Implementing ICE: Overview of the Updated CAP-X and New SPICE Tools

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 [0:00:00 SLIDE 1 OPENING]

Operator:

Please stand by. We are about to begin.

Ladies and gentlemen, thank you and welcome to the FHWA ICE Overview U.S. Department of Transportation conference. Participants are in a listen only mode. Later we will conduct a question and answer session.

I would like now to turn it over to the host, Jeff Shaw.

Jeff Shaw:

Good afternoon and good morning. My name is Jeff Shaw I'm with the FHWA office of safety and I manage the intersection safety program. I'm pleased to present this webinar today. We are excited about introducing new tools one new, one updated that supports intersection control evaluation (ICE) policies and procedures. This is the culmination of months of work and we will go into detail about why we are producing these tools and what we hope to accomplish. To start I would like to welcome everyone, once again.

[0:01:15 SLIDE 2 WEBINAR OUTLINE]

Jeff Shaw:

The outline for today's webinar, I will begin with an overview about intersection control evaluations, the motivation for the project, who is our team and where do we see these tools fitting into overall ICE efforts. Pete Jenior will present on the SPICE – Safety Performance for Intersection Control Evaluation – Tool and Bastian Schroeder will present on the updated CAP-X – the Capacity Analysis for the Planning of Junctions – Tool. We will have time at the end following the presentations for Q&A. During the presentations, they will do some live demo of the spreadsheet tools so you will be able to see exactly what the spreadsheet environment looks like, the different tabs and entries and get a good feel for how the tool works. I mentioned in the chat pod that I will reopen the file download pod after presentations are concluded. We did that have that open prior to starting and we will have it open concluding the webinar.

[0:02:43 SLIDE 3 ACKNOWLEDGEMENTS]

Jeff Shaw:

I would like to acknowledge the support of the Highway Safety Manual Implementation Pooled Fund. It's one of our jointly funded efforts with many States, in this case, advancing the implementation of Highway Safety Manual procedures and techniques. This was a partnership with the HSM Implementation Pooled Fund to produce the SPICE Tool. We jointly funded this project together and

added the update to the CAP-X using FHWA program office funds. It's a great example of partnerships with States on high priority initiatives.

[0:03:25 SLIDE 4 POLL QUESTIONS]

Jeff Shaw:

At this time, I have a few polls to ask you to participate in. Let me open those up. Some of them are typical, how many people are watching the webinar where you are from and what type of organization are you representing. If you would please answer those polls. We like to know -- we have a good idea of who our audiences state and local agencies, consultants who work for state and local agencies, it's good to know if we have new people in the audience. Of course, familiarity with intersection control evaluation policies and procedures. It's growing in use so we expect there is some familiarity, but probably a lot are hearing about it for the first time. I appreciate your voting in the polls. I have broadcasted the results. In question number one, the majority of people are watching this alone but we have several groups, a couple dozen. That's great. Organizationally, the majority of folks come from state DOTs. A lot of consultants which is good to see and sprinkled in we have some of my compatriots from Federal Highways and the university and academic worlds. Finally, on the third question ICE familiarity, it looks like we have an interesting split. A little over one third of the people are learning more about ICE, and half have heard about ICE before. A smaller proportion have hands-on experience preparing ICE reports. It's great to see that we have a majority of people that are familiar with ICE and welcome to those of you who are new to ICE. Hopefully, after the webinar you will have a better sense of what that's all about.

[0:05:53 SLIDE 5 PROJECT BACKGROUND AND OBJECTIVES]

Jeff Shaw:

For the background, a couple things motivated this. We've had steady implementation of innovative intersections and interchanges, and Federal Highways has promoted alternative and innovative intersections for years. Our efforts to promote the implementation of roundabouts goes back 20 years. Other intersections are the U-turn-based designs and the crossover-based-designs, those are more within the last decade. The good news is we have seen increasing implementation. We featured these in our Every Day Counts 2 initiative in 2013-14 and as a result more agencies are building these. They are safer and proven to reduce severe crashes, the types of crashes where people die in or are severely injured. This is a good thing. The hard thing is that we have so many more choices. Literally, if you look at different geometric types along with the different variations in the types of control whether the use stop, signal control etc. – when you look at the options there are several dozen, proven options. That's a lot to sort through on every intersection project. As a result, we have states and even some local agencies looking to adopt intersection control evaluation or ICE policies. These are frameworks for sorting through which intersection types and controls make the most sense for a project.

[0:07:47 SLIDE 6 PROJECT OBJECTIVES]

Jeff Shaw:

The point of this project was to develop tools that make it easier to quickly scope the different alternatives that are available to you as a practitioner. We have two different tools that support looking, one at safety the SPICE Tool, and one at operations the CAP-X Tool. These are both intended to be used as scoping or early screening tools. These are not intended to be the tools you would use for final design or final decision. There are other tools available to do that. Spice may be an early tool for safety performance, once you have a refined alternative and you are down to one alternative and a no-build, you would be looking out a full Highway Safety Manual evaluation. For capacity, CAP-X Tool will let you screen from alternatives to see which would basically provide competitive operational quality. Later in the project, after you refine the alternatives you would be doing a full-blown HCM or using a third-party vendor tool to look at the operations and get a better understanding. This project is to create tools used on the front end.

[0:09:17 SLIDE 7 POLL QUESTIONS]

Jeff Shaw:

With that said we have a couple more poll questions just to find out what kind of familiarity you might have with these tools. The first question will be about your experience, if any, with CAP-X. CAP-X has been out for many years now. What we are showing you today will be an update to CAP-X. And, we are just curious have you used HSM methods to screen intersection alternatives before. Great activity in the voting pods, thank you very much. Interesting. It looks like for CAP-X experience roughly 1/3 of folks have used it before. The clear majority have not. That means that we appreciate you turning in today and learning more. Hopefully, you will find this tool useful in your efforts going forward. For HSM screening it's a bit more of a close to even split. About half the folks dialed in have used HSM methods to screen intersection alternatives and half have not. That's also good. Hopefully that means those of you familiar with the HSM methods will be able to dive right into the SPICE Tool and use it right away. Those who have not, hopefully you will find the SPICE Tool to be a good first step towards using the HSM on your projects. Thank you, for your voting. We will close those.

