SEPTEMBER 2011

Welcome to the UDOT Research Division SEPTEMBER 2011 Edition Newsletter

This is a quarterly publication that provides highlights of the Division's research activities as well as other helpful information.

A MESSAGE FROM THE RESEARCH DIRECTOR

By: Cameron Kergaye, PhD, PMP, PE

The AASHTO Research Advisory Committee held its annual meeting in Salt Lake City last month. The theme of the meeting was 'The Road to New Partnerships and Possibilities' which seemed timely in light of RITA's recent release of an RFP for new UTC competition. However, the focus was on national efforts to strengthen the identification and implementation of valuable research results.

Combined with the TRB State Representatives meeting, participants included directors and managers of research from state DOTs, FHWA, AASHTO, TRB, NCHRP, SHRP 2, CUTC and a few research-oriented consultant firms. UDOT's Executive Director, John Njord, provided opening remarks and later joined a panel discussion on engagement of agency leadership in research.

The purpose of the annual meeting was to learn about best practices and share information on transportation research. There was an exchange of ideas, problems and solutions to solve national issues related to DOT research programs. Among many challenges presented was that of research funding.

To offset limited research funds, states are encouraged to participate in NCHRP's call for problem statements. While many university researchers are aware of this opportunity, funded research is often awarded to problem statements with strong DOT authorship. So I encourage UDOT engineers to consider submitting NCHRP problem statements by the September 15th deadline. I also encourage university experts to partner with their DOT professionals to jointly develop statements that address our transportation challenges.

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By: David Stevens, P.E.
UDOT Research Division

APRIL WORKSHOP BRINGS NEW PROJECTS

We had a successful "UTRAC" Research Workshop on April 7 at the SLCC Larry Miller Campus in Sandy, Utah. At the workshop nearly 100 people from UDOT, FHWA, Utah's research universities, consulting firms, and other research partners gathered to discuss the research needs of UDOT, and decide which ones are the highest priorities.

The general session featured a keynote address by James Christian, Administrator of the FHWA Utah Division, on Every Day Counts initiatives being promoted by FHWA nationwide. We presented the Trailblazer Award to Blaine Leonard for promoting transportation research while working in the Research Division over the past several years.

There were 42 problem statements discussed and prioritized at the workshop, representing 5 subject areas: Construction & Materials, Maintenance, Traffic Management & Safety, Geotechnical, and Structures. After the workshop UDOT central division leaders reviewed the ranked list of problem statements and selected 13 high-priority statements for their new research projects.

These 13 new projects were presented to a group of UDOT senior leaders (the UTRAC council) and will be funded by the Research Division for this new fiscal year. Some of these are planned to be pooled fund projects with transportation departments in other states. The 13 new projects address the following topics:

Cameron Kergaye, UDOT Research Director, addresses workshop participants

- Low temperature test for asphalt mixtures
- Cold-in-place asphalt pavement recycling
- Performance of pavement preservation treatments
- Sign management plan & system for UDOT
- Utah winter severity index
- Cost effective selection of snow plow blades
- Mobility-related work zone traffic control performance measures
- Safety effects of signal improvements
- Design and monitoring of surcharged embankments

Additional information on the 2011 workshop, the above new projects, and other past workshops can be accessed by going to our web site (www.udot.utah.gov/go/research) and clicking on "UTRAC Workshop."

Some additional problem statements from the 2011 workshop will be funded as new research projects by other UDOT divisions. We appreciate these efforts and look forward to working with technical experts from throughout the Department and our consultants on all the new projects.

The Construction & Materials workshop breakout group discusses research problem statements

By: Kevin Heaslip, Ph.D., P.E.
Utah State University
Abdul Wakil, P.E.
UDOT Research Division

DEVELOPMENT OF A SIGN MANAGEMENT SYSTEM FOR UDOT

With current budget constraints and limited resources it is imperative that transportation agencies adopt comprehensive management strategies for an agency's assets.

In the past transportation asset management has been primarily focused around maintaining road and bridge assets. The Manual on Uniform Traffic Control Devices (MUTCD, 2003) included a revision that mandated minimum retroreflectivity levels that must be maintained for traffic signs (FHWA, 2007). Since the establishment of this mandate, which included a requirement that agencies adopt a management strategy for maintaining sign retroreflectivity, there has been a significant emphasis on sign asset management.

