Miovision Safety Product Specification

Copyright statement

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Overview

Intersection Video Conflict Analysis Study

Miovision's primary safety product is an intersection video conflict analysis study. This product contains near-miss data and data visualizations on up to 60 conflict types generated from 60 hours of video. This specification presents the scientific approach, parameters, deliverables, software, example visualizations, and accuracy levels associated with this primary product. This specification also presents additional professional services products and additional data products that can be provided as extensions or variations of the primary intersection video conflict analysis study.

Scientific Approach

Miovision's video conflict analysis uses computer vision powered by artificial-intelligence to measure spatially accurate trajectories of road users. From these trajectories we measure the speed of road users in conflict and the temporal separation of these road users. These kinetic variables are linked to the likelihood of a potential injury collision in the future.

We propose a project approach which applies the following core principles:

- Safe systems and kinetic energy/risk model
- Scientific accuracy in surrogate safety
- Precise and low-cost countermeasures
- Engineering integrity and local expertise

MicroTraffic's video conflict analysis uses computer vision powered by artificial-intelligence to measure spatially accurate trajectories of road users. 5 key conflict analysis factors to determine near-misses and severity:

- Temporal separation (Time to collision (TTC), Post Encroachment Time (PET), T2
- Speed of road users in conflict
- Angle of potential impact
- Order of interaction (e.g. left turn in front of or behind through vehicle)
- User size and vulnerability.

These kinetic variables are linked to the likelihood of a potential injury collision in the future, with a 94% level accuracy in peer-reviewed third party research.

Recommended Parameters

Using variables from the above five categories in the kinetic risk model, for each conflict, we record, which we recommend as parameters for this project:

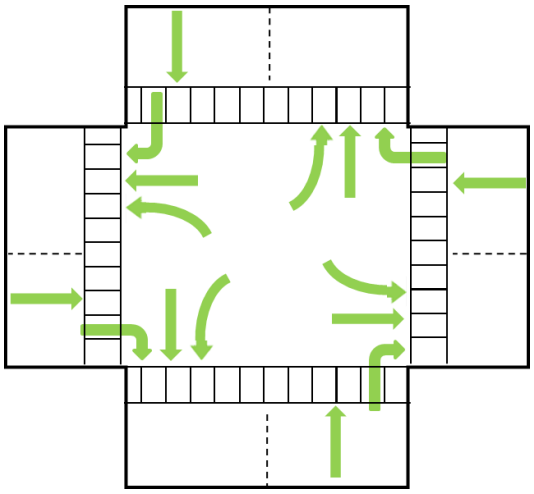
- Conflict risk rating (low, medium, high, critical)
- Conflict configuration (analogous to crash configuration, comprised a pair of road user type and road user movement values)
- Conflict Time of day

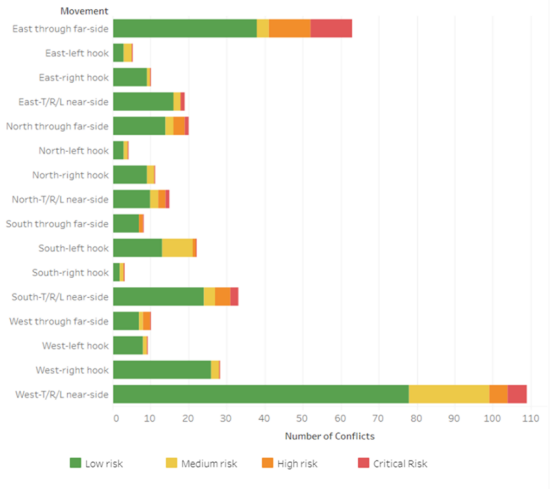
The following 60 types of conflicts can be analyzed, and we recommend these as measurement parameters for this project, for conventional intersections.

