation, undated.
https://connect.ncdot.gov/resources/safety/Pages/TEAAS-Crash-Data-System.aspx
*From the web site:*

> The Traffic Engineering Accident Analysis System (TEAAS) is a crash analysis software system downloadable from the internet and available free of charge to state government personnel, municipalities, law enforcement agencies, planning organizations, and research entities. TEAAS contains information on all reportable traffic crashes occurring in North Carolina since 1990. It also contains all ordinance information for all state-maintained roads and highways.

This web site provides access to detailed information and resources about TEAAS, including the following:

> **Collision Diagrams (Instructions)**, North Carolina Department of Transportation, January 2013.
> https://connect.ncdot.gov/resources/safety/Crash%20Data%20and%20TEAAS%20System/TEAAS/Collision%20Diagram%20Instructions.pdf
> This resource provides step-by-step instructions for loading and using the collision diagramming program.

## Ohio

**Safety Analysis Guidelines**, Ohio Department of Transportation, December 2018.
http://www.dot.state.oh.us/Divisions/Planning/ProgramManagement/HighwaySafety/HSIP/SafetyAnalysisGuidelines/Safety_Analysis_Guidelines.pdf
*From the introduction*:

> The purpose of these guidelines is to establish a procedure for completing safety analysis, conducting safety studies and preparing the crash information to show realistic visualizations of the crash data on aerial maps/sketches, as well as establishing a uniform format for ODOT safety study reports. The guidelines contain samples of maps/figures to be used when presenting the data to local officials, ODOT employees and the public for review, input and comments.

See page 71 of the PDF for "Safety Study Analysis Resources and Tools," a discussion of the various tools Ohio DOT uses and parameters for their use.

**Crash Analysis Module—CAM Tool**, Ohio Department of Transportation, January 2013.
http://www.dot.state.oh.us/Divisions/Planning/ProgramManagement/HighwaySafety/HSIP/GCAT/CAM%20Tool_Help%20File.pdf
This document is a "help file" for the Excel-based Crash Analysis Module.

## Oregon

**Collision Diagram Tool Evaluation Project**, Christopher Monsere, Oregon Department of Transportation, October 2008.
Project description and final report at https://trec.pdx.edu/research/project/959
*From the summary*: The purpose of this report is to identify current practices and challenges with collision diagramming at ODOT's Crash Analysis and Reporting (CAR) Unit, research available tools, and to recommend a collision diagramming tool for implementation.

## Pennsylvania

**District Highway Safety Guidance Manual**, Pennsylvania Department of Transportation, December 2014.
http://www.dot.state.pa.us/public/pubsforms/Publications/PUB%20638.pdf
This publication includes references to Pennsylvania DOT's crash analysis tool, Crash Data Analysis and Retrieval Tool (CDART). CDART is a web-based query tool that allows users to select criteria to generate standard reports and maps, which can then be used to evaluate and analyze crash data.

### South Carolina

**"SCDOT Collision Diagram Tool,"** D. Brett Harrelson, *39th International Forum on Traffic Records and Highway Information Systems*, October 2013.
http://www.atsip.org/program/Presentations2013/Presentations%201013/s31_SCDOT_Collision_Diagram_Tool_Harrelson.pdf
The presentation summarizes South Carolina Department of Transportation's use of a collision diagram tool.

### Texas

**CRASH**, Texas Department of Transportation, 2018.
https://www.txdot.gov/inside-txdot/division/traffic/crash-system.html
*From the web site*: Crash Reporting and Analysis for Safer Highways system (CRASH) is a free, secure Internet application for law enforcement agencies to process Texas Peace Officer's Crash Reports (CR-3) electronically. It is a component of the Crash Records Information System (CRIS).

The CRASH system includes the following features:

- Ability to enter crash data over any Internet connection
- Process supplement reports easily
- Integrated diagramming tool
- Auto population of fields
- Touch-screen capability for Toughbooks
- Use of intersection templates
- Embedded help

## Commercial Products

This section presents commercial products commonly used in traffic engineering and a sampling of products used by law enforcement.

### Traffic Engineering

**Accident Information Management System (AIMS)**, JMW Engineering, Inc., 2017.
http://jmwengineering.com/
*From the web site*:

> AIMS displays accidents on GIS map with our patented 3-dimensional stacked symbol plot. It plots accidents on GIS map with symbols corresponding to the locations where the accidents occurred. It plots mid-block accidents according to distances or mileposts. If a location has two or more accidents, it stacks the symbols on top of each other, creating a 3-dimensional view. Locations with a higher stack of symbols mean more accidents.

This web page provides access to detailed information and resources about AIMS modules, including the following:

**"Collision Diagram Roadway Layout Module,"** Accident Information Management System, JMW Engineering, Inc., 2017.
http://jmwengineering.com/aims00/Modules/CollisionDiagramRoadwayLayoutModule.htm
Features include the ability to generate a roadway layout map from a centerline GIS map or a layout map, and plot both intersection and midblock collision diagrams directly on a map with roadway layout.

