The Use of ITS Technologies in Collision Response and Investigation

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Presentation Abstract:

Bellevue traffic engineers are utilizing Intelligent Transportation System (ITS) and cutting-edge technologies to alleviate traffic congestion and promote safety. Our response to collisions includes utilizing tools such as instantaneous 911 call notifications, traffic camera systems, and an adaptive traffic signal system. The use of ITS technologies helps engineers become proactive with short-term traffic congestion relief at the onset of a collision.

By viewing collision video footage then comparing with both police reports and traffic signal history data, engineers develop a better understanding of human behaviors and collision contributing factors. The discovery and understanding of what "actually" happened and led to a collision is often shared with the Police Department. Footage is also released via public records requests. Collision footage can facilitate investigations and promote fairness to all involved parties.

The use of ITS technologies can facilitate implementing long-term engineering solutions that reduce congestion, human frustration and the potential for future collisions. Understanding contributing factors and the events that led to a correctable collision may help identify hot spots and lead to engineering solutions such as re-configuring intersection channelization, traffic signal phasing/timing, and corridor synchronization improvements. Reducing the potential of collisions allows agencies to get closer to Vision Zero, which is a noble goal to try to eliminate serious and fatal injury collisions.

Background:

Bellevue, Washington is located 10 miles east of Seattle. Its population now stands at 142,400, and the city supports more than 148,000 jobs. It is booming with rapid growth. By 2035, Bellevue's population is projected to top 160,000 and jobs are projected to exceed 195,000. Bellevue's Transportation Department promotes livable communities. Mobility for people and goods is a must to support the city's economic development plans. Bellevue strives to facilitate access for all people and is rapidly implementing multimodal facilities throughout it's transportation system.

Today, there are well over one million daily trips to, from, within, or passing through the city. Some of our intersections serve up to 80,000 vehicles per day; but we can't build our way out of traffic congestion. Due to roadway capacity limitations within the available right-of-way, there is competition among transportation modes and use of available resources. The fact that there is a strong correlation between traffic volumes, congestion, human factors and collisions, Bellevue's ITS engineers face a big challenge: How to keep all modes of transportation moving safely and efficiently.

Bellevue has been at the forefront in adopting new technologies. By 2016, we became 100 % adaptive and operated all of our 200 traffic signals via an adaptive traffic signal system called Sydney Coordinated Adaptive Traffic System (SCATS). SCATS took five phases and five years to implement citywide with a price tag of $5.5 million.

Bellevue has adopted a Smart Mobility Plan. It has also been rapidly implementing improvements and working towards a complete street network. Since we are dealing with human factors that affect our decisions, we view signal coordination as a part art, part science.

In traffic signal operations, an engineer's goal is to move all modes of transportation in the most efficient yet safe manner. Even though this may seem counterintuitive, we recognized that improving the efficiency of the transportation system actually results in improvements to traffic safety for all modes and this may happen directly or indirectly. Following are our objectives for signal timing and synchronization:

- Maximize throughput for arterial green bandwidth; yet utilize the optimum cycle length to satisfy and balance volume and mobility needs for all modes of transportation.
- Balance and minimize user delay of all modes of transportation including pedestrians, bicyclists and drivers, which may encourage compliance to the rules of the road and eventually reduce collisions.

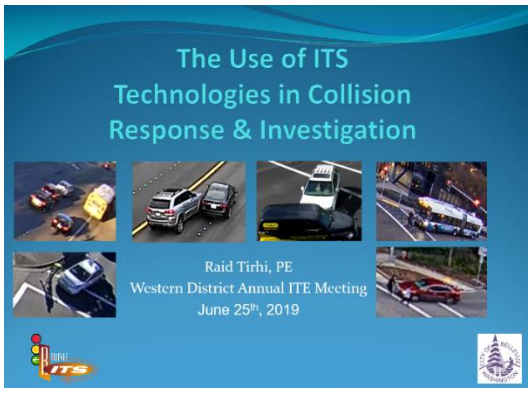
- Minimize the number of stops at synchronized signals along a corridor, hence, reduce running red lights and rear-end collisions.
- Manage traffic queues to reduce left turn blocking the through lane and the associated sideswipe collisions.