- 12 Vehicle-vehicle conflicts (right angle, turning movement, rear-end, merging)
- 16 Vehicle-pedestrian conflicts (through near-side, through far-side, left hook, right hook, mid block)
- 16 Vehicle-cyclist conflicts (through near-side, through far-side, left hook, right hook, mid block)
- 16 Vehicle-scooter conflicts (through near-side, through far-side, left hook, right hook, mid block)

The following conflicts types are recommended for roundabouts:

- 4 merging vehicle conflict points at roundabout entry points
- 4 lane change conflicts zones within the roundabout
- All pedestrian crossings: vehicle entering conflicts and vehicle exiting conflicts
- Vehicle-cyclist conflicts at all entry and exit points



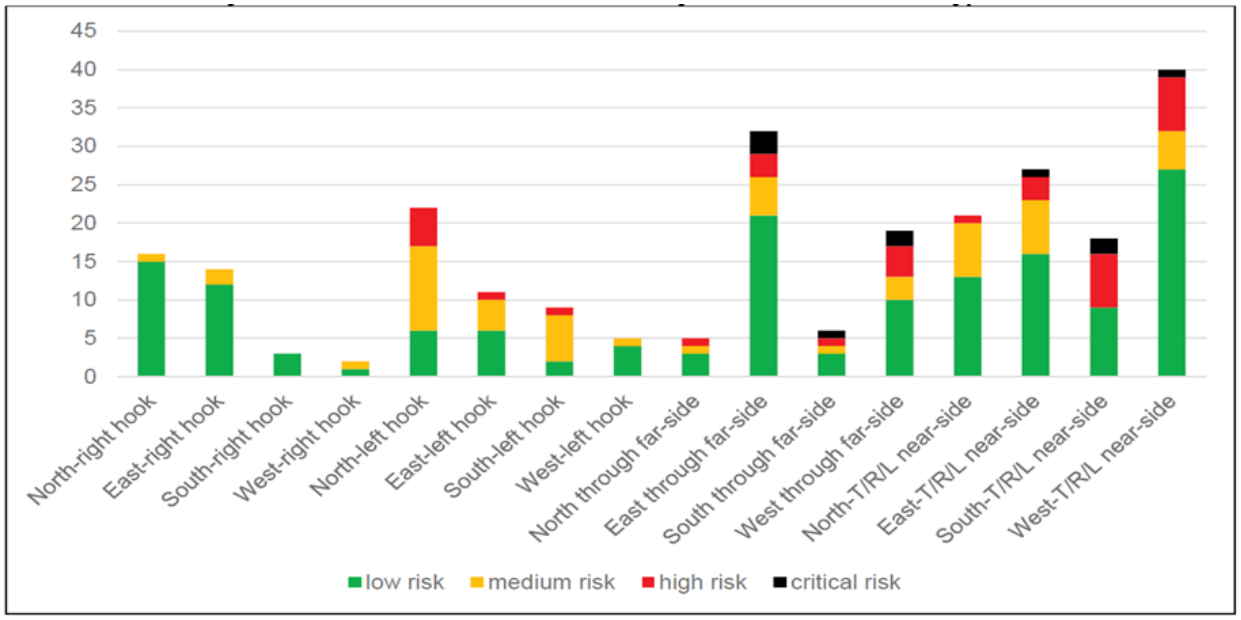


Deliverables

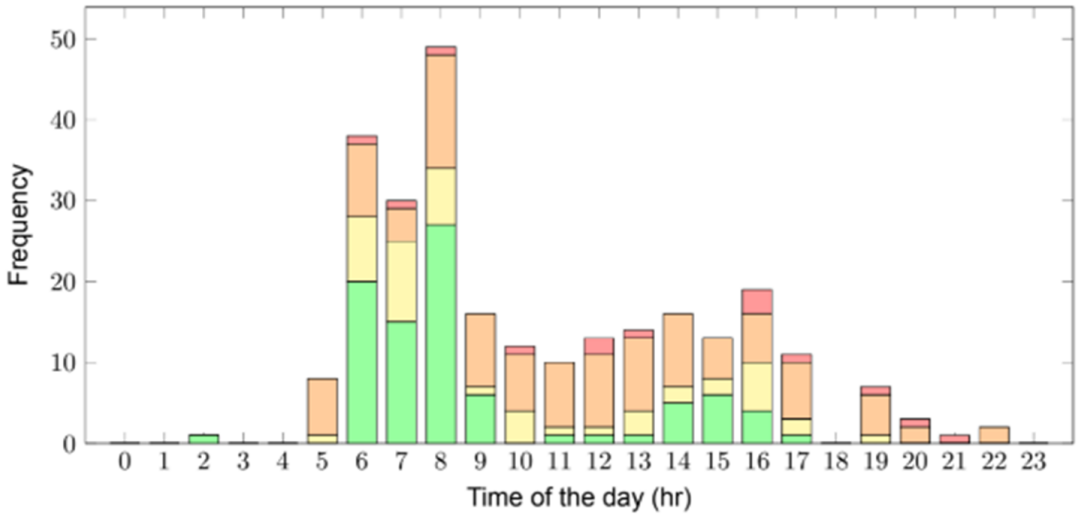
- PDF conflict analysis report, including various visualizations
- Conflict analysis raw data files
- Clips of all conflicts

Software

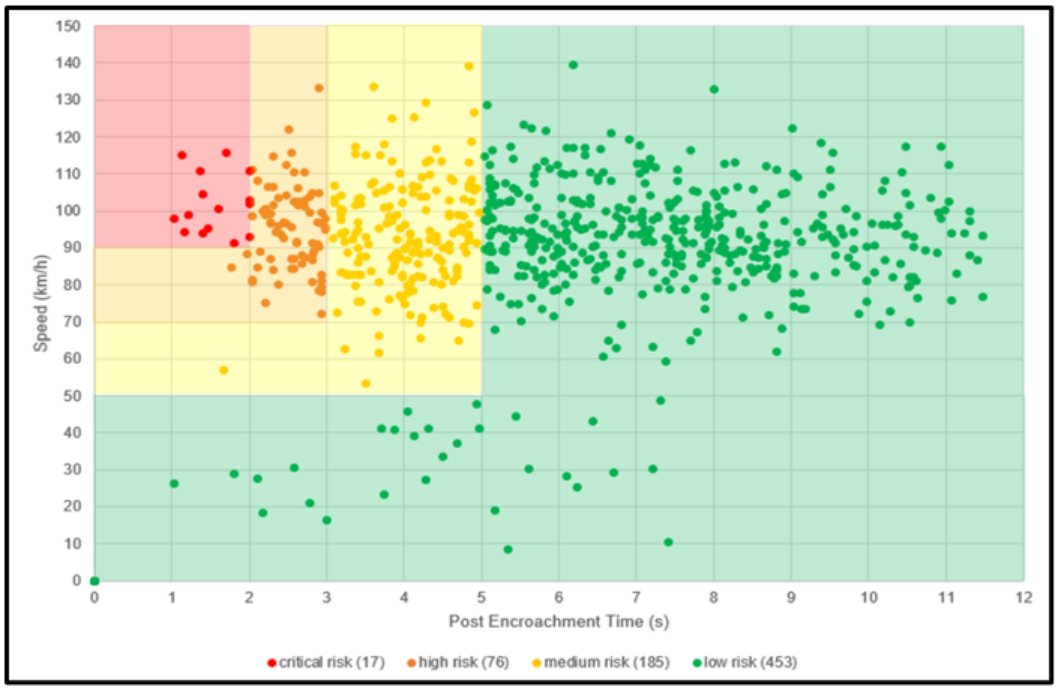
Our portals export data in multiple formats, many of which are supported by PowerBI's import functions, such as .csv and .xls. Static reports and web-based dashboards are available. The following images show some of the export capabilities of our software.