[0:11:05 SLIDE 8 WHAT IS ICE]

Jeff Shaw:

Let's quickly talk about what is intersection control evaluation or ICE, as we refer to it. ICE is the performance-based framework to utilize a consistent process and objective metrics to look at all of these different, dozens of intersection alternatives that are now proven to work in the U.S. ICE consists of two pieces – the policy part says you must do this each and every time you have an intersection project and the process piece which says here is how we want you to do it. Typically, ICE is done in two stages. The second stage, the alternatives selection stage, is the one that should be familiar to most people. This is basically the preliminary engineering analysis that we are already doing. What ICE adds into the mix is the screening step. With so many different alternatives available to us, whenever we have and intersection project we need a way to whittle that list down in a useful, but efficient way. ICE is the way that states and local agencies are looking to do that now. The idea is that it applies to all access related decisions. It's a way to leverage safety performance criteria into early stages of a project. While

they were still scoping out what should we look at for an intersection improvement. It promotes consistency, transparency and objectivity when we look at intersection projects. Instead of someone coming in say with a new development and saying I want a signal here and there and a driveway here and so on. Rather it would be let's back up and look at using in the ICE procedures which intersection types are the ones that meet our goals for safety and mobility along this piece of roadway. The last thing ICE does, it leaves the door open for future innovations. We wouldn't have so many intersection types to choose from if some state or local agency wasn't willing to try something new. There are probably new innovations and intersections we have not tried here in the U.S. Having this ICE procedure in place, having the framework allows us to be more open to saying, none of these other things look like they will work let's try something new.

[0:13:51 SLIDE 9 EXAMPLE ICE PERFORMANCE CRITERIA]

Jeff Shaw:

To give you a sense of what performance criteria states and local agencies are using in their ICE procedures. This should be a familiar list. For a lot of agencies, safety, this is the first chance to use HSM-based methods to screen alternatives and to really look at it in terms of the number of crashes and the number of severe crashes. To differentiate the alternatives based on that safety performance. Operational quality, we are used to that and we will continue to look at that. For nonmotorized users for walking and biking, this is a chance to look at the alternatives and see among the different choices available, what might be the best choice for a complete streets approach. More states have Complete Streets policies so we need the ICE performance criteria to reflect that. The right-of-way, environmental impacts, costs both construction and lifecycle and overall feasibility are things you can incorporate into your ICE performance criteria.

[0:15:07 SLIDE 10 STATES WITH ICE POLICIES]

Jeff Shaw:

The last slide before I throw it over to Pete is to say ICE is growing at a pretty rapid pace. If you look at this map, this reflects current state of ICE policies in America. We currently have nine states with ICE policies. Prior to 2013, just five years ago, prior to that point there were only two – Minnesota and Wisconsin. In 2015, we added California, Indiana and Washington to the list of states with ICE policies. In the last 2.5 years have added Georgia, Florida, Nevada and Pennsylvania. If you look at the hatching you can see there's a tremendous amount of activity and several states which are looking at policies or language to put in their manuals. There are other states that are not shaded yet, who have inquired about ICE and want to know more about it, and I think in short order will be developing ICE policies and procedures of their own. This is where states are going, this ICE approach to looking at different intersection alternatives and vetting them through a process. Next, we will talk about the SPICE Tool and CAP-X Tool. Pete, please talk about the SPICE Tool.

[0:16:51 SLIDE 11 GENERALIZED ICE PROCESS AND ROLE OF TOOLS]

Pete Jenior:

Thank you, Jeff. Just a final note before we move on, the vision here with ICE is screening out alternatives. There are a variety of tools available that states have developed on their own that various individuals use. The two key Federal Highway tools are the CAP-X Tool for operations which already exists and is being updated and the SPICE Tool which is brand-new. We are going to talk about SPICE Tool first because it's newer and there are fewer people familiar with it. I will cover that presentation.

[0:17:30 SLIDE 12 SPICE TOOL VISION AND NEED]

Pete Jenior:

The vision, the need for this tool, safety comparisons are becoming more common at intersection level but they can be challenging if we want to compare a signal versus a stop sign. HSM has pretty clear ways to do that. For the most part, we are looking at roundabouts and alternative intersections and newer forms in ICE. They can be more challenging to analyze. There are a lot of crash modification factors in the clearinghouse, what should someone use when they are analyzing an individual project if there four factors for restricted crossing U-turns, what's the best one to use, how do they get applied? Do you apply it to an existing condition, or to another alternative, if the CMF alone did not tell you, or if it made some modification and how is that linkage made? There are new safety performance functions developed for the second edition of Highway Safety Manual they are available in various reports that maybe not everyone knows how to find or they are available and reports not in analysis tools. The goal for the SPICE Tool was to bring all these together but yet keep it at a manageable level of effort for screening alternatives.

[0:19:09 SLIDE 13 SPICE TOOL OVERVIEW]

Pete Jenior:

The SPICE Tool is focused on intersections alone and it looks at both at grade intersections and ramp terminal intersections. We could do an analysis of a traffic signal versus a stop sign versus two-way stop control at-grade or we could look at a ramp terminal intersection and analyze should this be an interchange with signals, should this be an interchange with roundabouts at the ramp terminal, should it be a diverging diamond interchange. The SPICE Tool analyzes those, but the interchanges are limited to diamonds. In the Highway Safety Manual, there are ways to analyze ramp terminals of partial cloverleafs, diamonds or ramps don't align, and various other forms but the goal for this tool was to be focused on that simple a case the diamond intersection which is most relevant to alternative forms. That's what the SPICE Tool analyzes, referred to as a D-4 type in the HSM. Simultaneous evaluation we are choosing a type of control so we want to analyze many types at once.

