New York Department of Transportation

Data Integration in CLEAR

New York State's Safety Management Tool

SAFETY DATA CASE STUDY

FHWA-SA-20-060

Federal Highway Administration Office of Safety

Roadway Safety Data Program

http://safety.fhwa.dot.gov/rsdp

U.S. Department of Transportation
Federal Highway Administration

NEW YORK STATE OF OPPORTUNITY. Department of Transportation

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SI* (MODERN METRIC) CONVERSION FACTORS

APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
		AREA		
in^2	square inches	645.2	square millimeters	mm^2
ft^2	square feet	0.093	square meters	m^2
yd^2	square yard	0.836	square meters	m^2
ac	acres	0.405	hectares	ha
mi^2	square miles	2.59	square kilometers	km^2
		VOLUME		
fl oz	fluid ounces	29.57	milliliters	mL
gal	gallons	3.785	liters	L
ft^3	cubic feet	0.028	cubic meters	m^3
yd^3	cubic yards	0.765	cubic meters	m^3
	NOTE: volumes greater than 1000 L shall be shown in m^3			
		MASS		
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams (or "metric ton")	Mg (or "t")
		TEMPERATURE (exact degrees)		
°F	Fahrenheit	5 (F-32)/9 or (F-32)/1.8	Celsius	°C
		ILLUMINATION		
fc	foot-candles	10.76	lux	lx
fl	foot-Lamberts	3.426	$candela/m^2$	cd/m^2
		FORCE and PRESSURE or STRESS		
lbf	poundforce	4.45	newtons	N
lbf/in^2	poundforce per square inch	6.89	kilopascals	kPa

APPROXIMATE CONVERSIONS FROM SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
mm	millimeters	0.039	inches	in
m	meters	3.28	feet	ft
m	meters	1.09	yards	yd
km	kilometers	0.621	miles	mi
		AREA		
mm^2	square millimeters	0.0016	square inches	in^2
m^2	square meters	10.764	square feet	ft^2
m^2	square meters	1.195	square yards	yd^2
ha	hectares	2.47	acres	ac
km^2	square kilometers	0.386	square miles	mi^2
		VOLUME		
mL	milliliters	0.034	fluid ounces	fl oz
L	liters	0.264	gallons	gal
m^3	cubic meters	35.314	cubic feet	ft^3
m^3	cubic meters	1.307	cubic yards	yd^3
		MASS		
g	grams	0.035	ounces	oz
kg	kilograms	2.202	pounds	lb
Mg (or "t")	megagrams (or "metric ton")	1.103	short tons (2000 lb)	T
		TEMPERATURE (exact degrees)		
°C	Celsius	1.8C+32	Fahrenheit	°F
		ILLUMINATION		
lx	lux	0.0929	foot-candles	fc
cd/m^2	$candela/m^2$	0.2919	foot-Lamberts	fl
		FORCE and PRESSURE or STRESS		
N	newtons	0.225	poundforce	lbf
kPa	kilopascals	0.145	poundforce per square inch	lbf/in^2

*SI is the symbol for the International System of Units. Appropriate rounding should be made to comply with Section 4 of ASTM E380.
(Revised March 2003)

Acronyms

Acronym	Description
ACG	Accident Crash Geocoder
ALIS	Accident Location Information System
CLEAR	Crash Location and Engineering Analysis Repository
FDE	Fundamental Data Elements
FHWA	Federal Highway Administration
GIS	geographic information system
HSIP	Highway Safety Improvement Program
HSM	Highway Safety Manual
ICL	Interactive Crash Locator
IIM	Intersection Inventory Management
LRS	linear referencing system
MIRE	Model Inventory of Roadway Elements
MPO	metropolitan planning organization
NYSDMV	New York State Department of Motor Vehicles
NYSDOT	New York State Department of Transportation
PIES	Post Implementation Evaluation System
SHSP	Strategic Highway Safety Plan
SIMS	Safety Information Management System
SP&R	State Planning and Research

