

# RESEARCH AND TECHNOLOGY REVIEW

*NDOT Research*

## **PROJECT COST ESTIMATION FOR PLANNING**

By Dr. Sirous Alavi, P.E., and Dr. Kambiz Raffiee

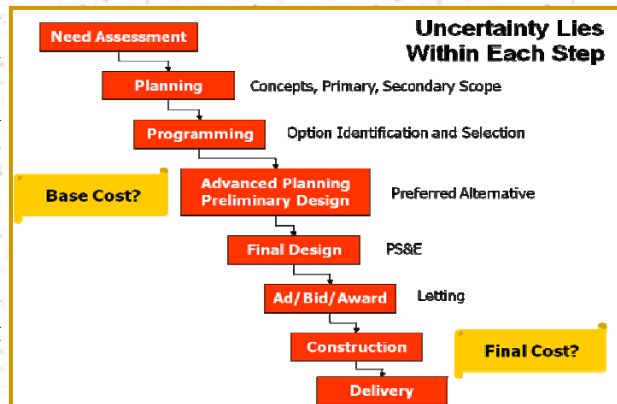
Inaccuracy of early cost estimates continues to plague the construction industry in general and highway construction in particular. Ninety percent (90%) of transportation infrastructure projects constructed worldwide are reported to have experienced cost overruns.

Because project nominations are linked to estimates of future funding and the analysis of system needs, the inaccurate cost estimates lead to overloading work programs with many projects that are underfunded. This often leads to misallocating design resources and creating false expectations with the public and other stakeholders.

To address this issue many federal, state, regional and local transportation agencies have launched programs to mitigate the discrepancy between budgeted costs and final costs of their projects. A research project sponsored by NDOT on “Project Cost Estimation for Planning” is underway by Sierra Transportation Engineers, Inc. (STE). The primary objective is to provide a good methodology for accounting for risks (uncertainties) in planning cost estimation. Risk factors can be driven by environmental mitigation requirements, insufficient knowledge of right-of-way, unforeseen engineering complexities and constructability issues, and changes in market conditions.

As shown in the above figure, project uncertainty lies within each step of the project from inception to completion. STE conducted a comprehensive literature review of the cost estimation practices by a number of agencies around the country. The results of the literature review were instrumental in the development of a “Risk Tracking System” for NDOT. The Risk Tracking System contains two modules. The first module is a database, which can be used for continuous updates of cost and schedule changes through various risk factors throughout the life of a project. The second module is a Monte Carlo simulation element that can be run to provide up-to-date risk analysis based on historical data.

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Project Cost Estimation & PEC Meeting

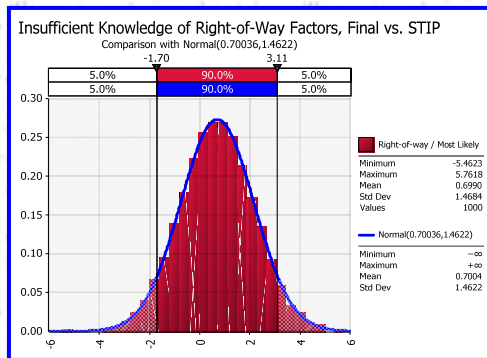
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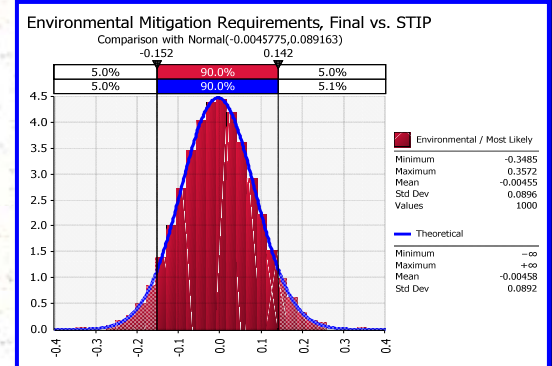
The figures below conceptually illustrate the fitted distribution of risks during the Monte Carlo simulation analysis. NDOT spent a significant effort in assembling the necessary data for the risk factor simulation analysis. Work is currently underway to utilize the cost data to develop the initial set of NDOT specific risk factors.



