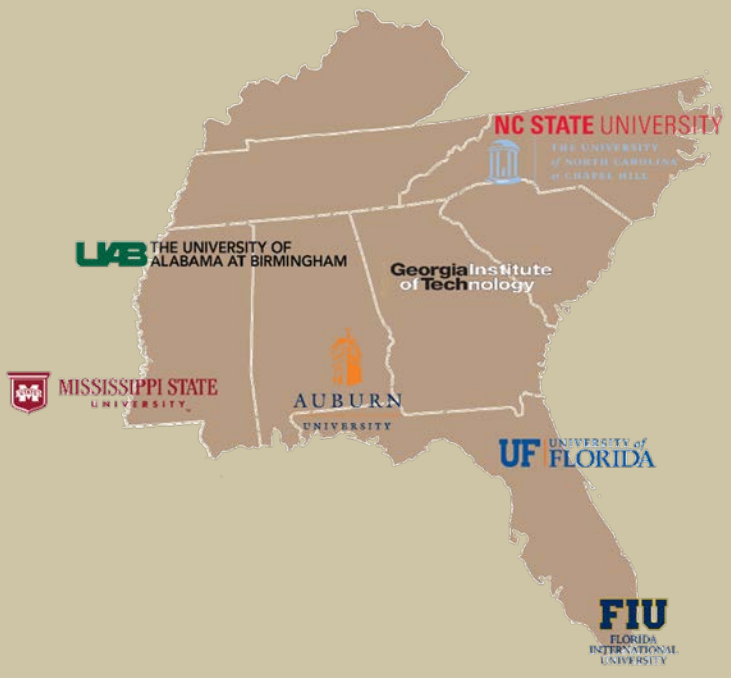
2016

STRIDE | Southeastern Transportation Research, Innovation, Development and Education Center

Final Report

Hands-on Workshop: Dynamic ATM Strategy Selection Tool FREEVAL-DSS (Workshop 2, Knoxville, TN)

(Project # 2016-002)



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(North Carolina State University)

April 2016

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Disclaimer

Acknowledgment of Sponsorship

This work was sponsored by a grant from the Southeastern Transportation Research, Innovation, Development and Education (STRIDE) Center, a U.S. DOT Region 4 grant-funded University Transportation Center.

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ACKNOWLEDGEMENTS

We greatly appreciate the assistance from the following individuals in making the necessary arrangements for and sponsorship of the workshop for which the outcomes are reported herein.

- Dr Lily Elefteriadou, Professor, University of Florida and Director, STRIDE Center
- Dr. Asad Khattak,, Professor, University of Tennessee at Knoxville
- Ms. Lisa Gay and Deanna Flinchum at the University of Tennessee, Knoxville

EXECUTIVE SUMMARY

This activity is a natural follow-up of the STRIDE project 2013-009S –"Dynamic Traffic Control Interventions for Enhanced Mobility and Economic Competitiveness". A deliverable of the project was the development of a dynamic version of FREEVAL, the computational engine of freeway facilities in the upcoming HCM update. The FREEVAL-DSS tool (for Dynamic Strategy Selection) enables the user to intervene within a FREEVAL run after each 15 minutes and implement one or more ATM strategies from a select menu.

The workshop was intended to be a mechanism to both receive feedback on the tool, as well as disseminate its capabilities. Eleven participants including graduate students and post-docs attended the 2.5 hour workshop which was conducted in conjunction with the UTC Conference for the Southeastern Region, which was held in Knoxville, TN on April 1, 2016. The formal feedback received from the participants was extremely positive, and spurred the presenters to plan to offer a subsequent workshop in Chicago in conjunction with an upcoming ITE conference in June.

1. BACKGROUND

According to the latest Urban Mobility Report, US urban motorists in 2011 traveled an additional 5.5 billion hours and purchased an extra 2.9 billion gallons of fuel as a result of congestion. The economic impact of degraded mobility has been estimated at $21 billion, which is quickly eroding the nation's economic competitiveness. The Federal Highway Administration estimates that about half of all congestion delays are caused by non-recurrent congestion events, including incidents, weather, work zones, demand surges and inadequate base capacity.

Yet methods for assessing the effectiveness of active traffic management (ATM) strategies aimed at improving mobility are still rooted at a planning level approach rather than the operational levels of implementation. This research has intended to develop efficient methods that dynamically evaluate the current traffic system performance, propose interventions that can ameliorate the performance as needed, and implement and re-evaluate the effectiveness of the intervention.

The research team has developed methods and a computerized tool (FREEVAL-DSS) that will propose and implement near real time active traffic management strategies on simulated freeway facilities. In a way, what the tool does is create a virtual (simulation) lab for assessing ATM methods in the same fashion they would be considered, evaluated and implemented in a freeway traffic management center (TMC), that is: observe conditions→diagnose problem→propose solution →implement solution→observe, and so on.