[0:20:39 SLIDE 14 SPICE TOOL CRASH PREDICTION]

Pete Jenior:

Basic logic behind the scenes of the SPICE Tool. We want at the top of this chart we want the predict of safety of an alternative. If there's a safety performance function then we go to the left side and use that safety performance function. If there's not we look for a crash modification factor. That crash modification factor could then be applied to an existing condition or another alternative. If we don't have a safety performance function or a crash modification factor then the SPICE Tool does not provide crash prediction. This is limited to things where there have been safety studies, using crash data collected in the field. There's nothing in the SPICE Tool based on conflict points or other surrogate measures. The advantage is that there is consistency. Some newer intersection types are not included in the SPICE Tool.

[0:22:00 SLIDE 15 CONTROL STRATEGY SELECTION]

Pete Jenior:

I appear to have lost my connection. I will continue. Now we're going to look through key screens of the SPICE Tool. The SPICE Tool is made in Excel. We will open up that file in a minute and get a closer look. For now, we are going to look at screenshots and talk at a high level about how the tool work is. A user specifies basic information like are they looking at an interchange or an intersection, are the only interested in the opening or would they like the entire analysis. A user will specify which types of intersections they want to look at. This screen shows different at grade intersections and the majority aren't turned on. Turning them off means a user is not entering information and they are not displayed in the results. There will be many projects where it's known that something may -- a given intersection type won't be feasible and there is no need to carry that through the analysis if you don't want to. If you're on a rural, two lane highway and you are looking at a site in your primary focus is on a traffic signal or roundabout, you don't need to analyze alternative intersection forms that require immediate. That makes no sense in the context of that project. We want to carry through results. While this is intended to be a screening level tool there's a recognition that there will be obvious analysis that a second -- certain intersection makes no sense at a certain location.

[0:23:55 SLIDE 16 INTERSECTION INPUTS]

Pete Jenior:

Users enter basic information on the intersection form. At the top of the screen and with the light-yellow cells these are simply asking for the number of right turn lanes and left turn lanes at different intersections. If we look at the bottom portion of this slide, where the cells are gold. These are optional inputs that would result in a full HSM crash prediction. These are all of the part C and you might ask for others such as the NCHRP spreadsheets or IH DAs -- DSM. These might be challenging but when you're at the national foot level you might not know if you're going to have elimination or what your signal phasing will be. Default values are provided for those inputs. If you can refine them that's great. Of not you can stick with the default values and you will have a more approximate crash prediction that trends across alternatives, greater are lower numbers of crash frequency from one alternative to another would still hold true.

[0:25:23 SLIDE 17 OPTIONAL CMF OVERRIDE AND CALIBRATION]

Pete Jenior:

A lot of states have started to calibrate the highway safety manual where they have developed state specific calibration factors or even within different regions of the state their own calibration factors. This would enable someone to put those in. This tab also enables new crash modification factors. I did note earlier what if we have four modification factors for restricted crossing U-turn. How do we know which is the best? Here are the spice -- SPICE Tool we made that for you and we put in what we think is the best nationwide crash modification to use for that intersection type. If your state has done your own that's part -- more appropriate to use and there's a way to be entered. Likewise, there are inputs for other intersection types maybe there's a type certainly there are that don't have crash modification factors and maybe a new one will come along. There is no CMF four-quadrant roadway. If the CMF is developed and you are using the SPICE Tool you may enter that in yourself and analyze quadrant roadways. It probably does not need to be used often but maybe one time to adapt something to your state or as a new intersection form comes along, you could import information.

[0:26:57 SLIDE 18 CRASH PREDICTION OUTPUTS]

Pete Jenior:

Finally, we get to the results. I know some of these screens have been hard to see. I'm trying to give you a flavor for what the tool looks like more so than seeing all individual outputs. We will change gears and look at an example where we have my Excel tool opened up.

[0:27:25 SLIDE 19 AN EXAMPLE – EXISTING SIGNAL]

Pete Jenior:

Our example here is a four-lane divided highway in a suburban environment. This is an existing intersection. It's skewed, congested, it has safety and operational issues and alternative intersections are being looked at to reduce crash frequency and congestion.

[0:27:56 SLIDE 20 AN EXAMPLE – TOOL DEMONSTRATION]

Pete Jenior:

We are looking at restricted crossing U-turn's, median U-turns and displaced left turns. These appear to be viable for the site in terms of overall right of way and impact or cost. We will look at different crash predictions for these alternatives. Jeff, could you let me switch over to the Excel tool.

Jeff Shaw:

Yes, I will open up another pod Pete. Let me size it up and then -- go ahead.

Pete Jenior:

You should be looking at the SPICE Tool. I'm going to click through each screen. Some are just informational and here is the cover.

The introduction sheet, there's a disclaimer sheet and then we get to project information.

Here's where you label the project there's nothing computational but we can label what our project is. There's also the functionality to import data from CAP-X. That would be -- there is little data used in both tools but things like a project name, project site cup -- which alternatives are and aren't being used for analysis, those can be input.

We have a definition tab that defines things, terms used in HSM analysis. If you're not sure what counts as a major street through Lane, we were talking about both directions, shared lanes and illustrations at some point the skew angle and that's how that would be measured. Sometimes HSM inputs get complicated. They can be hard to grasp at a single line of text, so this sheet is available if you're unclear about those items.

Now moving onto different control strategies and I have made choices where we will analyze at grade intersections. We will only look at one year of analysis for simplicity but this tool can conduct an entire lifecycle analysis and interpolate ADT in between your opening year and design year to capture crashes at every year. We're in a suburban environment on a 4-leg intersection with 40,000 ADT on the major road and 24,000 ADT on the minor road. We will analyze the existing signal, a displaced left turn, a median U-turn, and a signalized RCUT.

For intersections such as the alternative intersections that only have crash modification factors, there are no more specific geometric inputs needed. If we look at the existing traffic signal, the number of turn lanes has a fairly large impact on crash prediction. A user is required to enter how many approaches have a left turn lane and right turn lane and in this case all four approaches have both. Here we have additional inputs where for a full HSM analysis, we will simply leave the default values for the sake of this example to represent a planning level analysis. We aren't going to go in and determine these. We can do that later if we desire.