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Executive Summary

The New York State Department of Transportation (NYSDOT) has a broad-reaching goal to provide safe and efficient roadways throughout the State. This case study presents NYSDOT's significant advancement in safety data integration and analysis. NYSDOT is developing a State-specific safety management system known as the Crash Location and Engineering Analysis Repository (CLEAR). Funded through State Planning and Research funds, CLEAR will replace three existing legacy systems, meet all safety performance legislation and federal standards for reporting, and support the six-step roadway safety management process outlined in the Highway Safety Manual. A geographic information systems-enabled crash geocoding engine will automate several steps in the geolocation process, as well as support accurate and timely delivery of crash data between the New York State Department of Motor Vehicles and NYSDOT. CLEAR will enhance safety analysis workflows, reinforce existing safety analysis standards, and increase user access to advanced analytical tools.

Introduction

The New York State Department of Transportation (NYSDOT) has a broad-reaching goal to provide safe and efficient roadways throughout the State by applying sound traffic engineering in an effort to prevent crashes, eliminate fatalities, and reduce the severity of injuries sustained. NYSDOT has had a robust safety management program for many years through data-driven efforts like the Strategic Highway Safety Plan (SHSP) and project implementation through the Highway Safety Improvement Program (HSIP).

NYSDOT was an early adopter of a linear referencing system (LRS) for transportation and safety data management. However, as data systems become outdated and technologies advance, the need for a new, customized safety tool became apparent. NYSDOT is developing a State-specific safety management system known as the Crash Location and Engineering Analysis Repository (CLEAR). The objectives of the system itself are guided by improving data integration, increasing user access, and enhancing current safety management methods and processes. These objectives help support the roadway safety management process in the Highway Safety Manual (HSM) at NYSDOT.

Prior to the development of CLEAR, NYSDOT could only perform network screening on State roads. CLEAR will increase NYSDOT's ability to include locally owned roads into the network screening and safety management process.

Purpose and Need

NYSDOT is developing a roadway safety management tool that integrates crash, roadway inventory, and traffic volumes on all public roads. The tool, known as CLEAR, is part of a larger transportation data system implementation effort to:

- Revise highway safety program business processes/workflows, with updated documentation.
- Transition to the Statewide Enterprise LRS containing all public roads.
- Migrate legacy data to a new database.
- Retire three legacy safety management systems.
- Train and educate the user community within NYSDOT and its safety partners.

Target Audience:

- Safety Engineering and Planning Staff
- Information Technology Staff
- Data Managers and Stewards
- Crash, Traffic, and Roadway Inventory Data Managers

Funding

NYSDOT made incremental improvements to their existing safety management systems in previous years using funding from federal grants; however, this funding stream has typically not been enough for a major programmatic upgrade. To develop CLEAR, NYSDOT used an allocated federal funding source—State Planning and Research (SP&R) funds. These funds are typically reserved for research activities and data upgrades. NYSDOT found that the use of SP&R funds was easily justified as existing technologies had become out of date, were no longer going to be supported, or otherwise needed to be updated. HSIP funds were not used to develop CLEAR.

Legacy Systems

The CLEAR system will replace three existing legacy systems currently used in the State of New York to manage and analyze crash data and serve as the State's safety management system. These systems include:

- **Accident Location Information System (ALIS):** Web-based geographic information system (GIS) application which allows users to access crash data through custom queries and analyze the data with several reporting options and formats.
- **Safety Information Management System (SIMS):** System which stores State and local crash data and is used for identifying High Accident Locations (HALs) in the State system each year.
- **Post Implementation Evaluation System (PIES):** System that evaluates countermeasures and projects and assigns a reduction factor percentage.

Capabilities of CLEAR

CLEAR will meet all safety performance legislation and federal standards for reporting, including the Model Inventory of Roadway Elements (MIRE) Fundamental Data Elements (FDE) (Federal Highway Administration 2017). CLEAR will feature several individual modules for safety management that integrate safety data through a common workflow. The most relevant modules to safety data include Crash Geocoding, Safety Application, and Data Viewer. The following provides a general overview of these modules.

