Benefits of Highway Traffic Research

WALTER H. KRAFT
International President
Institute of Transportation Engineers
Senior Vice President
Edwards and Kelcey, Inc.

The benefits of highway research are many and include savings of lives, savings of billions of dollars, reduced accidents, better procedures, and an improved quality of life. These benefits are not always perceived as being useful by the public or even the profession, since some research does not produce a product that can be applied by practitioners in the field. However, this type of research is necessary for other research to occur. We obtain this type of research, which we can call basic research, from our think tanks in universities, industry, and government. The benefits of basic research are very difficult to assess, but it is necessary to advance our state of knowledge and our profession. Without it, we would not be able to continue to make the great strides that we have made in the past.

Most of us, being more practitioners than researchers, are generally aware of the type of research that produces a timely usable product. Usually, a problem is stated, it is defined and analyzed, alternatives are formulated, benefits and costs are analyzed, testing is done, a selection is made, and a program of betterment is implemented. In many cases the benefits and costs can be described in both quantitative and qualitative terms. Other times, the benefits are difficult to describe quantitatively and are described strictly in qualitative terms. In a few minutes, I will present examples of projects that have quantative and qualitative results.

First, let me discuss another type of benefit—the unreported benefit. Research is not only for the non-practitioner in an academic setting. Most of us do research everyday. It is my experience that the common characteristics of most engineers that we have come to respect are their ability to do research and advance the state of the knowledge through innovative solutions. We meet these engineers everyday in our professional lives and often listen to them speak at professional meetings.

These engineers are the ones that do their homework. Typically, they are technically competent, have kept up-to-date on developments in the profession, had the ability to recognize the potential to do things better, and had the personal fortitude to take a chance and promote the adoption of better methods. All research has a risk of failure, but even in failure we learn. In fact, there are those who say that we only learn through failure.

From our knowledge and competence, we become curious. We think of a better idea and test it. If it is bad, we ask what was learned, and try to develop a better idea, and test that one. If the idea is good, we should promote its use. You will note that I said *should* promote, since this is why much research remains unreported and does not increase the state of knowledge in the field.

The documentation and promotion of proven better ideas can be done simply in many ways. This could include memorandums or letters to other engineers, reports, articles in professional publications, telephone calls, and speeches at meetings. I am sure that you can think of others. As with anything, the hardest part is to get started. I hope that I can encourage you to share the results of your research for the benefit of our profession.

Many times, the benefits of research are easier to quantify in the construction area such as in the following example.

Many two-girder continuous reinforced concrete bridges were built by the Kansas Department of Transportation (KSDOT) between 1955 and 1965, using two-girder continuous reinforced concrete construction. When the bridges were inspected, shear cracks, which could result in failure were found in some girders.

Epoxy crack injection was tried, but was unsuccessful because the shear capacity of the girder did not improve. Some severely cracked girder sections were removed and replaced at a cost of $30,000 to $40,000 per section. Not many repairs were made since eventually it would be more cost effective to build a new bridge. This presented a problem because Kansas had 84 state bridges that were susceptible to girder shear cracking.

In 1976, research began to develop a technique that would repair the cracks and increase the girder's shear capacity. A budget of $100,000 was provided by the Kansas Department of Transportation (KSDOT) and the Federal Highway Authority (FHWA). The research was done by KSDOT's personnel and resulted in the development of a repair technique called post-reinforcement. It consists of four steps:

1. Use silicone sealent to seal cracks in the girder;
2. Drill one-inch-diameter holes;
3. Fill holes with epoxy; and,
4. Place a rebar into the hole.

In 1984, the average cost of repairing a girder half was about $2,500. A summary of the cumulative saving by selected years is as follows:

YEAR		SAVINGS
1982	-	1.0 million
1983	-	4.5 million
1984	-	8.9 million
1986	-	20.0 million

These savings were realized from a $100,000 research and development study including research involvement through the implementation phase.

Besides quantitative benefits there was also the qualitative benefits of increasing the girder's shear capacity to 10 percent above 1981 American Association of State Highway and Transportation Officials (AASHTO) requirements. Also, one lane of traffic can usually be maintained on the bridge during repair.

Another research effort deals with improving safety. Almost 20 years ago, California Department of Transportation (CALTRANS) initiated a program to develop cushions to shield fixed objects along highways. The work was done in conjunction with manufacturers in a FHWA—funded research program to evaluate, test, and modify existing crash cushion concepts and systems to meet the state's needs. Based on this research, CALTRANS installed a variety of cushions. Between 1970 and 1984, the agency installed more than 949 crash-cushions that included water cells, sand barrels, steel drums, and two cushions using crushable cartridges. These have been hit approximately 2,200 times. An estimated 15 percent of these hits resulted in lives saved, (330 lives). While there was no direct monetary savings accuring to the state because of the installation of crash cushions, on the user side the savings is estimated to be about $30 million for the lives saved. Also, reduction in property damage, injuries, and potential law suits against the state were realized. The cost of the CALTRANS research and development program was approximately $345,000.