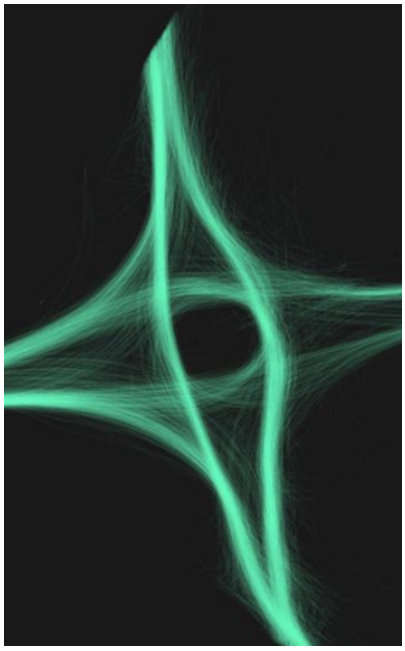
Conflict Configuration Summary Visualization for all Pedestrian Configurations



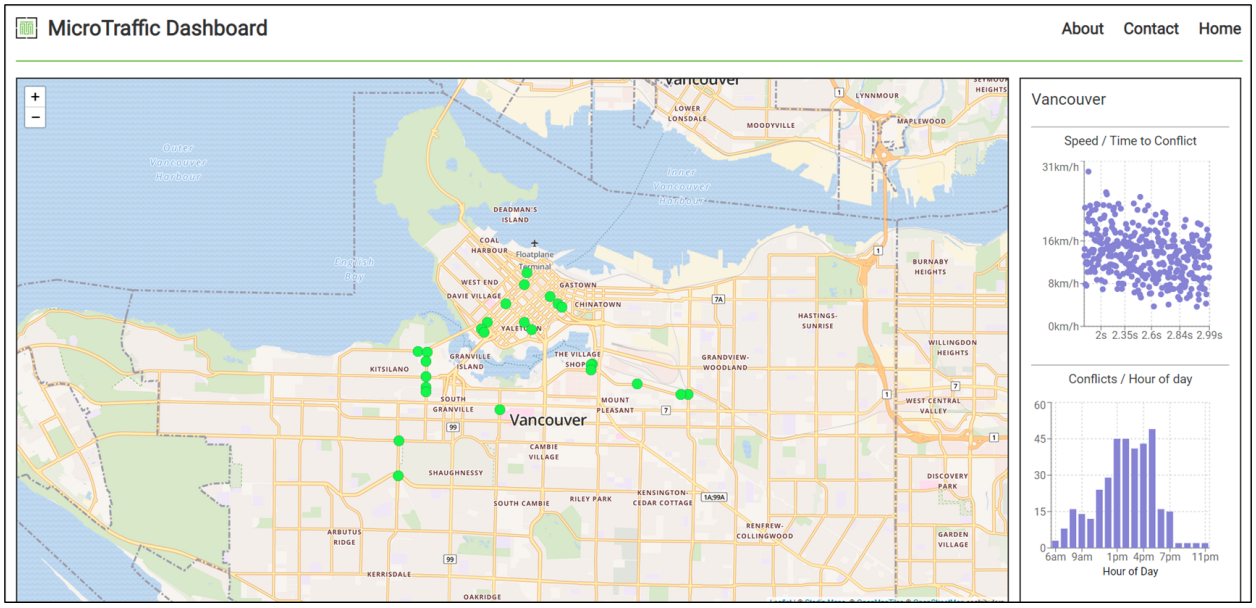
Conflict Temporal-Severity Distribution for One Configuration



Conflict Scatterplot for one Configuration



Conflict Trajectory Visualizations



Conflict Dashboard Output Visualization (Beta Version - Access by Special Arrangements Only)

Accuracy

We offer the following VBCA accuracy standards. These are not guarantees and can be affected by factors such as extreme weather, occlusions, and camera placement. However, through careful camera installation planning and a detailed quality assurance and quality control (QAQC) process, we normally deliver these standards:

- Temporal separation: +/- 0.1 s
- Speed: 10% RMSE (root mean square error)
- Road User Classification: 95%
- Counts, per 15 minute bin, per movement: 95%, or +/- 5 vehicles for volumes under 100 vehicles.
- False positive high and critical risk conflicts: zero

We achieve the above accuracy standards through the following 17 step integrated data processing and QAQC process.