Geocoding and Editing Crashes

The New York State Department of Motor Vehicles (NYSDMV) owns crash data prior to delivery to NYSDOT. Currently, NYSDOT uses its legacy system, ALIS, to geolocate and analyze crash data. CLEAR will follow a similar process to geolocate crashes that incorporates NYSDMV and NYSDOT in the data processing workflow.

Crash Geocoding Engine

On the NYSDOT-side, this engine will use a multi-tiered algorithm to geocode a single crash location based on tiers of information in the crash data fields from crash reports. If a single location cannot be determined (i.e., zero viable options or multiple candidate locations), the engine will update the status as a geocoding failure.

Automated Crash Geocoder (ACG)

The ACG is a routine that runs a nightly scheduled, automated geocoding for all new NYSDMV-uploaded crashes. The ACG retrieves all new crashes from NYSDMV and will iterate through the crashes, submitting the locational data for each record to the Crash Geocoding Engine to be geocoded. When the geocoding engine returns a successfully geocoded crash, ACG will add the crash (as a point feature) to the crash feature class within the CLEAR Geodatabase. It will also populate the crash record with the latitude/longitude coordinates, road segment ID, roadway characteristics, and all geocoding metadata (status, confidence, source) that is returned by the Crash Geocoding Engine.

The Interactive Crash Locator (ICL) will flag a case number of a crash record for subsequent processing if the crash cannot be successfully geocoded.

Interactive Crash Locator

The ICL is a browser-based tool that allows NYSDMV coders to load crash records on screen (e.g., reports, maps, location form), modify the data (e.g., edit typos), and perform the geocoding interactively (figure 1).

Interactive Crash Editor

This NYSDOT module, similar to the NYSDMV-applied ICL module, will provide a map display, query form, and data display to allow the user to manually edit crash and location data when errors are discovered. The application will provide functionality allowing the end user to correct the location and attributes of an existing crash that has already been geocoded.