There have been many concerns by transportation agencies over the implementation of the new standards. Maintaining minimum retroreflectivity levels can put constraints on maintenance budgets and carry potential negative impacts on transportation agencies (Opiela and Andersen, 2007).

While potential management methods have been proposed, there is little guidance offered with regards to specific methodology. In order to ensure compliance with the new retroreflective standards it is important to understand how to track sheeting performance as well as the current state of compliance when considering any management method. The development of a management strategy must include an evaluation of various methods as well as of their potential effectiveness in ensuring compliance with the new MUTCD standards.

It is the intent of the UDOT funded research project currently being conducted by Utah State University to build upon previous research by identifying issues that should be considered and by evaluating the effectiveness of various proposed management strategies with conditions unique to Utah.

To develop efficient management strategies it is necessary to identify the situations that are unique to a particular agency that contribute to the overall compliance with sign retroreflectivity standards. Establishing protocol to identify expected sign life as well as special situations and geographic areas that are high risk for premature retroreflective failure is an important step in being able to adequately implement a sign management strategy.

Previous research on certain factors thought to be significantly correlated with sign retroreflective deterioration has proven inconclusive. While general trends have been established for some factors, there have been limitations identified such as inadequate data, potentially important factors that were not considered and unexplained results. It has been identified that the performance of retroreflectivity sheeting is unique to individual areas and should be considered in developing a management plan.

Figure 1: Retroreflectivity Examples

(Continued on page 4)

To comply with the new standards, MUTCD provides six assessment or management strategies as guidance. An agency using one of the recommended assessment or management methods will be considered in compliance with standard mandated.

The methods acceptable for compliance are listed as follows from the MUTCD:

- Visual Nighttime Inspection
- Measured Sign Retroreflectivity
- Expected Sign Life
- Blanket Replacement
- Control Signs
- Other Methods

To develop a comprehensive and efficient sign asset management system that includes maintaining retroreflectivity, significant issues relating to the infield service life of signs must be identified. Identifying current compliance issues and circumstances unique to UDOT's assets will provide a basis for evaluating and developing a management strategy suitable to meet the needs of UDOT and ensure compliance with the new MUTCD standards.

In order to effectively develop a management plan to manage the retroreflectivity of traffic signs at a large scale this research will attempt to answer the following questions.

- What is the current state of art in managing sign assets for retroreflectivity?
- What is the current state of UDOT's sign assets?
- What problems can be identified relating to UDOT's assets and compliance with MUTCD standards?
- Given the conditions unique to UDOT's assets and Utah what strategy or combinations of strategies are best suited for meeting UDOT's needs?

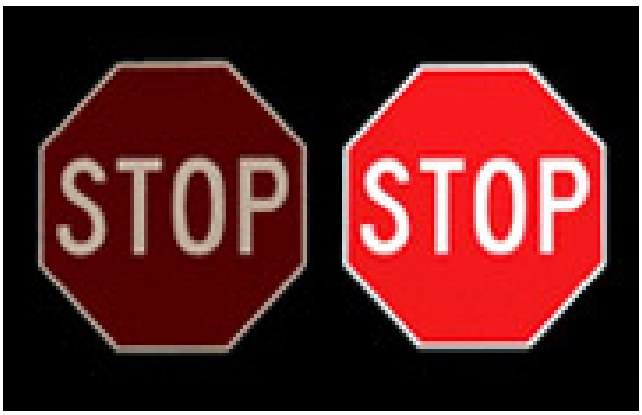

Figure 2: Regular Reflectivity Example

In order to evaluate the performance of retroreflective sheeting in Utah a management strategy must include a plan to assist in determining what kind of situations may contribute to performance failure in Utah. Additionally the effectiveness of individual management methods will need to be evaluated considering these unique situations in order to determine a suitable management strategy.