FREEVAL-DSS allows assessing alternative improvement strategies *before* actual implementation in their operations. In addition, it will add to the knowledge based on the development of real-time decision support systems at traffic management centers. The utilization of a macroscopic rather than a microscopic simulation model as a basis for the development will ensure an efficient use, calibration, and implementation of the developed environment.

The research team is proposing conducting a hands-on workshop on findings of STRIDE 2013-009S project and primarily FREEVAL-DSS tool. This will be the first workshop on disseminating the outcomes and findings of STRIDE project 2013-009S. The project team may propose to hold another workshop based on future opportunities.

2. OBJECTIVE

The objective of this project was to offer a 2.5 hours hands-on workshop on the FREEVAL-DSS tool which was developed under STRIDE Project 2013-009S -*Dynamic Traffic Control Interventions for Enhanced Mobility and Economic Competitiveness.* The workshop was offered with all the necessary perquisite materials that users need to acquire in order to be able to effectively use the FREEVAL-DSS tool. The project team planned to hold the workshop in conjunction with the UTC Conference for the Southeastern Region. The workshop was held in Knoxville TN on April 1 2016.

3. WORKSHOP DESCRIPTION

The workshop was held on April 1 2016 at the 2016 UTC Conference for the Southeast Region in Knoxville TN. It was a two and half hours workshop that was divided into two sessions. Dr. Nagui Rouphail and Dr. Behzad Aghdashi presented in this workshop. Appendix A contains the power point presentation that was delivered at the workshop. Table 1 shows the outline of the workshop material.

Table 1 – FREEVAL-DSS workshop outline

Time	Topic	Resource
1:30-1:45 pm	High Level Framework	Slides
1:45-2:00 pm	Program Installation	Flash Drive, Cloud
2:00-2:15 pm	User Demo Application	FREEVAL-DSS
2:15-2:45 pm	Hands on Examples	FREEVAL-DSS Examples
2:45-3:00 pm	BREAK	
3:00-3:15 pm	Administrator Demo Application	FREEVAL-DSS + HCM
3:15-3:45 pm	HCM Background- Freeway Facilities	Slides
3:45-4:00 pm	Questions, Feedback, Evaluation	

The total number of participants was 11. The Participants included professors, students, and post-doc researchers. Appendix B contains photos from this workshop. The participants were asked to bring their laptops for the hands-on component of the workshop. Participants attempted to implement Active Traffic Management (ATM) strategies on several example facilities. The project team provided each participants with a flash drive that included the FREEVAL-DSS tool, FREEVAL Users Guide, and PowerPoint presentation.

4. WORKSHOP OUTCOMES

The sections below describe results from our survey, comments from participants, and suggestions of our proof-of-concept study location.

4.1. WORKSHOP EVALUATION

The project team provided each participants with a feedback form. Nine Participants filled the feedback form and gave it to presenters at the end of session #2. Table XX shows evaluation results.

Table 2 – Workshop Evaluation Results (on a scale of 1 to 5, 5 being excellent)

Feedback Item	Participant #1	Participant #2	Participant #3	Participant #4	Participant #5	Participant #6	Participant #7	Participant #8	Participant #9	Average
Overall Value of This Workshop	5	5	5	5	5	5	5	5	5	**5.0**
Workshop Material and Presentation	5	5	5	5	5	5	5	5	5	**5.0**
Quality of the Instruction	5	5	5	5	5	5	5	5	5	**5.0**
Time Allocation and Duration	5	3	5	5	4	4	5	5	5	**4.6**

4.2. COMMENTS RECEIVED FROM PARTICIPANTS

Below are actual comments from participants:

4.2.1. Suggestions for Workshop Presentation

- Provide real world examples from field
- More example needed
- Maybe with more time
- It was great but I think you can continue to have more workshops
- It would be good to have extra hands-on experiences including the admin part
- It would be good if you can provide more background knowledge and history of the project
- Provide some instruction about the tool and more details

4.2.2. Suggestions for Instructors

- Provide more conceptual overview on the procedures in the analysis and tool
- Introduction can be short

- As a beginner user, it may be useful to just generally mention common mistakes that were made usually or the hidden parameters which cannot be aware of with overall knowledge of the software.
- It is nicely described
- It would be great if we had more time to model more strategies
- Nice presentation
- They are clear enough and instructive
- The instructor is excellent

4.2.3. Additional Comments

- Comparison with the other tools (same level)
- Thanks for preparing this awesome workshop so informative, interactive and interesting.
- Outstanding learning opportunity and that too free of cost
- Thanks for arranging such a workshop
- Want to join to another one in future

5. CONCLUSIONS

The workshop disseminated the findings of STRIDE project 2013-009S Dynamic Control Interventions for Enhanced mobility. The primary focus of the workshop was on the FREEVAL-DSS tool that had been developed under the same project. The participants asked to bring their laptops to perform hands-on experience with the tool and try to improve traffic condition on the example facilities by implementing a series of ATM strategies.