For all above reasons, Bellevue has focused on maximizing the use of existing infrastructure more efficiently and invested heavily in smarter traffic lights.

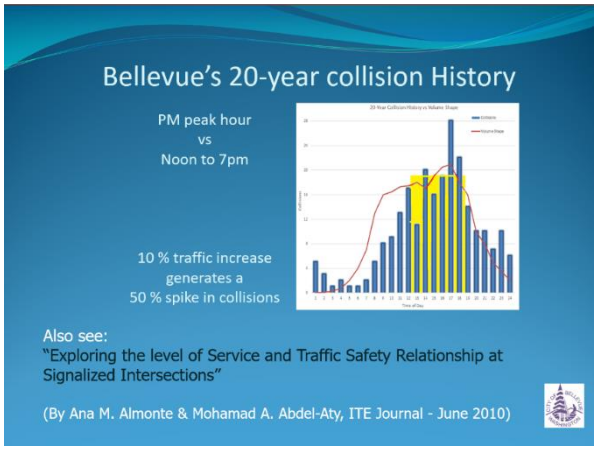
We understand that for every action there is a reaction and unintended consequences. Therefore, moderation is best. For example, if we utilized 10 seconds of yellow clearance interval instead of the calculated four seconds for one of the traffic signals, we could violate driver's expectancy and increase rear-end collisions. Utilizing overly conservative assumptions may lead to unsafe designs and being conservative may sometimes reduce safety instead of improving it. Due to the strong correlation between mobility and collisions, we find ourselves consistently balancing efficiency and safety needs. Traffic operation engineers should never sacrifice safety, but if they push the efficiency to the maximum extent feasible, they can balance outcomes and the safety need.

Transportation professionals are moving forward toward Vision Zero. We place greater emphasis on serious and fatal collisions to accomplish such a goal. While engineers may not be able to eliminate all collisions, we strive to understand the real issues and have the obligation to implement innovative and best practices to reduce overall collision probabilities. Bellevue is now utilizing ITS technologies in collision response and investigations.

The Use of ITS Technologies is Collision Response and Investigation:



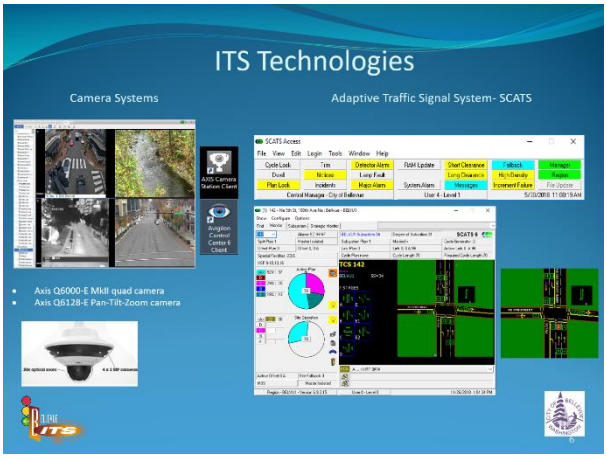
Bellevue engineers have been investigating local collision reports for the last 22 years. We also reviewed over 1,000 collisions that were recently captured by Bellevue's traffic cameras. It became obvious that erroneous human behavior across all modes of transportation is clearly a critical factor for well over 94 % of the collisions as indicated by national research papers.



The question is how many of those collisions can be corrected and how can engineers build safer systems to change human behaviors and outcomes? We believe that engineers placing themselves in the driver's seat during all aspects of their designs and actively looking for clues and collision patterns will help. Reviewing and understanding collision statistics, and that we are dealing with human life should encourage engineers do their best to make a positive change and reduce collisions.