The final reports for this project are available for download at the Research Division website. For more information on this study, contact Dr. Kevin Heaslip, kevin.heaslip@usu.edu, of Utah State University, or Abdul Wakil, awakil@utah.gov, 801 965-4455

By: Grant G. Schultz, Ph.D., P.E., PTOE
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IMPROVING ROADWAY SAFETY WITH STATISTICS & CRASH PREDICTION

In 2009 the UDOT Traffic Policy Committee identified a need for research that could support UDOT's efforts to select and evaluate roadway safety measures using advanced, science-based methods. With participation by the UDOT Traffic and Safety Division, a research team from Brigham Young University (BYU) recently completed a three-part study in which they provided UDOT with useful tools and recommendations to help fill the identified need.

In Part 1 of this study, the effectiveness of raised medians and cable barrier treatments was evaluated to demonstrate an application of hierarchical Bayesian modeling, and to provide valuable insights into the effectiveness of the selected treatments. The research team first reviewed existing literature on highway safety practices, including safety effectiveness evaluation methodologies. Then, several sites were identified where raised medians and cable barrier have been implemented in the last 10 years on Utah highways. One of these study sites is shown in Figure 1.

Figure 1. Raised median study site on 12300 South (SR 71) (Google 2010)

Relevant data for each of these sites were collected including crash data, average annual daily traffic (AADT) data, milepost data, and the countermeasure installation date. Finally, a hierarchical Bayesian model was developed for each type of treatment and used to determine the change in crash frequency and severity experienced at each site between the before and after periods.

As shown in Table 1, the results of the analyses indicate a statistically significant reduction for both crash frequency and crash severity for study sites where a raised median has been installed, and that the installation of cable barrier has a statistically significant reducing effect on crash severity and cross-median crashes for study sites where cable barrier systems have been installed.

Table 1: Summary of analysis results using a hierarchal Bayesian statistical model

Treatment	Type of Analysis	Probability of Decrease	Percent Change Expected
Raised Median	Overall	100%	-25%
	Severe	100%	-36%
Cable Barrier	Overall	0%	30%
	Severe	100%	-44%
	Cross-median	100%	-62%

However, the analysis showed that cable barrier was not effective in reducing overall crash frequency, as analysis sites experienced an increase of 30 percent in the overall crash frequency. These results were somewhat expected since cable barrier systems are not designed to prevent crashes but are designed rather to reduce crash severity. The hierarchal Bayesian model developed through this research can now be utilized as a tool in additional analyses, including hot-spot analysis, before -after change, and general safety modeling.

(Continued on page 6)

For Part 2 of the study, the research team worked with UDOT to calibrate the AASHTO Highway Safety Manual (HSM) Safety Performance Function (SPF) for rural two-lane two-way roads to make the nationally-developed SPF accurately fit Utah conditions. SPFs are models used to predict the crash frequency of a roadway based on the characteristics of similar roads and their crash histories. The secondary objective of this part of the study was to develop a Utah-specific SPF that can be used in lieu of the HSM SPF.

Various sources were used to compile data into a dataset large enough to produce reliable statistical models that predict crashes. As many characteristics as reasonably possible were investigated to find the variables that have a significant influence on crashes. The variables from their respective sources are shown in Figure 2. Reference to "Roadview" in the figure refers to UDOT's Roadview Explorer, an online photolog of roadway images.

The HSM SPF calibration factor developed for this study was 1.16. This factor indicates that Utah generally experiences 16 percent more crashes on rural two-lane two-way roads than are predicted by the HSM. Four new SPFs were developed, and the one recommended to UDOT for use with predicting crashes on rural two-lane two-way roads includes only four variables for a roadway segment: segment length, AADT, percent combo-unit trucks, and speed limit. This model is recommended because it accurately predicts crashes without requiring a great amount of data.

The models developed by this research are expected to be useful during the planning process and in yearly safety evaluations. An understanding of the factors that are related to crash occurrences can help UDOT and local agencies make informed decisions affecting the safety of our roadways.