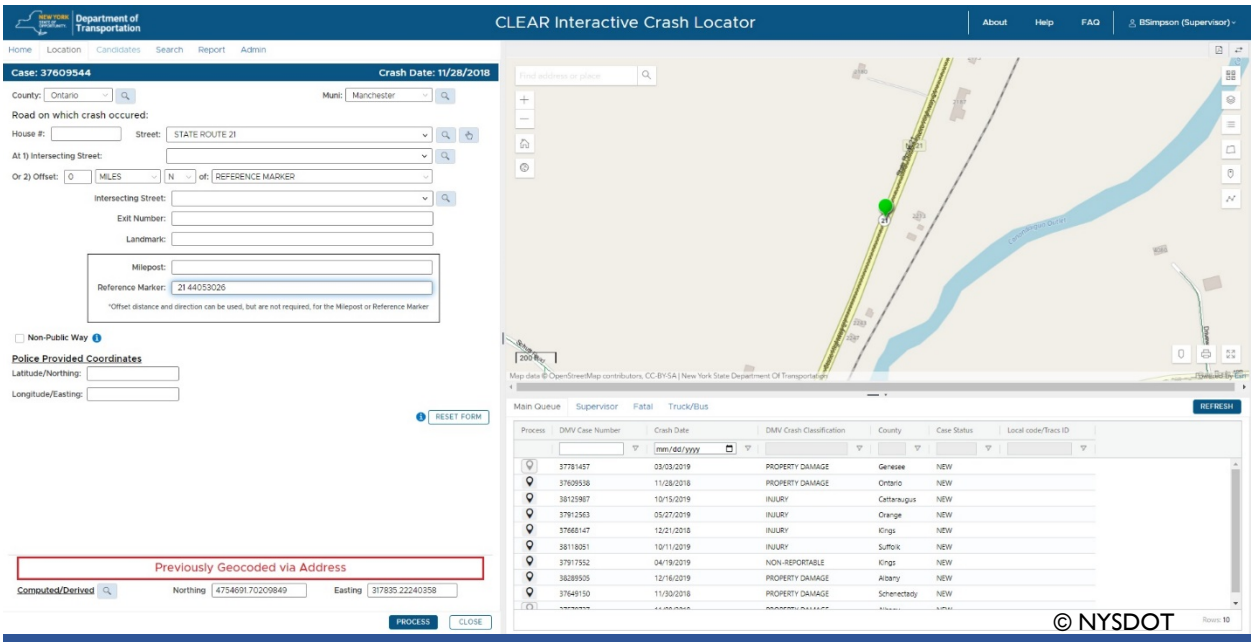


Figure 1. Graphic. Manually locating crashes in CLEAR.

CLEAR Safety Application

To reduce the frequency and severity of serious injury and fatal crashes, NYSDOT uses the roadway safety management process (figure 2) as defined in the HSM. The CLEAR Safety Application will enhance existing workflows at NYSDOT and reinforce existing standards through improved tracking and quality assurance.

The CLEAR Safety Application will address each of the six steps in four primary modules to focus the user interface and available tools on the operations that are most appropriate during any point within the safety management process. The modules are (1) Planning, (2) Analysis and Investigation, (3) Implementation, and (4) Evaluation. By organizing into the four modules, it will allow the user to progress through the safety management process logically but also allows easy access to a specific module when needed. This application will provide robust mapping, geospatial processing, visualization, query, analysis, and reporting throughout all modules.

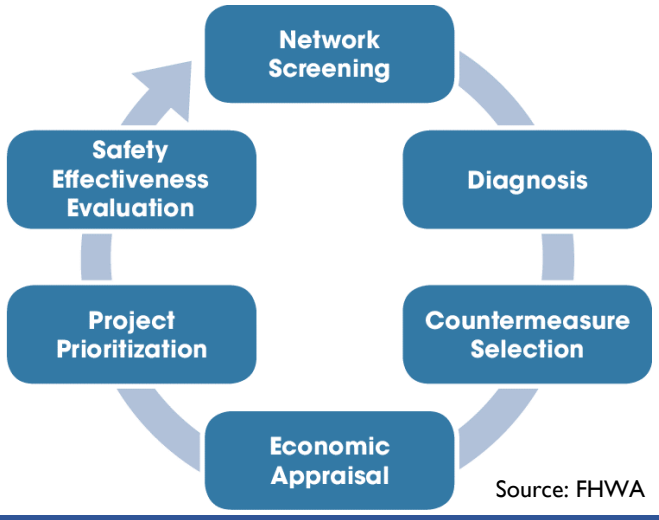
The following are brief descriptions of each module within the CLEAR Safety Application:

The **Planning** module will employ both hot spot and systemic screening approaches on the roadway network to identify sites with potential for safety improvements. The hot spot screening approach allows the user to select performance measures, establish crash thresholds, and conduct the annual screening of HALs for further investigation. Employing the systemic approach, users can screen the network by selecting focus crash types, focus facility types, and associated risk factors to identify candidate locations. This module also includes functionality to develop crash tree diagrams to support systemic screening.

The **Analysis and Investigation** module will help to diagnose contributing factors, select countermeasures, and perform an economic appraisal. This module supports thorough diagnosis of crash data summaries and trends, generates collision diagrams, compares expected safety effectiveness of multiple potential alternative countermeasures, and performs benefit-cost analysis to aid in project prioritization.

The **Implementation** module will manage, track, and generate reports throughout the project development process. The module will integrate with NYSDOT's existing safety management processes and tools for project investigation and tracking.

The **Evaluation** module will support post-implementation safety effectiveness evaluations of constructed projects. Some components of this module include user-built queries for certain types of improvements, estimations of crash reduction factors, and evaluation reports.



Source: FHWA

Figure 2. Graphic. Roadway safety management process (FHWA 2013).