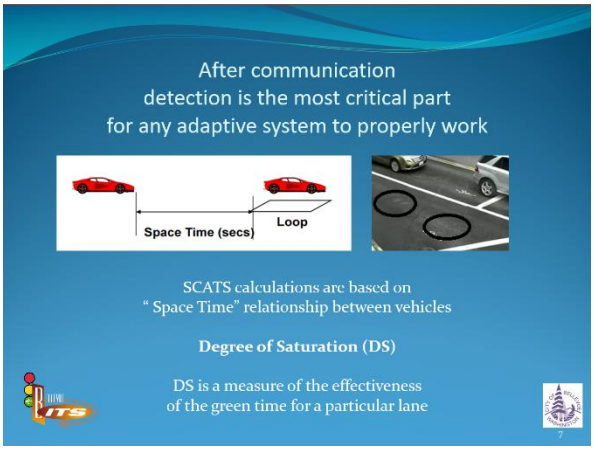
Bellevue's collision history data as well as national research indicate that urban evening peak hour traffic gridlock (LOS F) results in a significant increase in collisions. The local collision frequency rate during gridlock conditions shows an exponential increase compared to the hourly traffic volume rate as well. Bellevue's ITS engineers strive to be proactive in easing gridlock and improving traffic flow. We believe that reducing human frustration and distraction reduces the potential for erroneous human behavior which ultimately reduces collisions.

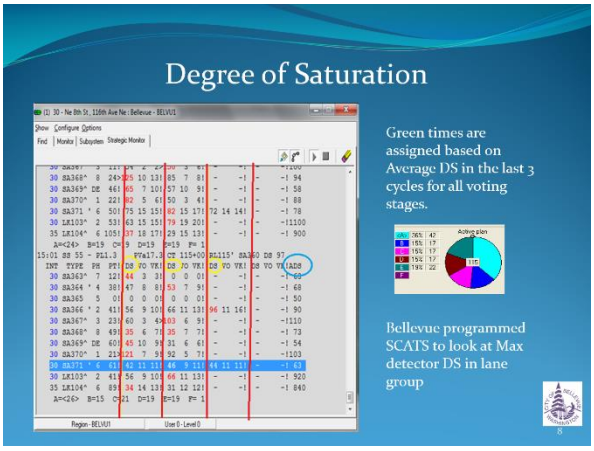
ITS Technologies:



Bellevue has already installed traffic cameras at half of the intersections with traffic signals. Because of the benefits and positive experience with the camera system, we plan to install cameras at all signalized intersections. We are also trying to maintain saving 30 days of camera footage at all locations. Some engineers might be concerned regarding saving footage fearing it will consume a lot of their valuable time by responding to public records requests. But what we found out is that by saving a few seconds of a collision footage saves us time instead of responding to attorney's calls and subpoenas trying to explain and answer questions regarding signal timing parameters and sequence. If a picture is worth a thousand words, then a short 6-second video clip can be worth a million words.

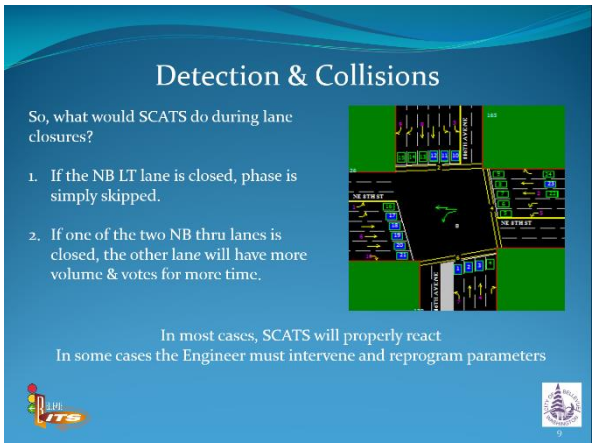
Bellevue is known for being a "Smart City" and at the forefront of adopting and innovating new technologies. We were the first agency in Washington state to implement an adaptive traffic signal system. Once we experienced the efficiency and safety benefits, we expanded the system citywide and became 100% adaptive. We received an ITE Transportation Operations Achievement Award in 2016.





Detection is a critical component for any traffic signal system to work properly. The SCATS signal system depends heavily on detectors. Detectors calculate the level of congestion known as the Degree of Saturation (DS). The system automatically implements several decisions such as split, cycle and offset. It can also trigger special functions based on preprogrammed conditions.