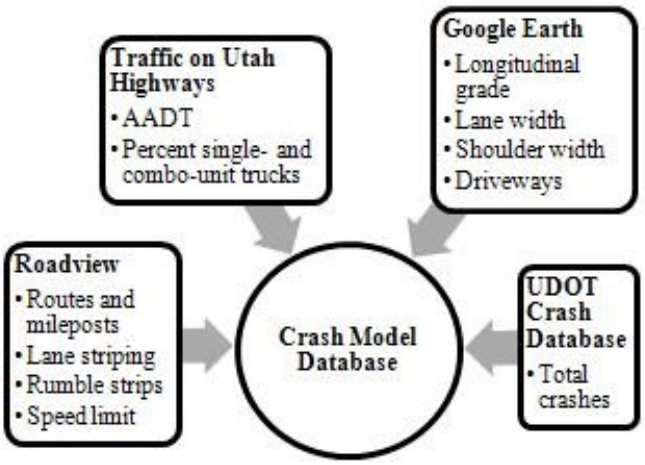

Figure 2: Origins of data used for the HSM SPF calibration and new SPFs

In Part 3 of the study, the research team provided UDOT with a recommended framework for highway safety mitigation and workforce development. This framework is based on the HSM Roadway Safety Management Process and includes identifying safety "hot spots", implementing cost-effective countermeasures, and improving future decision making and policy.

Three final report volumes on this research are available on the Research Division website. Additional information on the study can be obtained by contacting Dr. Grant Schultz (gschultz@byu.edu) or Dr. Mitsuru Saito (msaito@byu.edu) of BYU, Scott Jones (wsjones@utah.gov) of the UDOT Traffic and Safety Division, or David Stevens (davidstevens@utah.gov) of the UDOT Research Division.

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EVALUATION OF UTAH WORK ZONE PRACTICES

Work zones limit capacity, create queues, and present a distraction for motorists. As technology has improved, so have Temporary Traffic Control (TTC) devices in the attempt to make traffic flow smoother through work zones and increase the safety. Utah State University was contracted by UDOT to examine the compliance of Utah work zones with new standards implemented in the 2009 MUTCD. Changes in the 2009 MUTCD include guidelines for pedestrians to navigate safely, inclusion of a section on incident management, and modified guidelines on the use of traffic control in work zones.

To conduct the evaluation of Utah work zones, USU researchers audited 11 work zones in the summer of 2010 throughout the state of Utah. To supplement the data collected in the field, a survey was sent to members of the Associated General Contractors (AGC) Highway Committee to gather the outlook of experts concerning work zone and attain possible solutions.

After the audit of the work zones, each was evaluated adapting work zone road safety audit procedures previously developed by the University of Nebraska and Utah State University. These work zone guidelines were adapted into a quantification tool called the Work Zone Safety Assessment Risk Analysis Tool (WZ-SARA). WZ-SARA (Figure 1) was designed to identify risk in work zones and issues that should be addressed in a quick manner by construction personnel, engineers, and inspectors.

The output of WZ-SARA (Figure 2, p.8) is a risk score that represents the overall risk that the work zone presents to drivers and workers. Reduction of this score means that characteristics of the work zone that may cause incidents are mitigated. Furthermore, the spreadsheet is effective when comparing work zones and determining the relative safety of the work zones. In addition to comparison between work zones, WZ-SARA can also be used as a basis for a benefit/cost analysis.

The evaluation of the work zones resulted in the observation of many positive practices and the revealing of areas for improvement. Researchers observed a high level of adherence to the MUTCD in urban and rural work zones. However, the most common areas for improvement were regarding the use of positive protection and providing pedestrian pathways in work zones.

Before Improvement Audit

Road	Area
INTERSTATE	URBAN

	Advance Warning Area	Answer	Risk/question
1	Is there adequate advance warning distance?	NO	20
2	What is the condition of the signs?	LOW	10
3	Is the set-up of the signs crashworthy?	YES	3
4	Is the spacing between signs adequate?	YES	0.75
5	Are Variable Message Signs used?	YES	3
6	Is speed limit through the work zone clearly stated and enforced?	YES	3.75

	Transition Area	Answer	Risk/question
1	What is the condition of the signs?	HIGH	0.75
2	Is the set-up of sign crashworthy?	YES	3
3	Is an arrow board used, and fully functional?	YES	4.5
4	Are barrels set up correctly?	YES	1.5
5	Are there scrapped or crashed drums?	NO	1.5
6	Is the length of the taper adequate?	YES	3
7	Are barrels susceptible to being hit?	YES	5