There is active participation by project panel members from various agencies around Nevada including the Regional Transportation Commission (RTC) of Washoe County, RTC of Southern Nevada, City of Las Vegas, City of North Las Vegas, and Clark County. A series of interviews are underway with planning staff from those agencies to better understand the similarities and the differences of how agencies develop their early cost estimation for planning.

A ranking survey has been developed for widespread distribution among planning staff to capture the significance of various risk factors in project cost estimating practices.

This research is intended to improve the early cost estimation practices by capturing risk factors responsible for the variance between initial cost estimates and final project costs; this project is also on time with an early 2009 delivery date.



## PRODUCT EVALUATION COMMITTEE (PEC) JUNE 2008 MEETING RECAP

By Roma Clewell

**Membership:** The Product Evaluation Committee has had a change in membership due to retirements or position relocations. The new committee is Jason Van Havel (Chairman/Research), Ken Chambers (Operations Analysis), Steve Hale (Construction), Ray Hurley (Specifications), David Lindeman (District III), Kent Mayer (Maintenance), Dave Partee (Safety/Traffic), Mohamed Rouas (District I), Todd Stefanowicz (Bridge Division), Dave Titzel (District II), and Dean Weitzel, (Materials). Non Voting members are Roma Clewell (Research), Tie He (Research), Andrew Soderborg (FHWA), and Heidi Wood (Research). Two additional positions will be added; one position is in Equipment Services and the other position will represent Roadway Design.

**New and/or Revised Specifications:** The specification for Anti Graffiti Coatings 502.02.05a has been revised to include pre-screening criteria for permeability, adhesion to concrete, accelerated weathering, salt spray, and VOC testing. Also the retroreflectometer readings will be revised from 8 gloss units on a 60° gloss meter to 8 gloss units on a 50° gloss meter.

The specification for Concrete Stain 502.02.05 has been revised, deleting the Vehicle Type, Cure Time, Efflorescence and Water Absorption Resistance criteria. New criteria was added for Permeability. The Adhesion to Concrete's psi was changed from a minimum of 20 minutes to a minimum of 300 hours dry time, the Accelerated Weathering test hours were extended from 1500 hours to 3000 hours with no visible effects. Additionally, Salt Spray was reduced from 3000 hours to 500 hours with no visible effects.

The request to modify the Reflective Sheeting 716.03.01 specification was rejected due to FHWA's non approval of the Public Interest Finds on the 3M's DG3 Reflective Sheeting and because an ASTM category hasn't been developed. The vendor may apply under anyone of our current Qualified Product List (QPL) categories of type III-type X providing the minimum qualifications for that category are met. The investigation of this topic lead to the development of a NDOT committee who will explore the concept of limited or no overhead lighting systems on traffic signs. The request to modify the Rapid Dry Waterborne Paint Material 729.03.05 specification was rejected due to several factors. There were failures on a field test, inferior paint formulations and the core elements are too large and have been proven to shear off with nominal snow plow passes. Furthermore, FHWA has awarded 3M a Highways for Life grant to adapt it's all-weather pavement marking system to make it cost effective for temporary use in work zones. NDOT's policy is to use products with a proven history. Since the product is still being refined, it is premature to make any changes to current specifications. Lastly, NDOT has a policy to not introduce systems into our QPL categories, but to keep the formulations generic so that all vendors may participate.

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**Field Tests:** Briteline requested NDOT approve a field test for their 900 Permanent Tape and conditionally approve interim use of the tape in the South. NDOT's policy is to ensure that QPL products meet minimum requirements for both North and South conditions; therefore, the request for interim approval has been denied. NDOT did approve a North and South 3-5 year field test of the product on the condition that additional data is collected from other states and test decks during the 3-5 years.