APPENDIX A: PRESENTATIONS SLIDES

Session #1

Institute for Transportation Research and Education – N.C. State University

Active Traffic Management (ATM) at Your Fingertips

Workshop at the 2016 UTC Conference for the Southeast Region

Knoxville TN, April 1 2016

Behzad Aghdashi, Nagui Rouphail, NC State University
Samaneh Khazraeian, Florida International University

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Workshop Agenda

Time	Topic	Resource
1:30-1:45 pm	High Level Framework	Slides
1:45-2:00 pm	Program Installation	Flash Drive, Cloud
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3:45-4:00 pm	Questions, Feedback, Evaluation	

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Resources

- FREEVAL-DSS *(Dynamic Strategy Selection)* Tool
- PowerPoint Presentations (Session #1 & #2)
- FREEVAL-DSS Brochure
- YouTube Videos: http://go.ncsu.edu/freeval

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What is FREEVAL ?

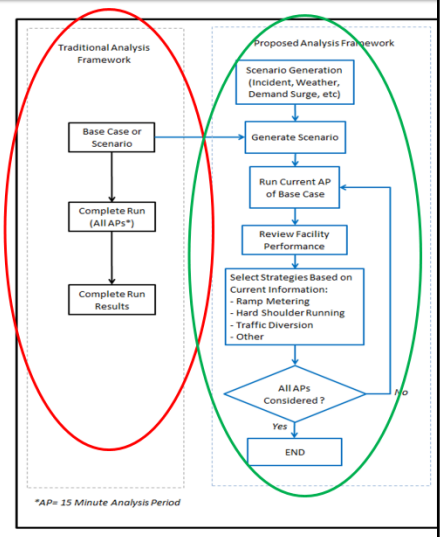
- FREEVAL is a computer tool for analyzing freeway facilities based on the latest version of the Highway Capacity Manual (HCM)
- Macroscopic model that requires few inputs and short run time.
- Facilitates analysis of multiple segments along an extended length of freeway (9-12 miles)
- Incorporates basic, on ramps, off ramps and weaving segments.
- Can analyze and model active and hidden bottlenecks.
- Consider multiple analysis periods up to 24 hours.
- All analyses are carried out in 15 minutes analysis periods.

ATM strategies Covered in FREEVAL-DSS

- DSS→ **D**ynamic **S**trategy **S**election
- Ramp Metering
  - Adaptive and Fixed Rate
  - Local and System Wide
- Hard Shoulder Running on user selected segments
- Traffic Diversion
  - Upstream of the facility
  - Into Managed Lanes (HOV/HOT)
  - Via VMS into off-ramps
- Incident Management

Dynamic Nature of FREEVAL-DSS

- Serves as a research and training tool for engineers and operators at freeway TMC's
- Creates a dynamic framework to test different ATM strategies at different points in time, depending on traffic conditions
- The analyst can intervene midstream, & can alter ATM Strategies within the simulation period