Here's the calibration sheet. We have calibration factor inputs for safety performance functions that are all set to 1 and since this is a National tool. We also have all of our crash modification factors in here. This example is not in any particular state so we don't need any calibration. Therefore, we can -- don't need inputs on this tab and we can go to results.

I've already hit the update results button. I will hit it again and we can see the results we have for this particular intersection. We have in one year we have 7.9 crashes at that signal and 2.81 are fatal or injury crashes. We can look through the different intersection alternatives that are included to look at their crash prediction.

To give you a sense of how this tool changes let me go back to the at grade input tab and let's say we only had two approaches with right turn lanes instead of four.

I will go back and hit compute update and now we have higher crash predictions because turn lanes in the HSM reduce crash frequency.

That is a brief introduction to the SPICE Tool it's a quick example that we can revisit later in Q&A, if there is interest and with that I'm going to ask that Jeff turn this over to Bastian.

[0:34:07 SLIDE 21 SPICE EXAMPLE KEY INPUTS]

Jeff Shaw:

Thank you, Pete. I'm going to hide this pod and Bastian you may take it from here.

[0:34:09 SLIDE 22 FHWA CAP-X TOOL]

Bastian Schroeder:

Thank you, Jeff. Thank you, Pete. So, a similar format to Pete's presentation, I will start out with an overview of the CAP-X Tool. It sounds like a third of you have used this tool previously. The general format is consistent with what you've seen before but we are now in version 3.0 of this tool and it's gone through a few updates. We encourage you to check out the latest tool. At the heart of it, it's intended to evaluate the traffic operations and the capacity of these various alternatives of intersections and interchange solutions using critical movement analysis. I will talk more about what that means and the idea, the premise is that it's a quick and easy to use tool with a single input that uses traffic volumes and it's automatically percolated across different intersection types, roundabouts, grade separated intersections and interchanges. On the screen, there are 22 different alternative configurations that are part of CAP-X and the ones in italics are new ones that have been added but the actual number of alternatives is greater because a few of these quadrant roadways for example has four versions, for partial cloverleafs there are options and even for the other intersections there are differences between whether the mainline goes East and West direction or North and South direction. There are 66 different intersection types that can be evaluated with a single volume input for this quick screening of alternatives. In an ICE process, it would be at a stage I evaluation of ICE to prescreen alternatives and move the rise to the top over into another analysis form.

[0:36:14 SLIDE 23 BASIC CAP-X CONCEPT]

Bastian Schroeder:

Here is the basic concept. You have a single input sheet where you enter your turning movement counts. There's a new input sheet for lane configurations and then you will get results for each different intersection. There are different tabs that highlight each point where two or more movements conflict. That's where the critical movement sum is evaluated versus the potential planning level capacity is for that point. The tool does not generate any delay estimates in the way the highway capacity manual analysis does. It's a capacity based screening tool for these junctions including graphics of the zones you might evaluate. You can do early capacity checks and fine-tune the alternatives like increasing the number of lanes for one of the points where you might have concern.

[0:37:17 SLIDE 24 WHAT IS CRITICAL LANE VOLUME (CLV)?]

Bastian Schroeder:

What is critical Lane movement or critical movement analysis? It evaluates the movements that go through a particular point. It takes conventional intersections, the through's, left turns and the movements in a controlled environment cannot move at the same time so it evaluates how much traffic is trying to get through a particular point over how many lanes and it takes into account the potential hourly capacity of that point. Not to generate the hourly capacity, but there are assumptions made behind-the-scenes on the traffic signal phasing and lost time. One of the more subtle enhancements to this version is that we are actually distinguishing between the intersections and their number of critical movements in a particular phasing scheme. For a traditional signal, you might have four critical movements, the two left turns and two through movements but in an RCUT type where you have simple signals you have fewer critical movements therefore reduced lost time and increased hourly capacity for those points. That happens behind the scenes and that's done automatically. The only input you put in is what the turning movement counts are, those volumes are then distributed across lanes, sometimes but most cases they are easily distributed. The roundabouts are usually methods for Lane utilization and movements. Those are then evaluated and compared against the hourly capacity value. To evaluate the overall intersection, each of the node specific critical movements are evaluated and then you get a sense of the maximum critical volume ratio is for that intersection to then determine the overall volume capacity ratio. All of these computations are done behind-the-scenes. You do have some ability to customize them in the latest version. I will show that in a similar demo to what Pete just went through.

[0:39:32 SLIDE 25 ANALYZING AN INTERSECTION WITH CAP-X]

Bastian Schroeder:

To start with an overview, I will show you some of the inputs and output screens in slides and then I will do a live demonstration.

[0:39:45 SLIDE 26 CAP-X INPUTS]

Bastian Schroeder:

Here is the input sheet. Similar to the SPICE Tool, CAP-X is a spreadsheet that starts from left to right. You click through multiple steps, multiple worksheets and they correspond to different steps in the analysis. You can use the maximize button at the top of your screen if you need to see this larger. You will see we have now numbered the steps. That's one of the big changes in CAP-X Tool is that we are in the application and having worked with a lot of States and stakeholders about how the ICE policies are implemented, we found in most cases it's less of an application of a universe of 30 different potential intersections that I want to evaluate but there's usually one specific intersection that's being evaluated for potential improvement. You will notice the restructuring in the input for CAP-X to reflect the typical workflow. This is a volume input, you enter the turning movement counts, you can enter heavy vehicle percentages to do a volume growth analysis or adjustment factors. You can change your truck to passenger car equivalent and there's new input for multimodal activity and there's a new default value for the sum of critical Lane movements. They reflect some changes in the Highway Capacity Manual 6th Edition that the HCM found higher saturation flow, higher capacities in urban areas than rural and we take into account the critical movement intersections where the lost time is reduced, the fewer signal

phases you have and fewer critical movements. That allows you to further customize and that's been applied to the different alternatives for you.