**"Collision Diagrams on GIS Map Module,"** Accident Information Management System, JMW Engineering, Inc., 2017.
http://jmwengineering.com/aims00/Modules/CollisionDiagramsOnGISMapModule.htm
Features include the ability to plot collision diagrams directly on a GIS map and plot types of crashes.

**"Google Earth Interface Module,"** Accident Information Management System, JMW Engineering, Inc., 2017.
http://jmwengineering.com/aims00/Modules/GoogleEarthInterfaceModule.htm
Features include the ability to execute Google Earth and display the 3-D plot or collision diagram on Google Earth's aerial photograph.

**Collision Data Module**, TES Information Technology Ltd., 2017.
https://www.tes.ca/software/collisions/
This software and data analytics vendor provides a comprehensive platform for transportation engineering and asset management, including collision data management and analysis software modules.

**Traffic Crash Location System**, Midwestern Software Solutions, LLC, August 2015.
http://www.ms2soft.com/products/traffic-crashes/
*From the web site*: MS2's Traffic Crash Location System (TCLS) module is a cloud-based software solution that maps, manages and analyzes vehicle crash data. Traffic engineers use the application to analyze traffic crash patterns and to create crash density heat maps. Crash rates and severity rates are automatically calculated by the TCLS and engineers can easily create complex intersection collision diagrams.

Police crash reports can be appended to each record for more detailed analysis. Each crash is geocoded on an interactive Google map providing traffic engineers with a visual assessment of crash locations in their jurisdictions.

**Solution Sheet: Automated Collision Diagrams for Safety Analysis**, Intergraph Corporation, 2013.
http://www.intergraph.com/assets/pdf/automatedcollisiondiagrams_solutionsheet.pdf
*From the document*: Because roadway safety is the main goal for any DOT, Intergraph offers the Automated Collision Diagrams solution to help you rapidly create diagrams that allow you to evaluate crash patterns within the road network and make faster, smarter decisions on the proper mitigation strategies. With Intergraph's solution, collision diagrams that once took hours, or even days, to create can be generated in minutes. You can even maintain these diagrams easier with our intuitive and robust diagram archival functionality.

**Traffic Collision Database System**, Crossroads Software, Inc., October 2001.
http://crossroadssoftware.com/support/tcdsbrochure.pdf
*From the introduction*: The Crossroads Software Traffic Collision Database System provides powerful, easy solutions for traffic records management and analysis. Running in the familiar

Windows 7 environment, the Collision Database makes data input easy with drop-down menus, "automatch" features, colored active fields, and easy-to-read navigation buttons. The system … uses city street layout information to verify the location of every collision in the database, thus providing an unparalleled level of accuracy. Using a full relational database engine to store, query, and edit collision records and an optional GIS mapping module, the Collision Database System analyzes collision data and produces multiple reports, collision diagrams, and maps of your collision information in just the format you need.

**Roadsoft: Safety Analysis Tools**, Center for Technology & Training, Michigan Technological University, undated.
https://www.roadsoft.org/safety-analysis-tools
*From the web site*: The Collision Diagram tool provides a visual representation of crash data at a given intersection. Collision diagrams use icons to denote different crash types and their locations within individual intersections. Using these graphs and charts, you can easily identify specific crash factors and pick locations within intersections to install new safety measures. Multiple levels of detail and analysis are available, allowing a user to go from network level analysis and drill down to viewing the actual incident reports for individual crashes.

## Law Enforcement

**Easy Street Draw**, PAE, undated.
http://www.trancite.com/v2/pages/easystreet-draw/landing-page.html
This crash diagramming software intended for law enforcement features GIS integration and includes an expansive symbol library.

**MapScenes System**, MicroSurvey Software Inc., undated.
https://store.microsurvey.com/software/forensic/mapscenes/mpscad/mapscenes-forensic-cad/
Product brochure available at
https://assets.microsurvey.com/media/files/en_US/mps/Brochure_MapScenes_Web.pdf
MapScenes Forensic CAD 2013 is a desktop forensic mapping software used by law enforcement professionals and accident reconstruction specialists. *From the product description*:

> Input evidence [is] collected at a crash or crime scene using data from evidence collection software to create detailed and accurate diagrams. Seamless integration with Evidence Recorder software ensures accurate diagrams, enabling investigators to testify on the specific "conditions and effects" of an incident with confidence.

**Watson Crash Reporting**, DataDriven LLC, undated.
http://datadriven.com/crash-reporting-software/
The Watson Crash Reporting module is part of the Watson Field Reporting package used by law enforcement. This module features the Watson Diagramming Tool, a cross-platform diagram generation tool, and GIS integration.