A related research effort was undertaken by the Connecticut Department of Transportation (ConnDOT) in the mid-1970's. This was a result of many accidents involving maintenance vehicles and other vehicles. For example, in early 1973, the rear end of a ConnDOT maintenance truck was struck by a vehicle traveling at 40-60 mph. The driver of the vehicle was killed and a ConnDOT employee was severely injured. In response to this and similar problems, a light weight portable energy-absorbing system was developed. Eight portable energy-absorbing units have been put in service since 1977 and have been struck by fast-moving vehicles. One was by a car traveling at 65 mph, but there were no injuries. Since then, other states have installed energy-absorbing units and have reported similar results.

For the next research area the problem was congestion, accidents, and costs; too many vehicles and pedestrians trying to use the same space at the same time; and, many highway design improvement decisions being made without adequate analytical tools. What was needed was an analytical tool to systematically and adequately develop rational solutions.

The first Highway Capacity Manual (HCM) became available in the 1950's. It presented a procedure to determine the vehicle capacity of roads. This was updated with the distribution of the 1965 HCM, where capacity or service rate was related to quality of flow. Since that time travel characteristics have charged or were influenced by population shifts, the 55 mph speed limit, right-turn-on-red, and other factors indicating that improved procedures for capacity analysis were needed. In fact, research had developed alternate methods that gave more realistic results than the 1965 HCM. What resulted was that there were many different and non-compatible methods being used, often producing different and erroneous conclusions.

In the early 1970's, major research efforts were initiated by the National Cooperative Highway Research Program (NCHRP) and FHWA to study highway capacity. Contractors were hired including Polytechnic Institute of New York and the Texas Transportation Institute of Texas A&M University. Guidance was provided by the Transportation Research Board's (TRB) Committee on Highway Capacity and Quality of Service with more than 60 volunteer professionals reviewing the work. The process took over eight years to complete and included more than 30 meetings with the NCHRP panel and TRB Committee. There were three drafts and many reviews resulting in the 1985 HCM. Its benefits are difficult to quantify because how do you quantify a better approach. Qualitatively the benefits include consistency, reliability, and recognized credibility. About 20,000 copies are in use providing better and more consistent decisions from project to project, in city to city, and country to country. The research in highway capacity has not ended, and will continue into the future.

Another area that has resulted in much research has been traffic signals, including their planning, design, and operations. Energy consumption at urban signalized intersections is most susceptible to efficiency improvements. On signalized streets, almost 1.5 billion gallons of fuel are burned-up each year during stops and delays at traffic signals. While many of these stops must occur so that cross-traffic and pedestrians can travel safely, many others are unnecessary or longer than needed.

Improved traffic signal management can reduce this waste significantly, saving both energy and time. Unnecessary stops and delays can be reduced or eliminated by the more systematic allocation of green time among the conflicting traffic movements. Synchronizing traffic signals along arterials or in a network, and optimizing the timing patterns, results in smoother traffic flow, reduces idling and stopping, saves time, and reduces fuel use.

We can use many methods of network timing, including one-quarter cycle offsets, time space diagrams, three dimensional models, and computer programs such as Sigop, Transyt, Soap, Passer, and others. Whatever is used, it helps. For example:

The Institute of Transportation Studies conducted a study to measure benefits in Berkeley, California. The test site consisted of 28 signals in a dense grid pattern within the central business district. An instrumented vehicle was driven before and after the new timing patterns were implemented. The results indicated that travel time was reduced by 10.6% throughout the day, stops decreased by 11.1%, and fuel consumption dropped 6.6%. The new timing patterns resulted in a yearly savings of 6,200 gallons per signal, or 173,000 gallons for the 28 intersection grid.

In 1982, the FHWA initiated the National Signal Timing Optimization Project as a fuel conservation effort in response to the high cost of imported oil. FHWA developed the TRANSYT-7 signal timing optimizing program as a technique to improve signal systems and evaluate results. Eleven cities were evaluated. The results indicated a yearly average intersection savings of 15,470 vehicle hours of delay, 455,921 vehicles stops, and 10,524 gallons of fuel. Also there was a decrease in air pollution, an increase in safety, and improved bus service.

This morning in San Diego more than 400 professionals are meeting to discuss strategies to alleviate traffic congestion. They are relating their experiences and learning of the experiences of others. The benefits of both formal and informal research are being presented. For those of you who are interested in the information being presented, I want to inform you that a compendium of papers and conference conclusions will be published by the Institute of Transportation Engineers.

There are many other examples that I could present on the benefits of research. I have presented a few, which have had positive benefits. I hope that these will stimulate you to perform your own research and report it to the profession. We should remember that research:

- Improves technical competency of those associated with it;
- Can have significant monetary pay-offs;
- Advances state-of-the-art; and,
- Advances recognition of the profession.

Every traffic and transportation engineer should be doing it.