[0:41:55 SLIDE 27 CAP-X EXISTING CONDITION INPUT/RESULTS]

Bastian Schroeder:

To start the analysis, this is the step two worksheet and it starts with an existing conditions analysis. We found in agencies that use the earlier versions of the CAP-X Tool that it was sometimes overwhelming. You haven't even started your analysis and you are presented with 66 different analysis types. Some may not be feasible but you still have to go through them and click through the worksheets to get a sense of the number of lanes. And you haven't even quantified your problem. We introduce this new existing conditions input which allows you to specify what is your base intersection, your existing conditions, is it a traffic signal, is it a roundabout or some other form, very basic input in terms of the number of lanes. You already get an initial look at the various zones and the volume to capacity ratios. From there you can select, now that I know the challenge, I will explore what other intersections I want to explore. You start with a baseline analysis which is the common way these studies are done.

[0:43:14 SLIDE 28 CAP-X INPUTS]

Bastian Schroeder:

From that existing conditions analysis, that high-level snapshot of what to expect in the analysis, we have this input which is new and it allows you to screen what types of intersections or interchanges you want to evaluate. This is an attempt to further streamline the process and cut down on the amount of work you have to go through to enter intersection specific Lane configurations. You know a grade separated solution or interchange now we have grade separated intersections, now that you know those will not be on the table, you can disable them. It will hide all worksheets and you don't have to look at the input. The same thing with roundabouts, maybe want to include them in the evaluation or they are off the table or you already knew it's not an option or for a 3X3 roundabout the agency isn't comfortable with it. Whatever your motivation, the idea is that the simple menus will hide worksheets and cells that are not needed for the various input to make this analysis more streamlined and fit within your workflow.

[0:44:28 SLIDE 29 CAP-X INPUTS]

Bastian Schroeder:

Another fundamental change that has happened, and while this work helps with the workflow, the number of lanes input is all contained in a single input sheet. For those of you who have used older versions of CAP-X you had to click on each individual configuration and specify the number of lanes distributed across what might be up to 20 worksheets. It could be cumbersome. It also turned out to be challenging to do quality control on, to ensure everything's been entered correctly. Consequently, in this version the cells have been locked in the number of Lane and put is done in a single sheet to further streamline the process. The one exception is the quadrant roadway it's very difficult to represent the different Lane configurations. If you are evaluating quadrant that still happens in the respective intersection tabs.

[0:45:34 SLIDE 30 NEW CAP-X MULTIMODAL ANALYSIS]

Bastian Schroeder:

Another fundamental change is multimodal analysis, where since the ICE process is looking at both operations and safety, it's interested in evaluating how different intersections and interchanges may work for pedestrians and bicycles. We included a qualitative assessment for how those other modes are integrated and the challenges. There is no prediction of safety. There are no crash modification factors or delay estimations and it's by no mean intended to be a replacement for a separate multimodal analysis. There will be research that's evaluating pedestrian bicycle safety at alternative intersections further but while that's underway we want to include an early framework to distinguish the pedestrian bicycle performance based on these key dimensions, the crossing control, is it a signal, are they long or short, how many lanes and it is it a slow or fast vehicle speed. We give ranges for this and the same thing with traffic volume, out of direction travel, the separation types for bicycles and there are defaults provided for all types of intersections that can be overridden by the user. You could change your bicycle facility from an on street accommodation in a shared lane to a bicycle lane or a two-way separate facility and that will impact multimodal scoring. Those scores are aggregated across the entire intersection to give you a planning level look for where some potential concerns might be for pedestrians and bicycles that can be thought of in terms of flags that need to be explored further as your analysis continues.

[0:47:39 SLIDE 31 CAP-X MULTIMODAL ANALYSIS]

Bastian Schroeder:

Here's a screenshot of the multimodal analysis. You go to the edit multimodal intersection configuration. I will show that shortly.

[0:47:52 SLIDE 32 CAP-X SUMMARY OUTPUTS]

Bastian Schroeder:

The multimodal performance included in a new summary output, so you still have the same detailed output you've always had in CAP-X but in addition you now also get a summary of the top 10 intersections; in the top 10 in this case is still defined based on the v/c ratio but then the pedestrian and bicycle issues are included and you can have that as part of your decision making as you look at the differences involving the capacity ratios might be subtle, there might be multiple alternatives that work equally well that would be acceptable but one may have better performance when it comes to pedestrian bicycle performance and that might be something that ends up as a preferred alternative.

[0:48:48 SLIDE 33 CAP-X FULL OUTPUT]

Bastian Schroeder:

You still have the full output and that means each intersection type or each zone up to five zones as well as the pedestrian bicycle details for each crossing or movement, that is still included in a full output if you want to dig deeper into the analysis.

[0:49:07 SLIDE 34 INDIVIDUAL INTERSECTION SHEETS]

Bastian Schroeder:

You can also still go to the individual intersection worksheets. This is an example of an RCUT in a north-south orientation. These previews are not dynamic in terms of the number of lanes but it gives you a sense of where the zones are and the concerns in terms of volume to capacity ratios so you can understand better where the challenges are and that might inform where you might want to explore an additional lane, for example.

[0:49:40 SLIDE 35 SAME EXAMPLE – EXISTING SIGNAL]

Bastian Schroeder:

To demonstrate further, if you wouldn't mind Jeff to open up the other share pod and I will share a look at the CAP-X Tool. We will walk you through what these look like.

[0:50:06 SHARED SCREEN]

Bastian Schroeder:

Here is the new CAP-X Tool, this is version 3. It's the welcome screen and the disclaimers and warranty and notices.

Similar to what Pete showed for SPICE a page with abbreviations and general assumptions. A couple of new features that I didn't mention previously we can now include share lane analysis and and how these should be accounted for in CAP-X. We now have unsignalized intersections that are two-way and all-way stop controlled; in rural environments where you are looking at an unsignalized RCUT type, the base conditions might be two-way stop control that have safety concerns. Those have been included. For those of you who are familiar with critical movement analysis that's a method that is focused on the signalized intersection control, so we use methodologies out of the planning and preliminary application guide for the HCM, to evaluate the stop controlled intersections. That allowed us to include unsignalized stop so these have now been integrated into CAP-X.