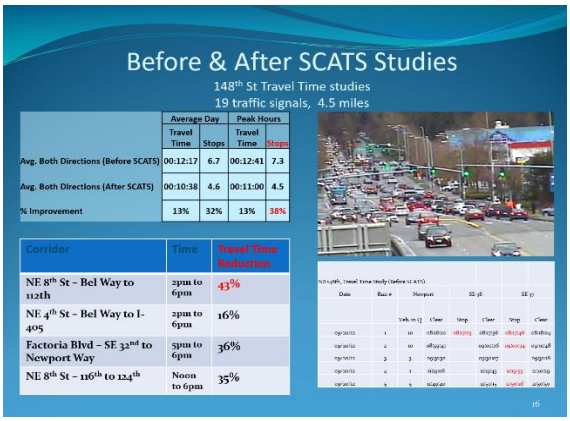
In the case of lane closures due to construction or a collision, detectors sense the change in demand for any specific lane and react accordingly.

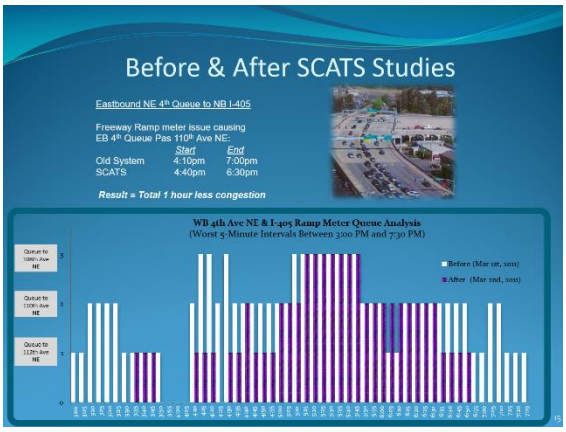


Before and After Studies:

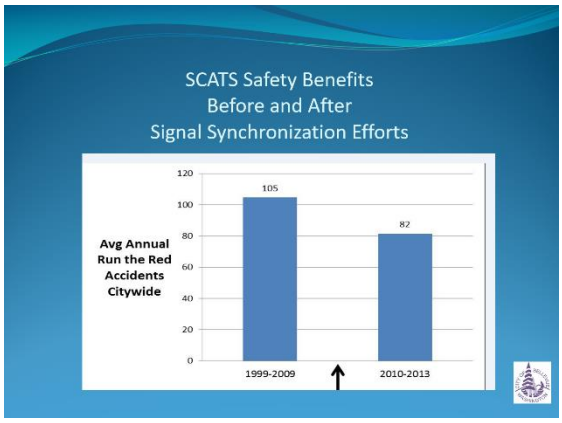
For each SCATS phase of implementation, we conducted before and after travel time studies. We documented where drivers stop, for how long, and total travel times along a corridor. For example, 148th Avenue carries an average of 40,000 vehicles per day and has 19 traffic signals within a 4.5 mile stretch. Before and after studies yielded up to 38% reduction in the number of through stops. Implementing SCATS on other principal arterials, such as NE 8th Street in downtown,

yielded up to 43% improvement in total travel time or reduced evening peak hour gridlock for one hour at a freeway interchange.

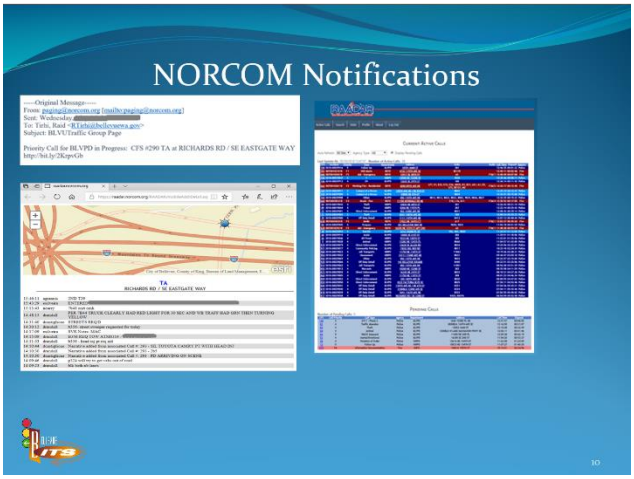




We believe that moving traffic efficiently yields safety benefits in collision reductions. A review of our collision database and a comparison of before and after SCATS implementation indicates a 22 % reduction in red light running collisions. It appears that our efforts towards improving signal timing and synchronization, reducing stops and delay, utilizing the smallest cycle length possible to improve the overall level of service for all modes of transportation all yielded additional safety, societal and environmental benefits. We are very satisfied with our adaptive signal system and believe the benefits to the traveling public are measurable and compelling.