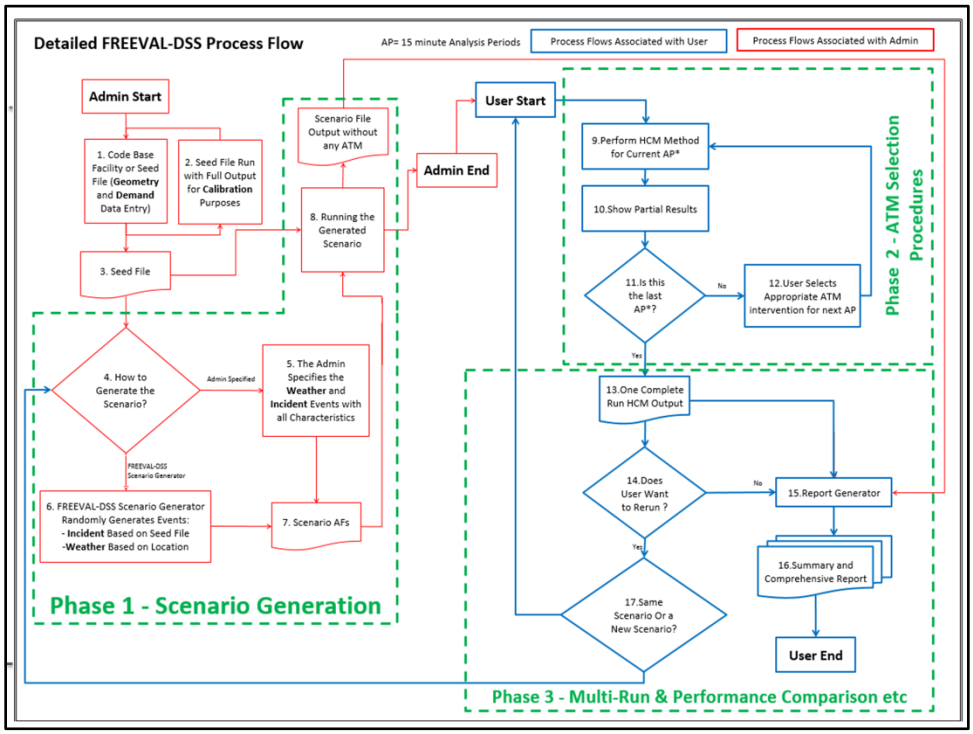
Administrator vs End User

- The framework accommodates two types of operators: **Administrator** (Professor; Supervisor ?) and **End User** (Student ; TMC Technician?)
- The **Administrator** configures the facility, specifies various congestion sources including **weather events, incident events, work zones,** or **demand surges**.
- The **Administrator** also configures the **menu of available ATM strategies** and the **form of output options** to the End User(s)
- The **End user** has access to selected ATM **interventions** from an available menu of options, after any 15 minute interval. Interventions can also be stopped or extended in time and space

Implementation Process

- Consists of three phases:
  - **Phase 1: Scenario Configuration** by the **Administrator**
  - **Phase 2: Simulation and ATM Interventions** by **End User**.
  - **Phase 3: Analysis Summary** and execution of multiple FREEVAL runs to compare Performance under various ATM strategies.

User Demo Application


Detailed FREEVAL-DSS Process Flow
AP= 15 minute Analysis Periods
Process Flows Associated with User
Process Flows Associated with Admin
Admin Start
1. Code Base Facility or Seed File (Geometry and Demand Data Entry)
2. Seed File Run with Full Output for Calibration Purposes
3. Seed File
4. How to Generate the Scenario?
Admin Specified
5. The Admin Specifies the Weather and Incident Events with all Characteristics
FREEVAL-DSS Scenario Generator
6. FREEVAL-DSS Scenario Generator Randomly Generates Events:
- Incident Based on Seed File
-Weather Based on Location
7. Scenario AFs
Scenario File Output without any ATM
8. Running the Generated Scenario
Admin End
Phase 1 - Scenario Generation
User Start
9.Perform HCM Method for Current AP*
10.Show Partial Results
11.Is this the last AP*?
No
12.User Selects Appropriate ATM intervention for next AP
Yes
Phase 2 - ATM Selection Procedures
13.One Complete Run HCM Output
14.Does User Want to Rerun ?
No
15.Report Generator
Yes
16.Summary and Comprehensive Report
17.Same Scenario Or a New Scenario?
User End
Phase 3 - Multi-Run & Performance Comparison etc

Session #2

Institute for Transportation Research and Education – N.C. State University

Active Traffic Management (ATM) at Your Fingertips

Workshop at the 2016 UTC Conference for the Southeast Region

Knoxville TN, April 1 2016

Behzad Aghdashi, Nagui Rouphail, NC State University
Samaneh Khazraeian, Florida International University

Freeway Facilities & FREEVAL Overview

- HCM Chapters
- Freeway Facilities Methodology
- FREEVAL
- Limitations
- Discussion

Freeway Chapters of the 6th Edition of HCM

- Chapter 10: Freeway Facilities
- Chapter 11: Freeway Reliability Analysis
- Chapter 12: Basic Freeway and Multilane Highway Segments
- Chapter 13: Freeway Weaving Segments
- Chapter 14: Freeway Merge and Diverge Segments
- Chapter 25: Freeway Facilities Supplemental
- Chapter 26: Freeway and Highway Segments Supplemental
- Chapter 27: Freeway Weaving Supplemental
- Chapter 28: Freeway Merges and Diverges Supplemental

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HCM Freeway Facilities

- Distinguishes Different Segment Types
  - Basic Freeway Segments
  - Weaving Segments
  - On-ramp and Off-Ramp Segments
- Extended Time-Space Domain
  - Queue propagation between segments and across time periods
- Flow Regimes
  - Undersaturated (**all** d/c<1.0)
  - Oversaturated (**any** d/c>1.0)
- Capacity and Free-Flow Speed Calibration
  - Work Zone Effects
  - Incidents and Weather
- Implemented in FREEVAL Software

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Why Analyze Freeways as Facilities?