# Contacts

CTC contacted the individuals below to gather information for this investigation.

## State Agencies

### Alabama

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### Arizona

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### Wisconsin

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## University Researchers

### Connecticut

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Transportation Safety Research Center
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### Safe Transportation Research and Education Center

Transportation Injury Mapping System
Safe Transportation Research and Education Center (SafeTREC)
University of California, Berkeley
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# Appendix A: Survey Questions

The following survey was distributed to members of the AASHTO Committee on Safety Management to gather information from other state transportation agencies about their use of collision diagramming systems or tools.

## Agency Use of a Collision Diagramming System or Tool

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*Note: Responses to the question below determined how respondents completed the survey:*

- *Respondents who answered "no" to the question were offered an opportunity to provide additional comments before finishing the survey.*
- *Respondents who answered "no, but our agency is considering using one" were directed to follow-up questions and were offered an opportunity to provide additional comments before finishing the survey.*
- *Respondents who answered "yes, our agency uses a system or tool developed in-house" were offered an opportunity to provide additional comments before finishing the survey.*
- *Respondents who answered "yes, our agency uses a system or tool developed in-house, but we're considering moving to a commercial product" were directed to follow-up questions.*
- *Respondents who answered "yes, our agency uses a commercial off-the-shelf collision diagramming system" were directed to the remaining questions.*

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1. Does your agency use a collision diagramming system or tool?
    - No.
    - No, but our agency is considering using one.
    - Yes, our agency uses a system or tool developed in-house.
    - Yes, our agency uses a system or tool developed in-house, but we're considering moving to a commercial product.
    - Yes, our agency uses a commercial off-the-shelf collision diagramming system.

## Agencies Considering Use of a New Collision Diagramming System

1. Please describe your agency's consideration of, or plans to transition to, a new collision diagramming system.

### System Description

1. What are the names of your agency's collision diagramming system and the vendor providing it?

2. Please describe your agency's collision diagramming system by selecting all that apply.
    - Web-based (agencywide use).

- Desktop-based (individual desktop use).
- Single stand-alone online system.
- Multiple tools (part of larger system).
- Commercial off-the-shelf (COTS) product with no customization.
- COTS product customized for agency use (please respond to Questions 2A and 2B below).
- Other (please describe).

2A. Please describe the type and degree of customization needed for your agency's collision diagramming system.

2B. Who is/was responsible for customizing the system?

- Our agency.
- The vendor.
- The vendor in collaboration with agency staff.

3. What type of licensing does your agency maintain?

- Individual.
- Sitewide.
- Other (please describe).

4. What features and functions are supported by your agency's collision diagramming system (even if your agency is not currently using them)? Select all that apply.

- Compatible with Google Earth (current day).
- Compatible with Google Earth (going back in time).
- Exports data to Excel.
- Exports data to Word.
- Exports GIS basemaps.
- Generates custom reports.
- Generates standard reports.
- Imports data via a text file.
- Imports data via an Excel file.
- Incorporates GIS basemaps.
- Maps crashes by node.
- Maps crashes by X,Y coordinates.
- Provides prebuilt templates for ramps.
- Provides prebuilt templates for T-type intersections.
- Provides prebuilt templates for X-type intersections.
- Provides records management functions.
- Reads to and from external databases.
- Standard set of mapping symbology.
- Upgrades/system updates provided by vendor.

5. Please describe other features and functions supported by your agency's collision diagramming system that do not appear in the list above.

6. If available, please provide links to documentation related to your agency's collision diagramming system. Send any files not available online to chris.kline@ctcandassociates.com.

**System Implementation and Maintenance**

1. When did your agency implement its collision diagramming system?
2. How long did it take to implement the system?
    - Less than 6 months.
    - 6 months to less than 1 year.
    - 1 year to less than 2 years.
    - 2 years to less than 3 years.
    - 3 years or more.
    - Other (please describe).
3. What was the total cost to implement the system?
4. What are the ongoing annual maintenance costs for the system?
5. Does your agency maintain an ongoing service contract for the system? If yes, please describe the service contract and its cost.
6. How often does your agency update the system?
    - Once a year.
    - Several times a year.
    - Every two years.
    - As required by the vendor.
    - Other (please describe).
7. Who is responsible for system updates?
8. Has your agency experienced any challenges when implementing system updates? If yes, please describe these challenges.

**System Assessment**

1. Please describe the strengths of your agency's collision diagramming system.
2. Please describe any challenges your agency has experienced using the collision diagramming system.
3. Does your agency have any plans to transition to another collision diagramming system? If yes, please describe your agency's plans.
4. Has your agency's collision diagramming system been challenged in court? If yes, please describe the result of this court challenge.
5. What recommendations do you have for an agency preparing to implement a new collision diagramming system?

## Wrap-Up

Please use this space to provide any comments or additional information about your previous responses.