NORCOM Notifications:

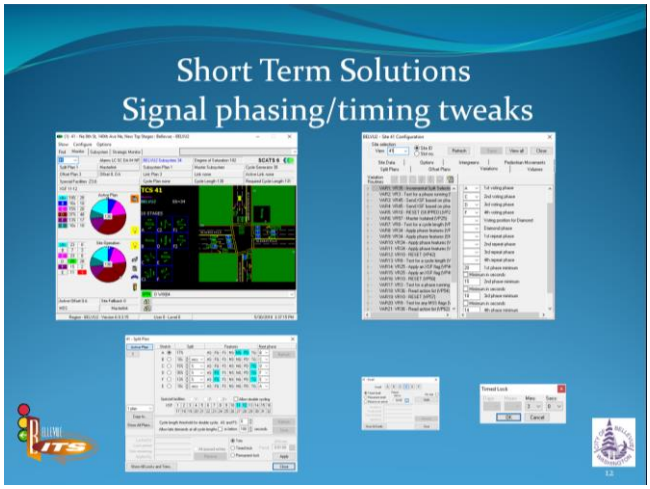


Bellevue is a High Performing Organization (HPO) and has adopted a "One City" approach. We encourage collaboration and support across all departments. For the past couple of years and whenever a collision happens, ITS engineers now receive an emergency notification from the dispatch center that allow to us be proactive, efficient and highly responsive.

Short Term Solutions:

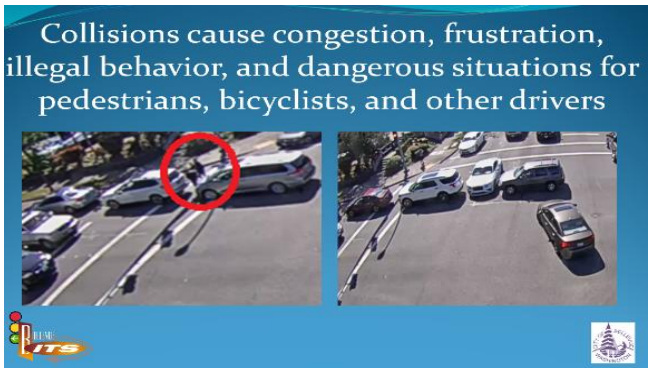
It is well known that some collisions can gridlock a roadway system and result in building traffic queues that take hours to clear after the obstruction is removed. With proper notification and tools such as traffic cameras, engineers can better understand conditions, assess the situation, and react accordingly. Now, Bellevue engineers can minimize or resolve congestion situations before they escalate.

In most cases, SCATS will properly react and self-adjust parameters relatively quickly (especially during non-gridlock conditions). But in some cases, the engineer must intervene and change SCATS parameters to diffuse congestion much faster than the system.



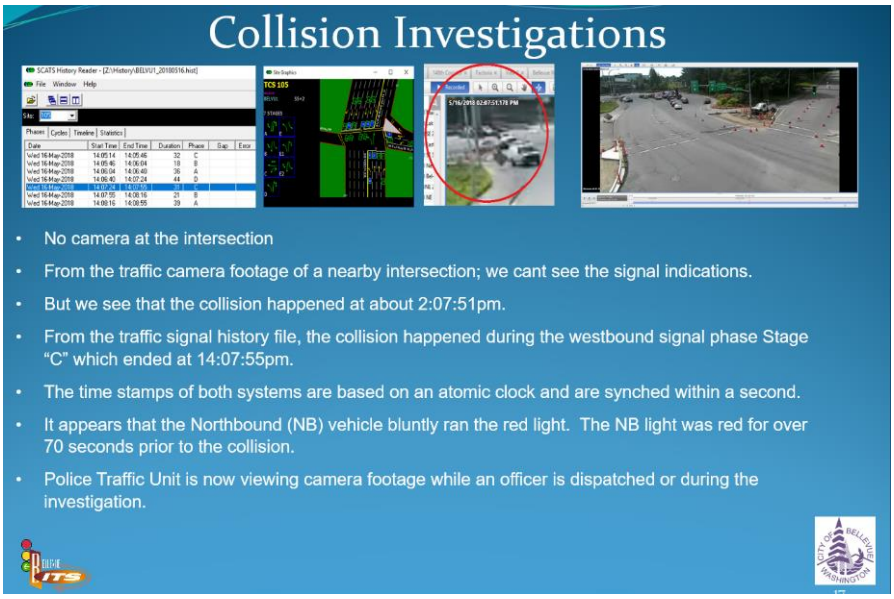
For example, if an emergency vehicle is standing on the detector and unnecessarily calling and extending a green phase, or if the road ahead is standing still, we temporarily skip the left turn phase since there is no place for them to go to and the receiving lane is already gridlocked or closed.