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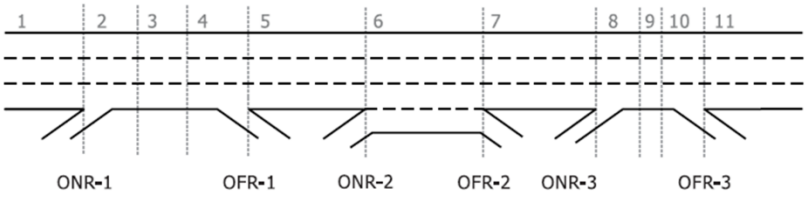
Capabilities of Freeway Facility Methodology

- Enables the modeling of oversaturated & under-saturated conditions in an extended time-space domain (24 hrs. / 15 mi)
- Models all active and highlights hidden mainline bottlenecks
- Tracks queues as they form and dissipate across segments and time intervals
- Allows time-variant demands and capacities
- Models incidents and short term work zones
- Validated against field data and compared to microsimulation very favorably

ITRE 6 http://www.itre.ncsu.edu

Freeway Facilities

- Method combines the analysis of multiple segments along an extended length of a freeway (up to 10-15mi)
- Incorporates segment methodologies for basic, merges/diverges, and weaving segments
- Considers oversaturated conditions with queue spillback
- Consider operations over multiple (15 min) analysis periods



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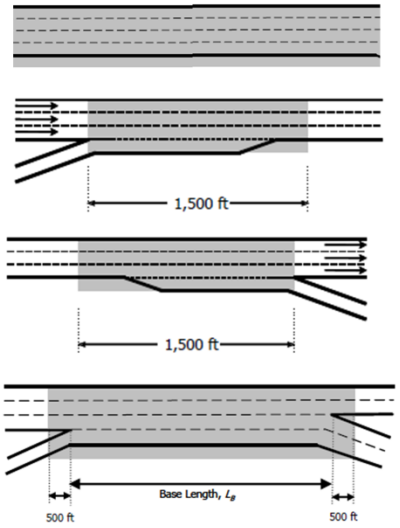
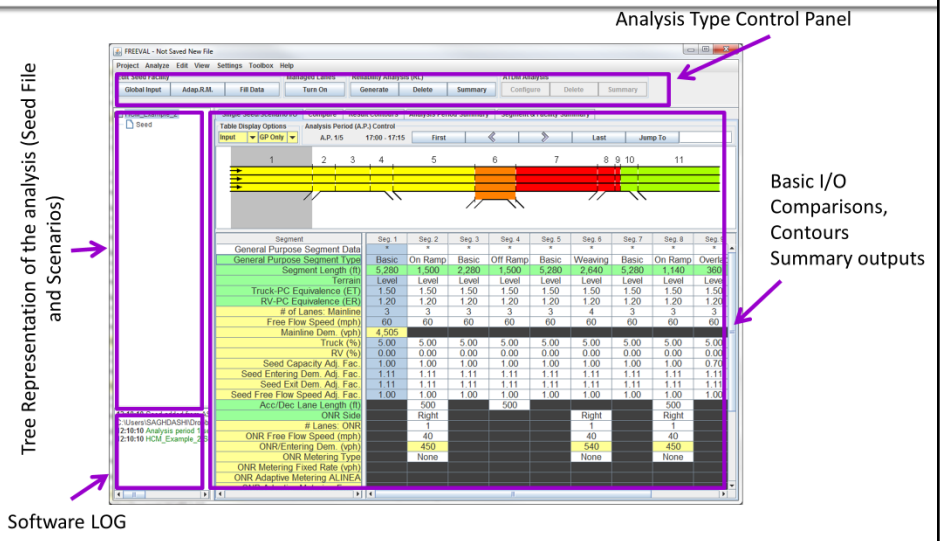
Freeway Facility Divided into Segment Types

- Basic **B** segment (Ch. 12)
- On-Ramp **ONR** segment (Ch. 13)
  (1,500 ft, ~ 455 meters)
- Off-Ramp **OFR** segment (Ch. 13)
  (1,500 ft, ~ 455 meters)
- Weaving **W** segment (Ch. 14)



ITRE 8 http://www.itre.ncsu.edu

FREEVAL 2015-E: Main Screen Layout



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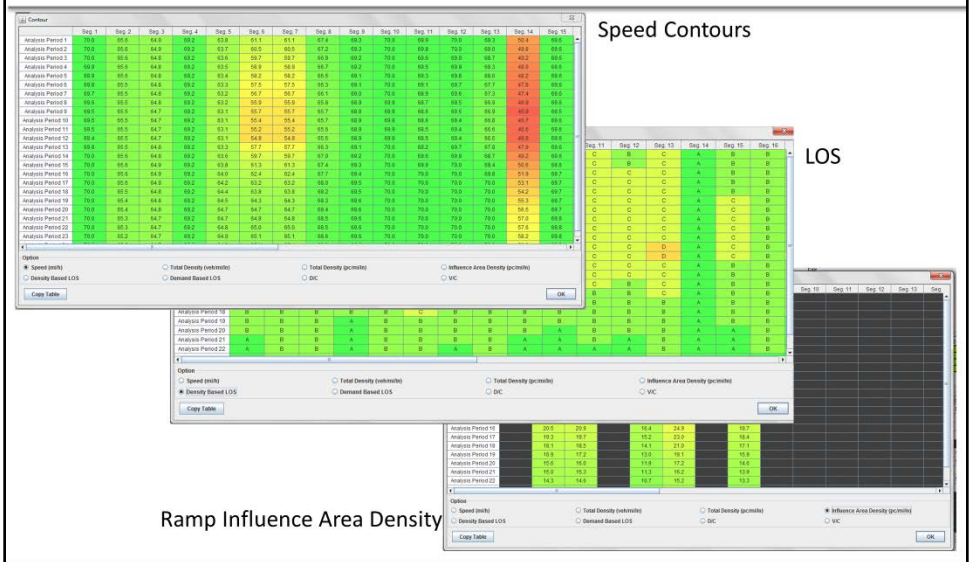
FREEVAL 2015-E: Performance Measures Contours