Here is your volume input. You start with just your simple configuration. You have some dynamic tabs the number of legs at the intersection as well as the East-West versus north-south orientation. If you change those it will hide various worksheets that you don't need. It lessens the analysis burden if you have to go further. You can enter in turning movement counts and you can override any of these defaults for the critical lane volumes if you have different values, you can use those but we have included them. Some of these values are quite high. So a two phase signal in an urban area that starts with 1900 cars per hour per lane flow rate from the HCM and subtracting lost time for critical movements. A much higher value than 1600 we used in the old CAP-X. You can always scale that back if that's something you are not comfortable with.

So Step 2 is this base analysis, a new input feature to select your base intersection. It's a traffic signal with this lane configuration of East-West arterial, dual through lanes, dedicated left and right turn lane and the side street approaches. It already gives me the overall capacity ratio as well as high-level results for pedestrian and bicycle safety. I have a general understanding of how far overcapacity this

intersection is. It's about 20% over capacity and that will help inform some of the alternative selections. If I'm only at a 1.2 ratio maybe I don't reach all the way to have to look at grade separations.

That jumps into the step 2B, should I look at roundabouts and if so which ones. In this case I eliminated the quadrant options. These weren't applicable, continuous green-T doesn't apply for a four leg intersection. It signalized so I won't go back to and all way stop or a two-way stop. 1800 vehicles per hour in the main direction. There are other options. You can always add them back in. I've also said I'm not interested in great separated intersections the echelon and I'm not looking at roundabouts or any interchanges. By deselecting these, all of the worksheets that follow are pre-filtered so where the input is more streamlined.

Including this one, if I jump into step 3, this is where the number of lanes are specified. For each alternative, I've specified the number of lanes. You can change things and it gives you the option of doing shared lanes and guidance. You notice that the grade separated intersections and interchanges have been hidden so I don't have to burden myself with entering the information. Only the yellow highlighted cells are those that need to be entered.

Next, I will jump into the multimodal analysis, if that is something you are interested in, you now have the ability to specify the multimodal analysis. There are categories for each individual crossing so a conventional intersection might have four crossings but if you have medians or additional lanes you would add additional crossings and those have to be evaluated. To do the pedestrian evaluation you go and specify for each intersection the total crossings that I'm evaluating and in this case the traffic signal base analysis has eight crossings. The reason it has eight crossings, if you remember, it's a divided highway so each mainline crossing consists of two crossings on the East and the West, then there are four individual pedestrian crossings on the two side streets, so that gives you six, and then you have two channelized right turn lanes which gives you eight. Those have all been reflected here and based on the number of lanes and the crossing control or vehicular speed at the crossing it allows you to screen alternatives. The displaced left turn jumps to 12 crossings, you have the major approach east-west and the minor being north-south, with four on the left and four on the right that gives you 12 total with the side streets, the diagonal and so forth. The order in which you specify does not matter. For the traffic signal, I started going in a clockwise direction. For the DLT I did all right turns and then the left and then all through movements. It will aggregate all of these and give you individual scores. You get a scoring for each individual crossing. The scores are here but it gives you the performance so you can get a general sense of pedestrian safety at this intersection. It's the same thing for bicycles. The dimensions are vehicular speeds, bike separation type, is it shared and the bikes are evaluated for each approach to the intersection, east, west, north, south for bike movements. They are broken down in separate segments.

I think I was kicked out, can you hear me?

Jeff Shaw:

It's loading backup. You are back.

Bastian Schroeder:

Okay. There are a lot of details and some of these can be skipped. It's generally quick to do, it's a drop-down menu, if you prescreen your alternatives. It's similar with pedestrians, you already get bicycle scores and you see that the bicycle provisions are worse than the pedestrian provisions for existing

intersections I assume there were no separate bicycle provisions. There were not on any of the aerials. Just bicycles intended to share a road with traffic that goes 45 miles per hour faster that results in a poor bicycle safety score. As you evaluate protected bike lanes or separate shared facilities some of these channelized lanes, at slower speeds, provide a better score than the others. The overall results and these are the top 10. I only have four treatments that I looked at and I can revise these with different assumptions on the number of lanes to change the v/c ratio further but I also still get the detailed results where for each zone within my intersection, I get a separate score for each individual intersection type.

[1:01:20 SLIDE 36 CAP-X EXAMPLE – KEY INPUTS]

Bastian Schroeder:

It seems that I'm disconnected again, Jeff. I think I'm close to the end anyway, and can take questions and provide more detail. We are hoping for 30 minutes of Q&A.

[1:01:25 SLIDE 37 QUESTION AND ANSWER]

Jeff Shaw:

I think I see that too. We will get back to the slide deck. Thank you, Bastian. Thank you, Pete. We will move into the Q&A portion of the webinar today. Operator?

Operator:

Yes. If you wish to ask a question at this time over the phone please press star 1 on your phone. A voice will indicate when your line has been opened. You may remove yourself at any time by pressing star 1 followed by 2. It star 1 and we will pause for a moment.

Jeff Shaw:

Thank you. I guess we can revisit a few questions from earlier in the chat pod but just so everyone is aware.

We had a couple questions from Tennessee. Is the DDI included? The answer is yes, the DDI is one of the diamond interchange alternatives addressed by the SPICE Tool and it's evaluated in the CAP-X Tool.

We had a question about whether the presentation would be available for download and that answer is yes. I'm going to reopen the download pod so people can download the items why we are doing Q&A. In this download pod, we have two spreadsheet tools themselves, the corresponding user guides, the slide deck from today's webinar and also a new primer document on intersection control evaluation, our new ICE primer.

Are there any questions on the phone?

Operator:

We do not have questions but it is star 1 if you have a question or comment.

Jeff Shaw:

Okay. It looks like we have one for Bastian from Arizona DOT. What figures are used to determine the B/C ratio in the CAP-X Tool?