#	Step	Description
1	Project Planning	Document objectives to inform camera placement plan and target indicators.
2	Camera Placement	Develop a camera placement plan that will ensure video will meet objectives and minimize QAQC burden. This step preempts the majority of potential accuracy problems.
3	Video Preprocessing	Batching video into processing units
4	Video Checks	Process to automatically flag and review conditions which may affect accuracy, such as camera shakes, movement, weather occlusions. If flags are raised, this may result in portions of video excluded, or re-recording, or additional QAQC interventions.
5	Domain Adaptation	Process to increase accuracy of computer vision by

		retraining the detector model using 50 to 100 annotated frames from the site in question.
6	Detection Processing	Process to automatically detect and classify road users in every frame using a neural network.
7	Homography	Technician-guided process to establish 20 to 30 correspondence points between video frame space and real world coordinates, in order to obtain a spatial translation matrix. This is done with an accuracy feedback loop until the spatial translation is accurate enough.
8	Tracking Processing	Process to automatically link detections into tracks.
9	Track Patching	Process to automatically flag questionable tracks based on technician defined criteria, such as broken or orphan tracks, which are raised to a technician for manual linking or correction as required.
10	Trajectory Processing	Patched tracks are converted to smoothed trajectories using a filtering algorithm to remove any noise that could cause speed inaccuracies. This step also generates movement labels for each trajectory (e.g. northbound left).
11	Indicator Processing	Safety indicators are automatically calculated from the trajectory database using our kinetic risk models.
12	Vehicle Conflict Cleaning	A technician reviews conflicts to remove false positives or edit the speed or proximity values based on manual measurements for any flagged conflicts.
13	Vulnerable Road User Conflict Cleaning	A technician reviews conflicts to remove false positives or edit the speed or proximity values based on manual measurements for any flagged conflicts.
14	Turning Movement Count Generation (Vehicle)	Counts are exported from the trajectory database. Spot checks are performed to confirm count accuracy levels at the 15 minute bin level.
15	Turning Movement Count	Counts are exported from the trajectory database.

	Generation (Vulnerable Road User)	Spot checks are performed to confirm count accuracy levels at the 15 minute bin level.
16	Speed Profile Generation	Speed distributions are exported for particular turning movements and measurement location gates. A technician uses ruler overlays in the VBCA software to confirm speed accuracy levels and adjust homography as necessary. Profiles include summary distributional statistics. Speed profiles are an additional cost item.
17	Diagnostic Report Generation	A report with all the conflict data is generated in static web form, raw data form (CSV), pushed to the dashboard, and made available dynamically via an API. Prior to publishing, a senior technician performs a final QAQC review to approve release.

Data Ownership & Data Protocols

All data is available through our cloud portals (datalink and TDO) in a variety of formats. Customers can download the data and video at any point in time during our partnership or after contract termination. All video footage is provided in .mp4 format and is available via the SD card. Data ownership and rights are documented in Miovision terms and conditions applicable to a safety product purchase.

Optional Add Ons

- Conflict location (latitude, longitude, and conflict meta data in a file that can be displayed in geographic information systems)
- Trajectories and all trajectory kinetic parameters
- Speed profiles
- 16 Vehicle-e-scooter conflicts (through near-side, through far-side, left hook, right hook, mid block)
- Video Capture

Professional Services Studies:

Note regarding engineering work product

Miovision road safety professional services reports will be prepared by road safety engineers licensed in their home jurisdiction with specialized training and experience in road safety. However, our engineers do not register for local engineering licenses in every global jurisdiction in which we operate. Accordingly, the professional services reports will not be stamped and should not be relied on as an engineering work product. A locally licensed engineer should make all final decisions regarding the implementation and design of any safety improvement suggested in a Miovision professional services study.