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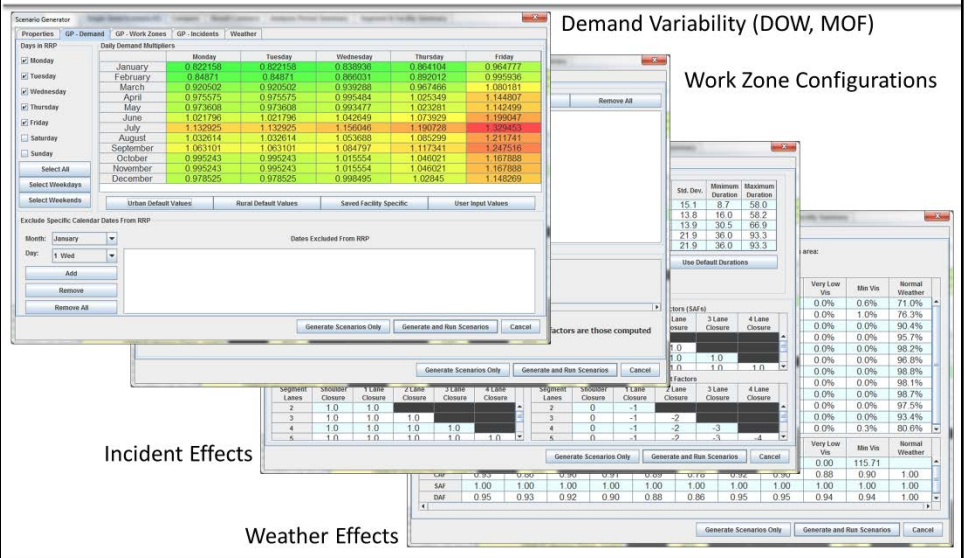
FREEVAL 2015E: Scenario Generation



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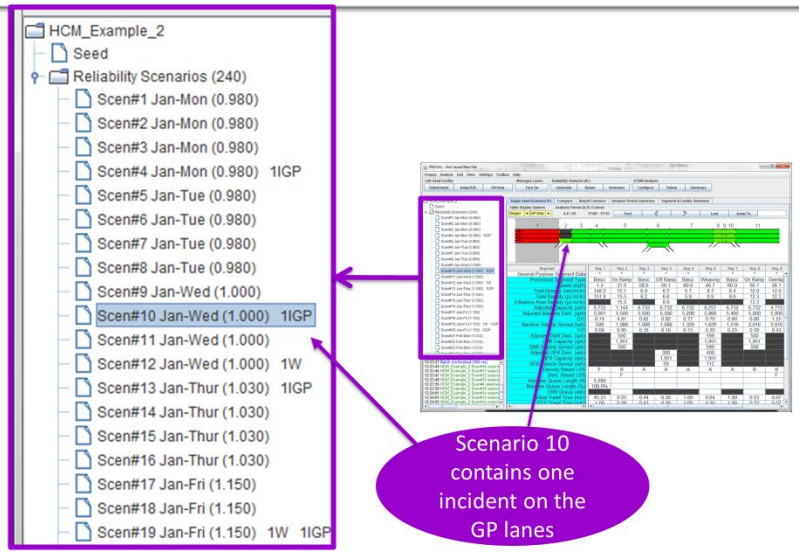
FREEVAL- Reliability Scenarios



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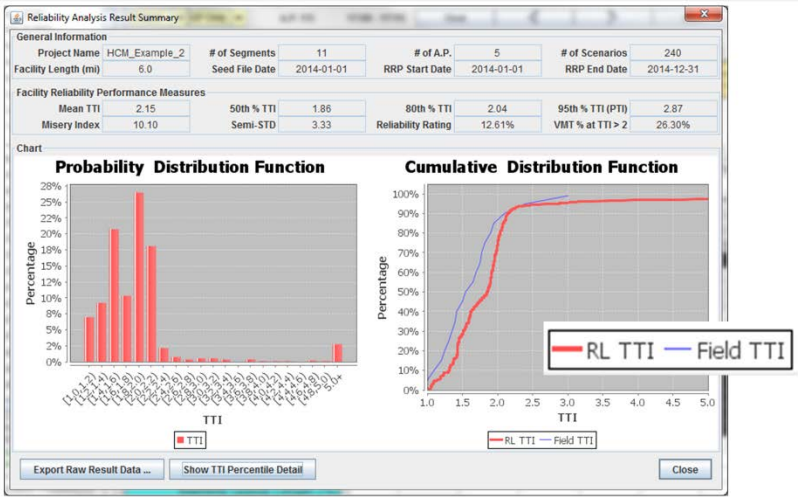
Reliability Summary Output