Bastian Schroeder:

The CAP-X Tool, the v/c ratio is evaluated by summing the volumes that go through a particular point. What happens behind the scene is that your turning movement counts and you enter your through, lefts and rights that are distributed across the intersection and every time you have two or more movements that share the space at the intersection, that sum of movements is compared against the capacity of that point and that point -- in that case the capacity becomes the function of the assumed signal phase. For traditional intersection with four movements with eight phase, or an RCUT might be just a two critical movement intersection. In terms of the analysis, those are then reported and each capacity analysis points are referred to as his own. The worst zone is the one that controls the intersection but you can jump to individual worksheets to look at how the various zones perform. I hope that answered your question. We do have the user guide available for CAP-X Tool, it did not exist before and that also explains that process further.

Jeff Shaw:

Thank you, Bastian. That did address the question. Pete, a question about SPICE Tool - how relevant is the SPICE Tool when comparing a conventional signal versus roundabout? Can you speak to your experience using the beta versions of SPICE Tool and the results?

Pete Jenior:

Sure, that's a key comparison that we had in mind when this tool was developed. The SPICE Tool is capable of doing that. We have crash modification factors for roundabouts in the SPICE Tool and the results are generally lower or fewer crashes with a roundabout than a traffic signal and there comparable size with roundabouts having fewer crashes than multiple lane roundabouts.

Jeff Shaw:

Thank you. Phil has a question that has to do with CAP-X Tool - any of the interchange options have provisions for roundabouts at their terminals?

Bastian Schroeder:

Yes. The interchange tab does include roundabout interchanges at each ramp terminal as an evaluation.

Jeff Shaw:

Thanks. I think this is a good point to acknowledge. What we've learned through this with Pete and Bastian and Lake Trask who did the macros on the spreadsheets, we've learned that CAP-X Tool has it it's limit and how far we can push a spreadsheet tool to consider so many different scenarios and sub scenarios. Bastian or Pete, would you like to address that quickly?

Bastian Schroeder:

You probably saw in the download pod; the Excel spreadsheet is up to 16 megabytes at this point. By having all these different intersection and interchange types all integrated we are pushing the limits a little bit. We had discussed taking the tool out of Excel but there were reasons for keeping it. Those are some of the limitations. Providing more options and intersection types and interchange types as well as the multimodal measures it's increased the size of the spreadsheet. Pete did you have a comment?

Pete Jenior:

Just going off that, as you use CAP-X certainly be patient while it opens. Don't try to do too many things at once. It uses a lot of resources. The SPICE Tool is more contained file size-wise.

Bastian Schroeder:

Another Excel detail and this was a change by Microsoft, the Visual Basic libraries are now packaged within the file and that's part of the reason for the file size. It can be frustrating because of load times but the big positive is you will no longer receive an error message where you open the tool and it says there is some visual basic object that you don't have and you need to download it, then you need to get an administrative I.T. person to install it for you. All those issues have gone away because Microsoft now packages the objects used in the tool with the tool itself. Hopefully, that will reduce challenges with agencies that have older versions of Excel and not necessarily the I.T. access and full Visual Basic. It should mitigate those issues that earlier versions had.

Jeff Shaw:

Thank you, Bastian. Let me pause for the questions in the chat pod and check in. Are there any questions on the phone?

Operator:

We have no questions in the queue at this time.

Jeff Shaw:

OK. Thank you. We do have a few more questions in the pod. People are chiming in. Thank you. Mike Reese asks, what is the single point with roundabout option?

Pete Jenior:

That option is essentially we think about a single point diamond, sometimes called a SPUI, where there is a signal in the middle. This would be having a roundabout at a diamond interchange but just one where everything -- all four ramps tie into it. It's usually wider than the freeway itself, going out to the edges. I know a handful of these exist in Kansas and some other States as well. That's what that alternative is.

Bastian Schroeder:

The key is that the major approach is grade separated, it is an interchange so you have through movement that goes and then the ramp terminals tie into a roundabout and then you have the arterial where the throughs, lefts and rights all tie into the roundabout. If you go to that tab or I could share it again and you can see in CAP-X Tool the graphic visualization should help with that. Can you give me back control so I can show what that looks like?

Jeff Shaw:

Sure. Let me open up the share pod again.

Bastian Schroeder:

This is a single point roundabout. The freeway would go in an east-west direction so it would be a single roundabout controlling all movement at the interchange. Rather than being a dumbbell, It's just a single circle.

Jeff Shaw:

Thanks, Bastian. Margaret asks an interesting question – curious to the safety performance for pedestrians at a DDI. Have you seen any analysis using this tool specifically for pedestrian safety analysis at a DDI? I will reiterate something you said which I think is important to keep in mind. This was an effort to input or provide qualitative metrics that really speak to the intrinsic characteristics of these different intersections in terms of number of lanes being crossed and the corresponding traffic speed and in the case of bikes is there an on-street, is it buffered and so on. These are qualitative more than quantitative but they do have some actual research basis for why these characteristics are important. Bastian, would you like to add to that?

Bastian Schroeder:

That's a great summary, Jeff. The direct answer is no, there is no specific pedestrian model or bicycle model for DDI or any other intersection forms, at this time. There is an active research project NCHRP 07-25 on pedestrian bicycle safety that will overcome those challenges and produce additional methodologies for the DDI etc. as well as any of the other ones and that project is expected some procedures, but in the absence of that there is useful material available in the guidebooks that were published by FHWA in 2014 and each guidebook has its own chapter on pedestrian and bicycle provisions that appear first since it is important to consider pedestrians and bicycles early. Those are available on the website. There is also case study material that will help you evaluate and interchange and the pros and cons of the considerations for walkways versus outside facility. Some of the case studies have useful details if you are specifically interested in DDI and pedestrian provisions.

Jeff Shaw:

Thanks, Bastian. William from Arizona asks another good question. I think maybe this is a good opportunity Pete to talk about considering other scenarios in the SPICE Tool. Can the tool evaluate adaptive versus non-adaptive signalization? I'm sure the answer is no. I don't think it's built for that nuance, correct me if I'm wrong, but maybe you could talk about how users could input other scenarios or consider other scenarios?