A field test for the Barrier System Incorporated's Tau II Crash Cushion was approved for I-515/US-95, SBL, near the casino center off ramp. The field test will serve to establish the requirements for an in-service performance evaluation. The Tau II Crash Cushion is a full re-directive and non-gating system. It is intended for installation on concrete or asphalt surfaces with impact capacities up to 70 mph and widths to treat hazards up to 102" wide.

**Informational Items:** In March a failure occurred with Trinity Industry's TRACC Family of Crash Cushions. This product was removed from the QPL due to a unit failure to function through full stroke length, and in at least one case, the shredders disengaged completely, resulting in significant reduced mitigation of forces. After addressing the failure and completing appropriate tests, the vendor may re-apply for possible inclusion on the QPL.

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Research would like to thank Dean Weitzel and Gayle Maurer, Materials Division, for their efforts in creating a "Going Green" program. The program encourages the use of "green products" by attaching a logo next to the product on the QPL, which will serve to identify the product has meet quantifying measures and definitions for an environmentally friendly, product. We'd also like to thank Army Hass, Multi Media-Publications Design Division, who designed the logo. More information will be forthcoming as the website is developed and the logos are populated on the QPL.



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Research has developed a web site that includes pages for our three disciplines: Research Program, Product Evaluation Program, Research Library. Links have also been established for Research's SharePoint site, the T2 Center, Standard Specifications, and forms.

The address for Research's web site is: [http://www.nevadadot.com/reports\\_pubs/Research\\_Pubs/](http://www.nevadadot.com/reports_pubs/Research_Pubs/)

## CONSTRUCTION'S FIELD TEST OF HENKEL LOCTITE'S MAGNA-CRETE ALL WEATHER FAST SETTING CONCRETE REPAIR SYSTEM

By Roma Clewell



In April, a team of NDOT construction workers met on US395 to watch a demonstration from Henkel Loctite's Fast Setting Concrete. Bob Bacchetti, Henkel Loctite's Adhesives and Sealants Specialist, brought out a 5 gallon bucket of aggregate and added in the activator stirring the mixture into a thick slurry. This was then poured on top of the damaged pre-treated surface (clean, dry, and free of loose materials) concrete barrier. Within 20 minutes the form was removed and the fast setting concrete was dry to the touch. Excess slurry was wiped away with water. Bob said that a summer additive and winter additives are available which can be mixed and applied from temperatures of 15°F to 130°F. Once in place, the area can be built upon, walked on, or driven over in as little as one hour. The product bonds to concrete, wood, glass, steel, and other construction materials. The expense of the product may be modified by adding extra aggregate to the mixture. The performance of the system was outstanding.



## ***CARSON HIGH SCHOOL SENIOR RESEARCH PROJECTS***

***By Roma Clewell***

In April a group of community volunteers came together to review the Carson High School senior class research projects. This program has been developing over the last eight years. It was developed to keep students engaged throughout the school year with an opportunity to be in charge of their learning. All seniors are required to participate including the students with learning disabilities. This year 440 students participated.

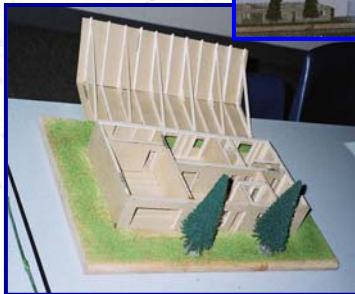
The process includes each student selecting a research project. The projects range from projects within a career field they are interested in to a topic the student has always wanted to try, but needed the motivation to accomplish. Any subject is allowed as long as it is not illegal or dangerous. Of course dangerous is relative as some of the students engaged in mountain climbing, sky diving, etc.