A proactive and expedient response will improve safety for both the primary and any potential secondary collisions including pedestrian or T-bone collisions.



Collision Investigations:

Bellevue Police Department is impressed with the Transportation Department's traffic camera systems and frequently use it in collision and other investigations. In several cases, Police will review camera footage just before an officer arrives to the collision scene.



Long Term Solutions:

Collisions are usually referenced to the nearest intersection in accidents reports. In some cases, the root cause is a result of traffic conditions at a downstream intersection. If we see an unusual number of rear-end collisions, it triggers us to improve the situation simply by tweaking the offset time instead of recommending more green time or increasing the signal cycle length. Changing lead/lag left turn phasing can also help mitigate the issue and still accomplish two-way synchronization.

Flashing Yellow Arrow (FYA) and Collisions:

We innovated a new signal phasing within the SCATS system and called it an "Adaptive Flashing Yellow Arrow (FYA) with Ped Minus Phasing". Utilizing detectors at strategic locations, we identify if a traffic queue is blocking sight distance for a left turning vehicle, then omit the permitted FYA phase for those cycles that meet the engineer's threshold. We may also program to skip the permitted FYA portion of the left turn signal phase if a pedestrian activates the push button on the sidewalk with the conflicting movement.

When engineers review traffic camera footage in conjunction with reading the associated collision report, they have a better understanding of what exactly happened instead of what a driver claims. A comprehensive review helps us in investigations, research, and engineering recommendations.

For example; with the help of video footage, we discovered that a high percentage of the collisions that are at intersections with FYA phase are actually happening during the clearance interval for the left turn phase. We believe that when drivers push the limits and illegally enter the intersection on the FYA without an obvious gap in traffic, they trap themselves in the middle of the intersection. Then feel forced to complete their maneuver during the last second of the yellow change interval. Unfortunately, at that point in time, the opposing through vehicle (which also share the same yellow interval) is unable to stop because they legally made the decision to continue moving straightforward.

Another example of collisions occurring at intersections with FYA is the use the lead/lag left turn phasing. Recently, there is a fear of a "Perceived Yellow Trap" concern in the ITE community. We conducted in depth investigation of all Bellevue collisions since implementation of FYA for the last 11 years. Our finding is that is there was no strong collision correlation between the two; Bellevue's experience is about a 54/46 for the collisions occurring on the leading and lagging phases respectively. While our study finding may not be the same as other agencies. This might be because our local drivers are already used to (or mentally trained to) the lead/lag left turn protected phasing.

Engineering Solution Limitations:

Even though the rules of the road are clear, some drivers need reminders to avoid bad driving habits. For example, when we noticed a sideswipe collision pattern for bus drivers going over their lane line on a dual right turn movement, we contacted the safety officer for the local transit agency. We asked them to encourage bus drivers to simply turn wide into the proper receiving lane (Education solution). We also installed chevron lines with raised pavement markings (RPMs) as guidance and to enhance the separation between moving vehicles (Engineering solution).