Pete Jenior:

That's correct. Our focus is on alternative intersection forms. There's not a lot in the tool for different variations of a conventional signal beyond what's in the Highway Safety Manual, such as adding a turn lane, or changing the left turn signal phasing from permissive to protected, are in the SPICE Tool as part of the HSM predictive method for signals. We know there are other things out there that have been quantified as safety improvements with crash modification factors that are known to impact safety at a signalized intersection and that SPICE Tool does have a feature where users can enter their own CMF. There would be an alternative as traffic signal with adaptive. If you have a study that's developed a crash modification factor for adaptive signal control you could put in that number, 0.76 or 0.53 or whatever, and then the tool could still do the lifecycle comparisons of crashes and you could compare a traffic signal with adaptive to a roundabout or RCUT or whatever alternative you might choose to analyze.

Jeff Shaw:

Thanks, Pete. The next question is from North Carolina. I think it's a good question. It's an important philosophical question that we face with all of these tools, not just the ones we are talking about today but concerns over how to address the "black box" approach to engineering decision-making. Certainly, this is something we discussed when we started this project. It something we discuss often when we try to create tools that more easily implement research, and I think we tried to walk a fine line between making the tools transparent, making the tools customizable, forcing the users to a certain extent to have to go through interactive steps and be a part of that process so they better understand the results provided on the backend. At the end of the day, could somebody plug-and-chug? Of course. Anybody with a few minutes to spend on Google could probably figure enough out about what do all these inputs mean and what numbers can I plug in to get an answer. Without the training and the knowledge to interpret those results, obviously that could be a dangerous step. I think we are sensitive to that, North Carolina. Hopefully, the production of the user guides that go along with the tools provide additional context. Pete or Bastian would any of you like to say a few words about this?

Pete Jenior:

Sure. I do see a related question from Georgia about IDs of crash modification factors. As it relates to SPICE Tool, the user manual, not so much the tool but the user manual, lists the sources of all the crash modification factors that are in there and the majority are online, there are older studies that are not online but links are provided where they are online, and someone can look up these studies and see what's there. Likewise, the safety performance functions are documented in the HSM or NCHRP reports. Those aren't the easiest things to calculate by hand compared to a crash modification factor where it's a single number. If you were to do that you would get the same result as the tool as if you were to use the other various HSM spreadsheets or analysis tools that have been made. The complexity of what we have here doing alternatives across entire life spans of projects on the safety side, it does lend itself to a macro code-based approach where it's harder for a typical user to follow through the calculations themselves. The results of the studies can be found in a hard document about where it came from. I hope that addresses the intent of that question. Perhaps, there's a broader question of whether someone is choosing to document, to read references or not, and it's a broader question am I now not thinking about intersection safety myself and just getting results out of the tool. I think that issue is inherent in any tool. You could say the same of Synchro for an operations analysis, there are always things that a tool doesn't account for that are present in the real world that you have to keep in mind.

Maybe, a crash modification factor that is a good representative CMF for a site in general perhaps does not apply to a given site because it's unique, it's adjacent to other intersections or there's a unique topography. That's where judgment comes into play. There's no good substitute for good engineering at the end of the day.

Bastian Schroeder:

Yes, that's how I understood the comment Jeff and Pete. It was the concern of making a tool too easy, like there's an easy button to traffic engineering are planning decisions. That is a concern and it needs to be balanced against making things too burdensome where certain analyses aren't done. I think what a few states have done to overcome some challenges is through the ICE policies and documentation requirements, there's a series of forms attached that need to be checked and tools like CAP-X and SPICE are just two pieces of the evaluation. There are clearly a lot of other things that go into an intersection study – right-of-way impacts, environmental impacts, benefit costs, as well as the safety and operation. I see these tools as streamlining certain components of a greater intersection evaluation. They are by no means intended as an easy button. They are not intended as the sole treatment or the sole tools to do an evaluation. They need to be taken in a broader concept.

Jeff Shaw:

Well said. I think your thoughts are a good segue into last question from New Hampshire. Other than calibration, how have those states which have ICE policies modify what was presented today? To that question, New Hampshire, the tools we are presenting today are what I would say are the kind of generic National version of the ICE tools and there are States that have created customized versions of what we've seen today and entirely new spreadsheet-based tools to fit their own state-specific project development needs. If you look to Pennsylvania, Florida, Georgia just to name three, you will see a combination of both tools and documentation steps that must be taken to complete an intersection control evaluation process. I think that's really what we would like to see everyone, and new states coming online, to emulate that same approach. We've got the tools to make the engineering work efficient, we've got the process and the documentation to keep it honest, objective and based on good engineering judgment and experience. Hopefully, by producing these tools we can give states who don't have ICE policies and tools already a bit of a head-start on that effort, and certainly we would not discourage anyone from looking at their peer States and their tools and may be asking do I want to copy that tool for example. Let me check one last time, are there any verbal questions?

Operator:

A final reminder it is star 1 if you have a question or comment at this time. It appears we have no further questions.

Jeff Shaw:

Okay. Thank you, very much. We will conclude the question-and-answer session.

[1:24:35 SLIDE 38 MORE INFORMATION ABOUT ICE]

Jeff Shaw:

We just have one last slide. We have a new webpage devoted to ICE. It can be found under our intersections webpages on the FHWA website. If you type that into the chat pod you should find the new ICE primer and the rest of these tools will be posted as soon as we have the webinar recording quality checked and ready for posting. I would say in the next several days, we should have all this information posted to this new ICE webpage. Hopefully, it will make it easier for people to find what they're looking for on ICE.

With that, we can conclude the webinar. I do want to thank Pete and Bastian for their presentations. Just to recognize Pete and Bastian both work for Kittelson and Associates working in collaboration with Leverson Boodlal and Kevin Chiang from KLS Engineering for Federal Highways. I want to thank the project team for their efforts to get these tools created and deployed.

With that, we can conclude today's webinar. Thank you very much for your participation. I look forward to any questions that you might have, feel free to call me or send me an email in later days. Have a good week. Thank you.

Operator:

That concludes our conference. Thank you for participating.

[1:26:46 END OF WEBINAR]