Total Risk Score Per Area		Percentage Per Area
Advance Warning Area	10.94	40.5%
Transition Area	5.01	19.3%
Activity Area	45.00	100.0%
Termination Area	0.81	40.5%
TOTAL	61.75	

Go To After Improvement Audit Form

Help

Go To Graphs

Figure 1: WZ-SARA Interface

To obtain expert problems/solutions feedback, the survey was sent to members of the AGC Highway Committee. The general consensus is that concrete barriers are the best countermeasure for worker safety, but it is not feasible to use them in all highway projects. The survey revealed concerns are related to cost of installation along with the delays that come with the use of concrete barriers. The survey also revealed that providing access for pedestrians is a challenge that the members of the AGC were striving to improve upon.

(Continued on page 8)

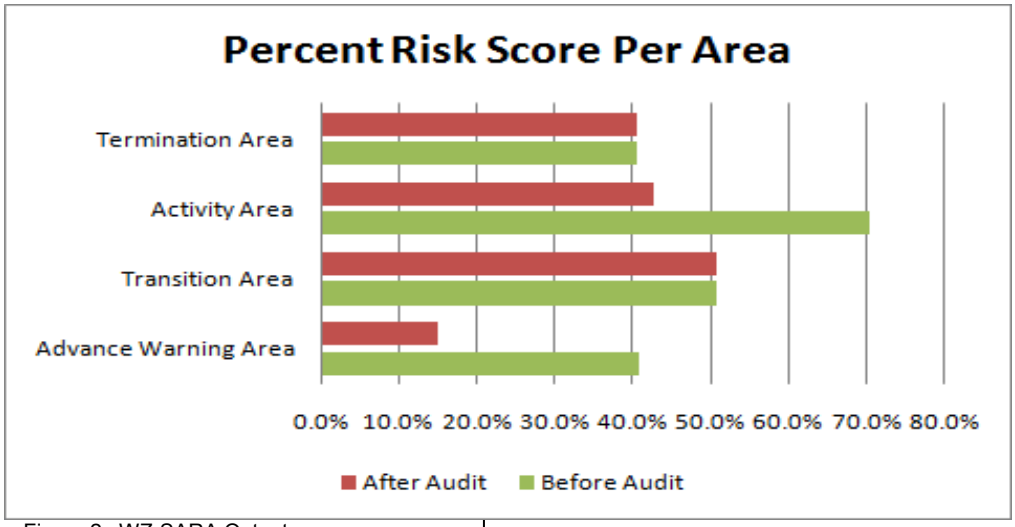

Figure 2: WZ-SARA Output

The recommendations for improvement of the observed work zones include:

- Speed limit regulation throughout the work zone. A clear statement of the speed limit through the work zone, and making clear to the driver that the limit will be enforced can make the work zone safer for workers and drivers.

- Set clear, non-conflicting, pavement markings or clear delineation for drivers. Using delineators whose retroreflectiveness is not compromised, and assuring that delineators are clean from cement dust or other materials that may do that.

- Making a pedestrian pathway available at all times. The use of special barriers that are detectible to pedestrians with disabilities. Also, coordination between construction and utility companies would be necessary so that only one side of the sidewalk is under construction and not both. Prioritizing pedestrian safety in the planning phase of the project could help with coordination, and set-up of a safe pedestrian pathway.

- More use of positive protection. Using concrete barriers, truck mounted attenuators and other devices that keep workers from the traffic stream would lessen the severity of crashes in work zones.

- Shorten the distance between the warning area and transition area. If the distance is too large between area, driver expectation can be compromised. Consistency throughout the state can remedy this problem.

These recommendations are easy to implement, and the impact can be significant. The implementation of WZ-SARA can be immediate, because of its simplicity and applicability.

The final reports for this project are available for download at the Research Division website. For more information on this study, contact Dr. Kevin Heaslip, kevin.heaslip@usu.edu, of Utah State University, or Daniel Hsiao, 801-965-4638, dhsiao@utah.gov of the Utah Department of Transportation.