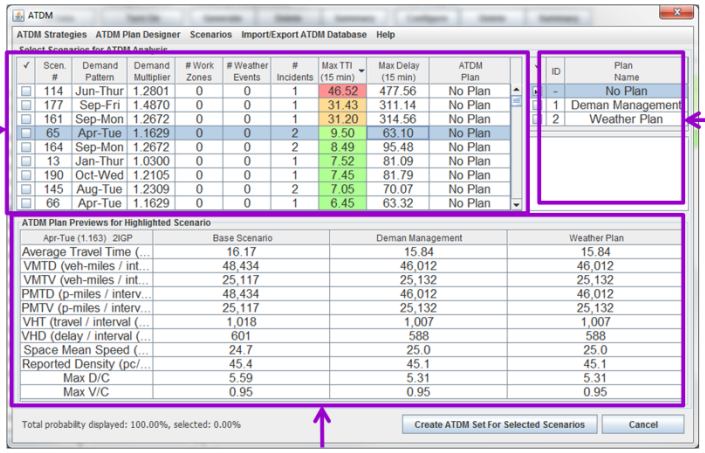


Enables Calibration of TTI Curve by Displaying Actual "Field" TTI for Facility

FREEVAL 2015E - ATDM Analysis

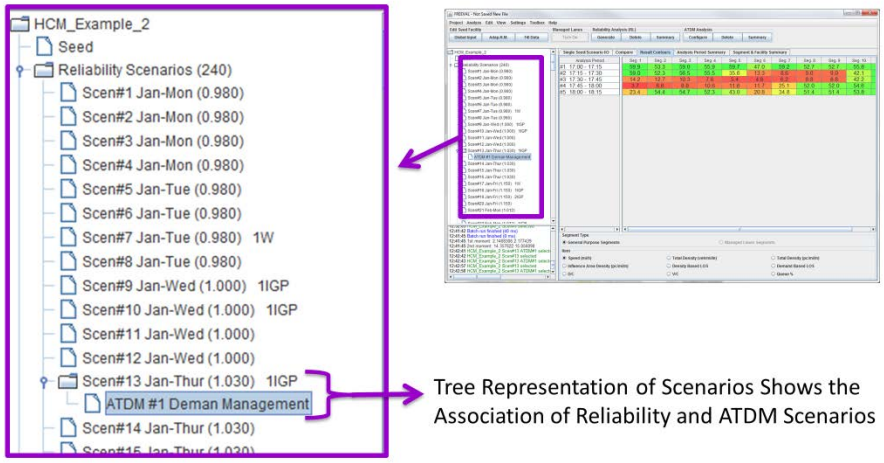
Scenario Selection and ATDM Plan (Strategies) Assignment

List of Available ATDM Plans



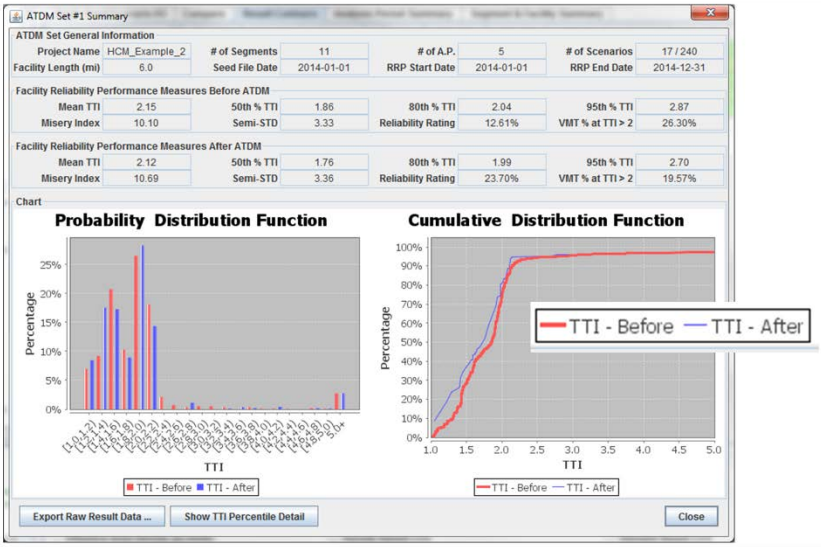
Facilitated Decision Making with
Scenario's Performance Measure under all Available ATDM Plans

FREEVAL 2015-E: ATDM Scenarios



Tree Representation of Scenarios Shows the Association of Reliability and ATDM Scenarios