CLEAR Data Viewer

This application is available to authorized users, such as NYSDOT staff and metropolitan planning organizations (MPOs), for general/ad-hoc visualization, query, and analysis of crash and safety data, beyond the more focused and robust analysis that will be conducted within the CLEAR Safety Application. The dashboard module will show a combination of charts, graphs, and tables that illustrate a high-level summary of safety metrics. The map display capabilities will include typical web-based GIS functions as well as advanced geospatial functionality like hot spot clustering, heat maps, spatial selections, filtering, and street-level views. Users will be able to perform ad-hoc crash and site analysis through a query interface that also includes reporting, exporting, and sharing capabilities with other users.

Intersection Inventory Management (IIM)

The IIM will be an application that facilitates the management and maintenance of the master intersection inventory for NYSDOT. This application will have two modes to facilitate change requests and inventory maintenance.

CLEAR Mobile Applications

Specifically designed for use in the field, mobile applications will provide live access to maps, data, and services when an internet connection is available. However, since internet connectivity cannot be guaranteed, both mobile applications will be able to "virtually see" geographic features within an area of interest (e.g., crashes, investigations, road centerlines) to load onto the devices for disconnected map viewing and editing.

Training

NYSDOT understands that the success of CLEAR will be largely dependent on effective training and continuous knowledge transfer to both system administrators and end users. The CLEAR vendor will develop and deliver instructor-led courses for each CLEAR module and application. All training sessions will be recorded and posted for new users, with the developer available for a live Q&A session following completion of the training. These trainings will be provided to NYSDOT staff, as well as local-level analysts and representatives closer to the full implementation of the tool.

Challenges

There are several data systems in New York that are undergoing updates or changes amid the development and implementation of CLEAR. These include AgileAssets™ for asset management, completion of an all public roads statewide LRS, and NYSDMV's crash data system. To overcome the uncertainty presented by these parallel transportation data efforts, the CLEAR project team communicates and coordinates with these different data/system owners to ensure integration is successful. NYSDOT notes that an effective data governance program may be able to help mitigate similar potential uncertainties at other State DOTs.

Additionally, New York has an emerging local road inventory. While CLEAR can analyze local roads, the types of analyses that are available for these locations are limited by the availability of data. NYSDOT

has several data collection initiatives, such as the County Counter Program Initiative for local partners to collect traffic volumes, to supplement the available data at these locations and to support more robust analysis.

Next Steps

Most CLEAR modules are still under development or are undergoing testing for user acceptance. As the tool enters production and testing is complete, NYSDOT will set up training events for NSYDOT staff and local representatives.

Conclusions and Lessons Learned

NYSDOT staff roles and responsibilities will not change with the development of CLEAR, but some of the processes for safety management, data acquisition, and integration will change. NYSDOT recognizes the importance of documenting data governance policies and processes for future users. A benefit of the CLEAR solution is the easy, standardized method to access and analyze safety data.

NYSDOT found that an iterative process when developing a new system allowed for constant refinement and redesign. The contractor met regularly with stakeholders—including NYSDMV, MPOs, regional DOT staff, safety staff, and information technology staff—to demonstrate user interfaces and workflows and gather feedback. Because CLEAR will be using data from various sources, it is important to keep communication lines open with other business units (e.g., asset management) throughout the development process. It is also important to engage other divisions within NYSDOT such as planning, design, and traffic engineering to help integrate safety throughout the project development process.

Receiving support from executive-level management was crucial in the Safety Program Development Section's pursuit of an updated safety management system. The Bureau Director understood the importance of data and was a champion in updating legacy systems with new technology and tools. The Safety Program Development Section also received positive feedback and approval from other data owners in developing a new safety management tool.

NYSDOT's new roadway safety management system, CLEAR, will reinforce existing safety analysis standards and increase user access to advanced analytical tools. The enhanced capabilities are made possible through the integration of multiple datasets, including crash, roadway, and traffic data on all public roads. Through this development effort, CLEAR will support the agency's broader goals of reducing fatalities and serious injuries on the State's roadways.

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