By: Mitsuru Saito, Ph.D., P.E.
Brigham Young University
Taylor R. Forbush, E.I.T.
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AUTOMATED ESTIMATION OF TRAFFIC DELAYS AT INTERSECTIONS

One of the key functions of the UDOT Traffic Operations Center is to measure traffic performance on surface streets so that real-time adjustments may be made. Performance at signalized intersections is difficult to measure because of the variation in traffic volumes, vehicles speeds, queue buildup, vehicle delays, and the degree of saturation. Having a method to automate traffic delay estimation would enhance the department's traffic management efforts. Ideally, the methodology would use existing technologies.

Brigham Young University conducted a study to determine if an algorithm could be developed that would allow traffic delays to be estimated using existing traffic detection hardware. The algorithm development used computer models using VISSIM traffic simulation software. Data collection points were set up in the model to collect vehicle identification number and a simulation time stamp at each collection point in the model. Exact travel times of simulation vehicles in the models were collected by matching vehicles with their upstream and downstream sensors and subtracting the downstream time stamp from the upstream time stamp.

The results for each of the vehicles were averaged to determine the average travel time. The average delay obtained in this manner represented the ground-truth delay. The ground-truth average delay was compared to the average delays determined by the algorithms developed in the study. The algorithm produced an accuracy level that could be used in practical application. The algorithm provided results with acceptable tolerances that could be used to determine a Level of Service or to obtain travel time estimates.

Results for the through-only type of facility offered the greatest level of accuracy, as expected. Delay values obtained from the through only configuration were all within 3 seconds per vehicle of the actual delay time.

Results for the roadway configuration with a driveway with sensors also showed reliable results. Results for the roadway configuration with a driveway with no sensors also showed accurate results. In the configuration without the driveway sensors, 84 percent of the results had averages with errors smaller or equal to 5 seconds per vehicle. Lastly, the results for the roadway configuration of a turning bay with turning bay sensors provided accurate results. 94 percent of the turning bay results had averages with errors smaller or equal to 5 seconds per vehicle.

One concern discovered in the research is that getting accurate results required having vehicle sensors located downstream of the stop bar at the intersection. The department's existing vehicle detectors at signalized intersections, whether inductive, radar, or video, are not currently configured to be able to detect vehicles after they have entered the intersection. This research was able to show that it is possible to accurately estimate vehicle delays using existing technologies. Unfortunately UDOT is unlikely to have the resources to reconfigure its intersection detection solely for this purpose.

The final report will be published soon at the UDOT Research Division website. For more information on this study, contact Dr. Mitsuru Saito msaito@byu.edu of Brigham Young University or Kevin Nichol knichol@utah.gov of the Research Division.

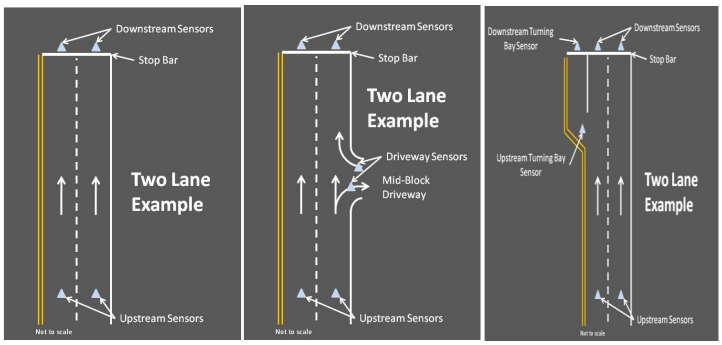

Figure 1: Two lane examples of through-only vehicles, mid-block driveway with driveway sensors & left turning bay.

By: Joni DeMille
UDOT Research Division

UDOT'S LIBRARY HAS SOMETHING FOR EVERYONE

Ever wondered what "color" you are? We have the Color Code books containing the self-test and details about each personality type. Want to advance? Brush up your interview skills with one of our technique books. A big meeting or presentation coming up? Stop by for a book on how to hold better meetings and give more dynamic presentations, or for a fun book with games and icebreakers. Want to learn Spanish? Check out our CD/DVD instructional set and get going.

Most of you probably know that UDOT's Lester Wire Library houses technical reference materials, research reports and AASHTO and TRB publications frequently used by our engineers. Our collection also holds many items of more general interest, including personal development materials. Examples of these items can be perused in the rotating display located outside the library doors.

Figure 1: The Library is open from 8:00 a.m. to 5:00 p.m. Monday through Friday.