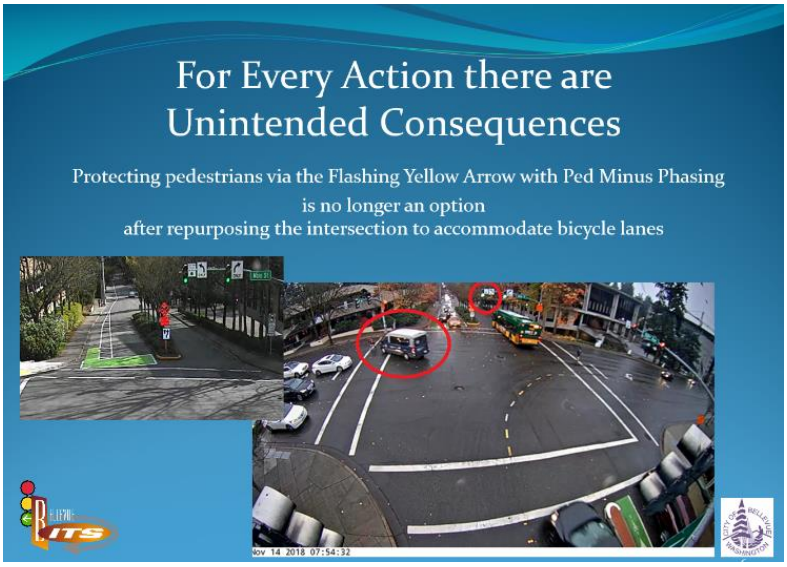
We resolved the issue for a few years, but we recently noticed one collision per year for the past two years. Additional signage or a physical barrier are not the best option at this location, but it appears that the Education and Enforcement options need to be frequently visited if we desire to eliminate such collisions at the subject location.

Efforts in Education:

Since the biggest issue to be resolved is correcting erroneous human behavior that leads to collisions, we use several educational tools to deliver safety messages. For example, we conduct Traffic Management Center (TMC) tours to provide safety tips for people of all ages who use all transportation modes. We emphasize on how to properly behave at intersections to prevent harm to themselves and others.

Case Study and Lessons Learned:

For every action there is a reaction that often includes unintended consequences. In limited right-of-way scenarios, we recognize that when we repurpose lane use to promote one mode of transportation over another, we introduce system inefficiencies and may have to deal with safety implications for other modes of transportation. For example, when we removed a travel lane and converted it into bike lanes, we reduced intersection capacity. Now, drivers suffer additional delay and appear to behave more aggressively when making left turns on a permitted movement. This resulted in increasing the conflict and exposure with pedestrians at crosswalks. Unfortunately, a FYA with a Ped Minus operation is no longer an option since there is no remaining right-of-way for a left turn lane.



A “Pedestrian Jump” could be an alternative accommodation for pedestrian safety for specific movements. But is not necessarily a safety solution for all pedestrians as pedestrians could be moving in all directions. Therefore, the ped jump is not necessarily going to eliminate all pedestrian collisions and may place some of them in the conflict zone.

Unfortunately, balancing the need of a complete street network that is efficient and safe introduces new challenges for transportation professionals to resolve.

Conclusion:

It is critical to work on fixing a specific issue and deal with it at its origin instead of patching up a symptom of a by-product. When we investigate collision patterns at a particular location, we might be able to find solutions that are unique to those special circumstances, conditions or contributing factors. But we should not generalize solutions citywide unless we have local data or credible applicable research to support a standard operating procedure or a policy.

We recognize that traffic engineers can’t always control human behavior, but it is our obligation to do our due diligence to reduce the probability of collisions. Furthermore, transportation professionals can get closer to Vision Zero if they enhance and invest more resources towards safety education programs for drivers, pedestrians and cyclists.

Finally, collaboration and providing support to partners in the vehicle design industry and facilitating smarter vehicles that connect to city infrastructure. Smarter designs may allow vehicles predict and react to a potential collision faster than humans may hopefully prevent or at least reduce collision frequency and severity.

Final Remarks:

We hope that this presentation reduces the fear of using smart technologies such as adaptive signal systems and recording camera footage. It sheds some light on the safety advantages for utilizing technology in collision response and investigations. Hopefully, this presentation will encourage public agencies to facilitate safety education programs and adopt ITS technologies in order to reduce future traffic collisions and therefore get closer to Vision Zero.