FREEVAL 2015E – ATDM Summary Output– All Scenarios



What the methodology 's limitations are…

- Does not account for off-ramp congestion due to surface street control and spillback onto mainline
- Not reliable in reporting the effect of multiple overlapping queue
- Less reliable for the analysis of extended length facilities (free-flow travel time greater than 15 minutes)
- Requires extensive demand inputs in each time period – cannot map sensor data to demand
- Time consuming in manually segmenting the facility into HCM analysis segments

Discussion and Questions

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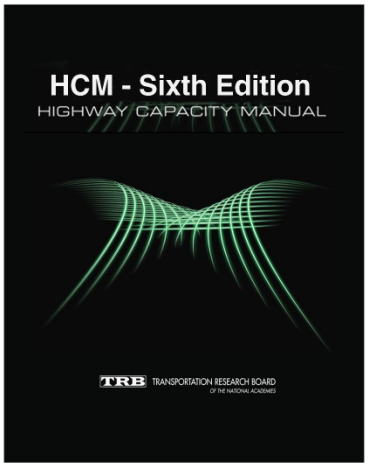
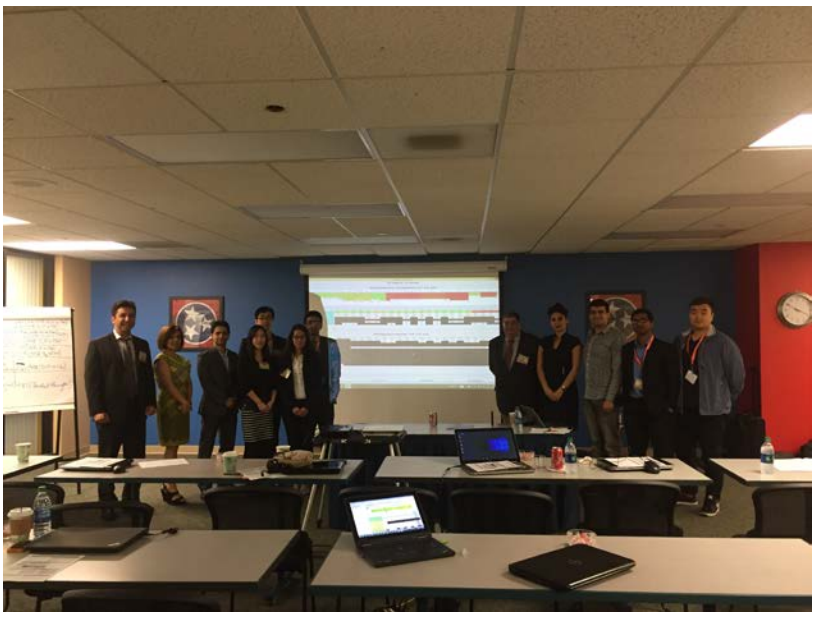
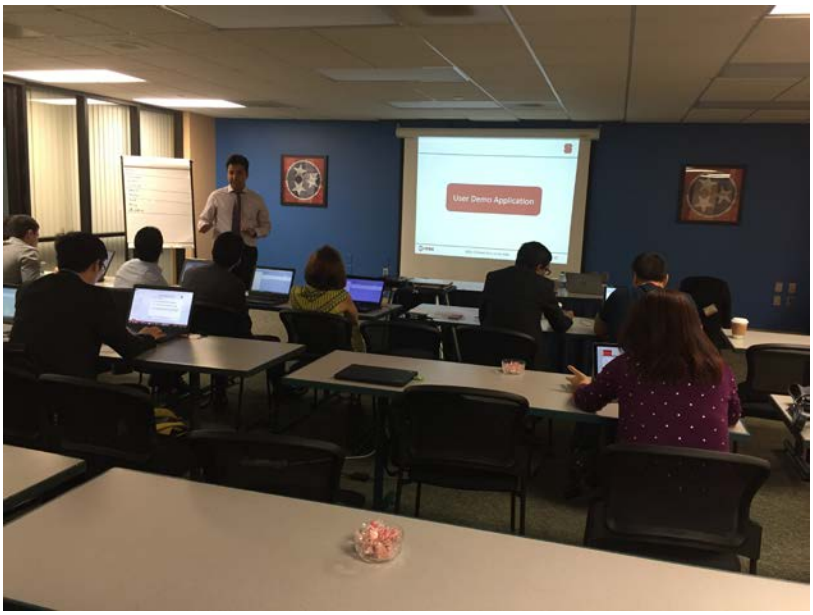


APPENDIX B: PHOTOS FROM THE WORKSHOP

Dr. Nagui Rouphail (NCSU), Dr. Behzad Aghdashi (NCSU), and Samaneh Khazraeian (FIU)



The Presenters and Participants



Dr. Behzad Aghdashi presenting at the workshop

Dr. Behzad Aghdashi presenting at the workshop

Dr. Nagui Rouphail and Dr. Asad Khattak (UT)