You might be surprised to learn that we have books on developing and improving leadership, communication, writing and customer service skills. Some of these topics are also available in audio or video/DVD format. We also have project management books, software manuals, including some from the popular "for Dummies" series, materials on building work teams, managing stress and panic attacks, resolving conflict and dealing with difficult people.

All of these famous authors are represented on our shelves: Stephen Covey, Lee Iacocca, Dale Carnegie, Anthony Robbins, Bill Gates and Lance Armstrong. We even have a smattering of books on finance and retirement, as well as some fiction and nonfiction books.

Feel free to come in and browse through our general collection for any items that might be of interest or of help in improving your skills. Library materials can be checked out for 4 weeks, with renewal available on items that haven't been reserved by another employee. If you need an item we don't currently have, we can request it from another library through interlibrary loan. The Lester Wire Library has something for everyone. Stop by any time during our working hours to check something out or just to see what we might have for you.

For more information regarding library requests please contact Joni Demille, jdemille@utah.gov, 801 965-4626.

A LOOK AT WHO WE ARE

The Utah Department of Transportation (UDOT) Division of Research is pleased to announce that Steve Bagley, M.P.C., has joined the research team as our Technical Writer.

Steve has a strong technical and media writing background with a wide range of professional and educational experiences that will be a valuable asset to our research team. He has researched, and written numerous grant proposals, academic research studies, corporate newsletters, various public relation pieces, etc.

Interestingly, Steve has worked in the film, television and radio industry for 15 years. Previously, he held several positions on seven different shows for KJZZ 14, was a D.J. for 88.1 KWCR and a freelance media consultant in the Salt Lake City area.

In addition to his media experiences, Steve has served as an AmeriCorps Vista for the Utah Office of the Lt. Governor, Utah Division of Homeland Security and The Utah Commission on Volunteers, where he temporarily managed the State of Utah Citizen Corps program, the Be Ready Utah Vista program, served as a Sub-Committee member on the FEMA Salt Lake City Urban Area Security Initiative, and the White House Disaster Recovery Working Group (2009). For his hard work and efforts, Steve received the Presidential Service Award from President Barack Obama (2010).

Recently, Steve graduated with a master of Strategic Communication degree from Westminster College where his thesis identified key characteristics of online viral videos. Also, he graduated with honors from Weber State University with a Broadcasting Bachelor of Science degree and received the National Deans List award for being in the top 7% of his graduating class in the nation. Steve minored in Military Science and participated in the Army ROTC where he was given the Superior Cadet Award from Maj. General Thrasher (2005).

The Research Division is enthused about benefitting from Steve's talent and diverse experience. Please join us in welcoming Steve to UDOT Research.

You may contact him at 801-965-4534 or Sbagley@utah.gov.

By: Abdul Wakil, P.E.
UDOT Research Division

RESEARCH POSTER SESSION

This year at our UDOT Annual Conference, we will be featuring a "Research Poster Session" in the foyer of the South Towne Exposition Center in Salt Lake City, Utah.

Come meet creative minds and discover new approaches to transportation practices. Visit with your professional and research colleagues in a poster session that will be displayed outside the main hall.

UDOT, university professors and students will present transportation challenges and solutions in an informal setting. Innovations and improvements to current practices will be discussed in a one-on-one setting. Poster session presenters will be available to answer questions on Wednesday, November 16, 2011, from 8 am -12pm. Registration will be opening soon.

We encourage our research partners to participate by preparing posters for this event. For more information, poster reservations and to submit topics please contact Abdul Wakil, awakil@utah.gov or (801) 964-4455

Research Poster Guideline Link

Completed UDOT Research

Research publications are valuable resources, documenting the results of important research projects. For a list of recently completed Research Projects, please visit the Research Division website at:

www.udot.utah.gov/go/research

If you would like to obtain an electronic copy or a printed copy of our completed research reports, please contact awakil@utah.gov.

Need a Literature Search?

The UDOT Research Division and library provide an important service through literature searches. These searches help identify published information about a topic of interest

To request a literature search, provide a brief description and some key words and submit it to:

Abdul Wakil at awakil@utah.gov.
or
Joni DeMille at jdemille@utah.gov.

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