Crash Predictions

Application of a scientific formula to predict the number of crashes occurring during the next five years, using near-miss conflict data and other input data to create the prediction. If countermeasures are proposed, predictions of anticipated crash reductions may also be provided using techniques from the Crash Modification Factors Clearinghouse. All predictions will be disaggregated according to three severity levels: fatal and injury crashes as a group (Nfi), total crashes (Ntot), and property damage only crashes (Npdo).

Video Road Safety Audit

A video road safety audit is a report by a road safety specialist that establishes the key risk factors and an intersection and brings forward a recommended program of improvements and countermeasures that are likely to reduce risk. The road safety specialist analyzes the results of a near-miss conflict study and additional background information in order to produce a video road safety audit report, according to the methodology below.

The following methodology will be applied to the video road safety audit:

- **Review Background Information -** Background information may include geo-referenced collision data, signal timing plan, network screening results, citizen safety concerns, traffic volumes, and geometric drawings.

- **Collision Analysis -** The collision analysis will evaluate collision frequency, rate, and severity, and identify temporal and spatial collision configuration distributions.

- **Video Conflict Analysis -** This will identify potential serious latent risk factors that are not yet apparent in crash data.

- **Geometric, Operations, and Human Factors Analysis -** The project team will conduct a geometric, operational, and human factors analysis at the location to identify key safety issues. This analysis will connect risk factors identified during collision and conflict analyses to likely underlying root causes.

- **Preliminary Findings Meeting**
  The project team will arrange a web meeting with the City of London. We will present risk factors identified and lead a discussion around potential countermeasures. These concepts will already be tailored very specifically to the site in question, and City of London staff will give input regarding what they feel is contextually appropriate. This meeting will help ensure that the project does not just produce stock countermeasure recommendations that are not tailored to the site and local practices.

- **Key Issues and Recommendations**
  The project team will identify key risk issues that have the greatest likelihood of contributing to injury or fatality. Recommendations will be provided for both short- and long- term treatments to address the key safety issues. Short-term treatments can typically be implemented in current year budgets, while long-term treatments require capital planning. The project team will evaluate the benefit of each treatment based on the application of available collision modification factors or engineering judgment, providing a forecast where possible. Our objective is to identify a program of countermeasures that can reduce risk by 80% or more, although this is not guaranteed.

- **Report**
  The project team will prepare a draft road safety audit report for review by the client. After a meeting and comment period, the report will be revised and finalized by the project team.

Meetings

1 Kickoff meeting - 1 hour
  Objectives: This kickoff meeting will be used for team introductions, to confirm scope and schedule details, to establish communication expectations and obtain initial information from staff about key safety concerns at the intersection.

2 Draft report review - 2 hours
Objectives: Present and discuss key findings. Receive feedback from staff regarding report finalization.
3 Project close-out - 1 hours
Objectives: Highlight changes made to report. Debrief the project for lessons learned. Staff to provide feedback to Miovision. Discuss future applications of video analytics.

Specialized Studies

The following specialized studies are offered within the Miovision product suite and require the installation of a Miovision Core DCM Unit and a 360 degree camera:

- Red light running reports
- Pedestrian compliance and violation reports

Please note, these are additional products not quoted as part of the proposed solution. Miovision Core DCM is associated with additional fees.

The following specialized studies can be performed with portable cameras in addition to intersection safety studies:

- Merging conflict analysis and late lane changing conflict analysis
- Wrong-way driving analysis
- Rear-end conflict analysis
- Speed profiles, 85th percentile, percent in any range, for any location gate or turning movement
- Gap availability distributional analysis and summary statistics
- Proactive Left Turn Warrant Analysis
- Mid-block Pedestrian Crossing Conflict Analysis Study
- Before-after studies documenting change in safety levels and mode shift
- Cross sectional research studies investigating the effects of design elements on conflict frequency and severity

Experience and Awards

Experience and Awards

Miovision safety technology has been used to complete video conflict analysis studies in more than 100 cities globally in Asia, Europe, Canada, and the United States. Miovision's video conflict analysis study technology has been awarded the following prizes:

- 2023 Japan Ministry of Highways DX Grand Prix Award for Excellence - First Prize, in association with Miyagawa, Oriental Consultants, and City of Tokyo
- 2022 Intertraffic ITSUP 2022, Amsterdam NL - First Prize
- 2022 Transportation Association of Canada Road Safety Engineering Award - First Prize, in association with York Region and EXP Group Consulting
- 2021 South By Southwest Smart Cities Pitch, Austin Texas - First Prize

Case Studies

Case studies from Austin, Los Angeles, and York Region are presented on the following pages.