Once the topic is chosen, the student chooses a mentor who provides direction, training, and documents the student's progress. At the end of the projects, the students prepare a research report (portfolio) that is reviewed by a community volunteer for completeness, professional appearance, quality of response, individual voice, and grammar/spelling (accuracy). The student also gives a verbal presentation on their topic, which is also reviewed by a community volunteer for content, organization, delivery, language and professional decorum.

The panel member volunteers represent State and City employees, Carson City Chamber of Commerce, Western Nevada College, Legislative Counsel Bureau, Carson City Senior Citizens Center, AARP, Nevada Appeal employees, Carson City Democratic and Republican Parties, School District employees, Board of Realtors, banking institutions, and parents. Three hundred forty-seven panel members served on four hundred seventeen panels.

Roma Clewell had the opportunity to participate this year as a judge. She enjoyed four presentations and was impressed with the caliber of the reports and with the faculty support and direction given to the students for preparing and presenting the reports.

*Joey Machado  
presented,  
"Engineering vs.  
Architecture".*



*Panel Members: Kathi Wexler, Robert Prater, Nan Kreher, Deani Pulsipher, and Tamera Pierce*

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Brad Mustafa presented, "Bowling".

Brittany Borges presented,  
"Fabrication of her 97  
Jeep Wrangler"



The intention of the project is for the senior students to come away with a sense of accomplishment and confidence with their abilities to transition into adulthood. The panel members are given an opportunity to see the side of the students rarely printed in newspapers and an opportunity to learn what Carson City High School does to educate the youth of tomorrow.

As a researcher, and panel member volunteer, Roma Clewell is excited about the youth of tomorrow, and proud this community is actively looking to tomorrow.

## NDOT Research

### New Technologies for Work Zones

By Dr. Hualiang (Harry) Teng

In the work zone project, speed monitoring display (i.e., speed trailer) was tested on I-15 Northbound between Flamingo Road and Tropicana Avenue (see the figure below). Scenarios for different sizes and flashing rates of speed signs were tried. In addition, the study also tested the performance of a second speed trailer in the tested work zone. Observational data were collected using videos that were processed later in house. Comparisons of the speeds collected for different scenarios were made for different types of vehicles running in free flow conditions based on hypothesis testing method and regression models.



The following conclusions were made:

- (1) Speed trailers can significantly reduce operating speeds on freeways.
- (2) The size and features of the sign did matter to the performance of speed trailer.
- (3) The displays should be enhanced and used in the right place and right time.
- (4) The additional speed trailer can be very effective in reducing vehicle speeds when the amount of speed reduction at the first location is not sufficient.
- (5) Speed trailers are very cost effective in reducing speed on freeways.

Thus, it is recommend that a speed trailer be used in work zones for reducing operating speeds. The study suggested that it is reasonable to require the use of speed trailers on construction contracts.

**Above picture:** A snap shot from the videos collected in the field. Speed trailer was on the upper left in the figure. The numbers shown in the figure are speeds measured using an image processing technique.

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**LIBRARY CORNER**

*by Heidi Wood*



The NDOT Research Library holds a large selection of magazines, journals, study materials, along with publications from FHWA, TRB, TRR, and US DOT.

Also, look at our webpage on the NDOT Homepage under, "Reports and Publications".

[www.nevadadot.com](http://www.nevadadot.com)

The Research Library is located in room 115, in the main NDOT Headquarters building. Stop by whenever you can, and I'll be happy to show you around. For those of you in other areas, remember; I send any book, anywhere in Nevada! So just send me a request of what you may need, and I'll put it in the mail to you!

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*About NDOT's  
R&T Review*

The NDOT Research Division administers the Department's research, development and technology transfer program and serves as the "clearing-house" for product evaluations.

Research and Technology Review is published quarterly by the NDOT Research Division. Its purpose is to provide the latest information on the NDOT research activities including product information and other pertinent research topics.

If you have comments or need additional information regarding any of the topics discussed in this issue, please contact the Research Division.

Edited by

Heidi Wood

Research Analyst