CITY OF AUSTIN - VIDEO ROAD SAFETY AUDIT AT LAMAR BLVD and MORROW STREET

Products

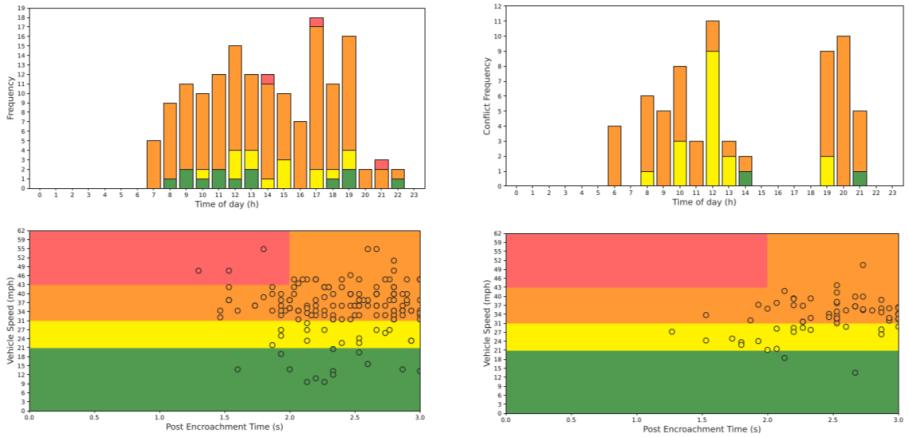
Intersection Video Conflict Analysis Study
Video Road Safety Audit (Recommended Improvements, Professional Services)
Before-After Study
Speed Profiles Add-On

Case Study Description

In 2020, Miovision technology was applied to produce an *intersection video conflict analysis study* containing data on the type, frequency, and severity of near-misses at the subject intersection. *Speed profiles* of turning vehicles at specific risk points were also generated as a study add-on. The Austin Transportation Department engaged our professional services team to produce a *video road safety audit* containing recommended countermeasures to address the key risk factors.

The study revealed that some specific conflict configurations were subject to abnormally high risk levels, with risk levels 6 times higher than benchmarks. The professional services report brought forward a program of low-cost countermeasures, including improvements to signage, crosswalk pavement markings, modification of right turn geometry, and some changes to traffic signal timings in the PM peak period.

The City of Austin implemented the recommended countermeasures over the following two years, and completed a risk reduction before-after study in 2023. The after data showed that high risk conflicts dropped by 63% for all modes, and by 80% for vulnerable road users: a dramatic step towards vision zero.



Before (R) vs After (L) Conflicts at Lamar and Morrow, Austin TX

CITY OF LOS ANGELES - VIDEO ROAD SAFETY AUDIT AT LA BREA and ADAMS

Products

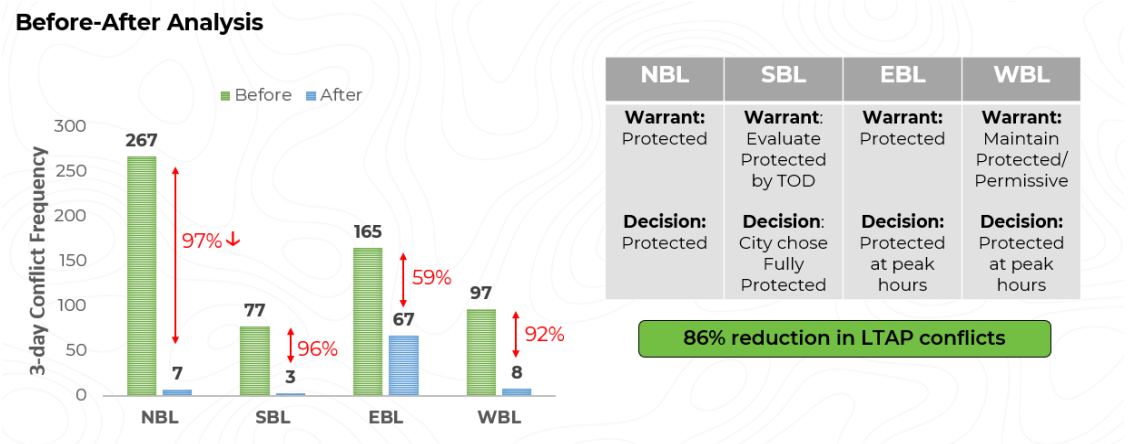
Intersection Video Conflict Analysis Study
Video Road Safety Audit (Recommended Improvements, Professional Services)
Before-After Study

Case Study Description

The City of Los Angeles (LA) has identified a high injury network representing approximately 600 of its total 5000 signalized intersections. LA has assigned 98 of these intersections to Miovision to perform intersection video conflict analysis studies and video road safety audits. When LA completes the installation of countermeasures recommended in the video road safety audit, Miovision completes another video study to measure the before-after reduction in risk.

Two risk factors stood out dramatically in the intersection video conflict analysis study. First, the northbound left vs southbound through conflict configuration experienced more than 260 conflicts during the 3-day study period, and more than half of these were high or critical risk. Second, the southbound right vehicle movement presented elevated risk levels to vulnerable road users when exiting the intersection, with 30 pedestrian conflicts and 8 cyclist conflicts involving this movement.

Road safety specialists from Miovision's professional services group provided a program of recommended countermeasures to precisely target the above two risk factors, as well as the other risk factors identified in the before study. The City of Los Angeles implemented these countermeasures and obtained an overall risk reduction of 86%.



NBL	SBL	EBL	WBL
Warrant: Protected	**Warrant**: Evaluate Protected by TOD	**Warrant:** Protected	**Warrant:** Maintain Protected/ Permissive
Decision: Protected	**Decision**: City chose Fully Protected	**Decision:** Protected at peak hours	**Decision:** Protected at peak hours

86% reduction in LTAP conflicts

YORK REGION, ONTARIO - BEFORE AFTER STUDIES AT FOUR INTERSECTIONS

Products

Intersection Video Conflict Analysis Study
Before-After Study

Case Study Description

York Region is home to 1.1 million people and is part of the Greater Toronto Area in Canada. The Region was interested in improving pedestrian and cyclist safety at intersections which were performing poorly according to crash network screening data.

The Region used the engineering firm EXP Group through a roster arrangement to conduct road safety audits of these intersections, and the Region asked EXP Group to obtain an Intersection Video Conflict Analysis study to help diagnose the most important risk factors for precision interventions.

Precision interventions were important to the Region because some of the safety interventions can increase signal delay, and the Region only wanted to apply them where the risk data showed they were necessary.

EXP Group identified precision low cost treatments based on Miovision risk data. The region installed these treatments and then Miovision measured the achieved risk reductions. The Region achieved a 94% reduction in conflicts. They won provincial and national awards for this project.

Intersection	Vehicle-Pedestrian/Cyclist Conflict		Vehicle-Vehicle Conflict	
	Before	After	Before	After
Bathurst Street (Y.R. 38) and Carrville Road/Rutherford Road (Y.R. 73)	12	1	14	0
Bathurst Street (Y.R. 38) and Clark Avenue	35	3	78	0
Major Mackenzie Drive (Y.R. 25) and Bayview Avenue (Y.R. 34)	222	18	32	0
Yonge Street (Y.R. 1) and Clark Avenue	27	2	4	0

LOW-COST TREATMENTS

No RTOR
Protected Left
LPI

RESULTS

94% conflict reduction

(100% for vehicles and 92% for VRU)