

50 Years of the Joint Highway Research Project (JHRP)

HAROLD L. MICHAEL

Director, Joint Highway Research Project

Head, School of Civil Engineering

Purdue University

INTRODUCTION

1987 is a big anniversary year for civil engineering at Purdue University. This is the centennial year - 100 years - of civil engineering being a unit of the University authorized to offer a civil engineering program at Purdue. From October 8 - 11 this year we will celebrate that event with a three-day program on the campus.

This is also the 75th year for the school to hold a state-wide highway conference at Purdue. In January 1913, W. K. Hatt, head of the School



Figure 1. The Annual Purdue Road School began in 1913 and soon thereafter included a Road Show in the Purdue Armory.

of Civil Engineering issued a call for a Civil Engineering Conference to cover the needs of county surveyors and city engineers. Roads and streets were heavily involved. A similar conference was held in 1914 at which a resolution was passed which called for a provision in the laws of In-

diana that there be a yearly School of Good Roads. In 1915 the name of the Civil Engineering Conference was changed to the Purdue Road School. Your program which states the 1987 Road School is the 73rd one, hence, is correct but it is actually the 75th road conference at Purdue.

On March 11, 1937, the Indiana Legislature passed an act which authorized the Indiana State Highway Commission to cooperate with and assist Purdue University in developing the best methods of improving and maintaining the highways of the state and the respective counties thereof. The act authorized the state highway commission to expend from the funds appropriated to its use for Miscellaneous Service funds for the use and benefit of Purdue University in carrying on progress of highway research and highway extension at or in connection with Purdue University and for the annual road school held at Purdue University. Today exactly 50 years later, March 11, 1987, I am pleased and honored on this golden anniversary of the Joint Highway Research Project to mark the historic occasion and briefly review its first 50 years.

The purpose of the Joint Highway Research Project was directed to be and still is:

1. To make basic studies of materials used in highways;
2. To facilitate economical design, construction, and maintenance of county and state highways;
3. To investigate traffic, safety and other items as desired and agreed upon;
4. To provide advanced instruction in the fundamentals of highway engineering and related research;
5. To provide practical experience in construction and maintenance procedures and in the use of highway materials.

EARLY RESEARCH STUDIES

The first studies of the project in 1937 were concerned with Test Road No. 1—evaluation of the weathering characteristics of stabilized materials. In 1938, Test Road No. 2 was built to study the performance of stabilized mixes under weathering and traffic, both as a surface course and as a base course. Other research on frost action, durability of aggregates, soil compactions, engineering characteristics of soils, bituminous mixtures, rock asphalt, pavement performance surveys, pavement costs, and traffic volumes quickly followed.

Since 1937, the Joint Highway Research Project has conducted 839 approved research projects. Twenty-seven of these are currently still in progress. These 839 studies have been conducted by more than 500 researchers, both students and faculty. The studies have produced approximately 2000 published papers, theses, and reports. Almost 500 students have received an advanced degree with specialization in highway

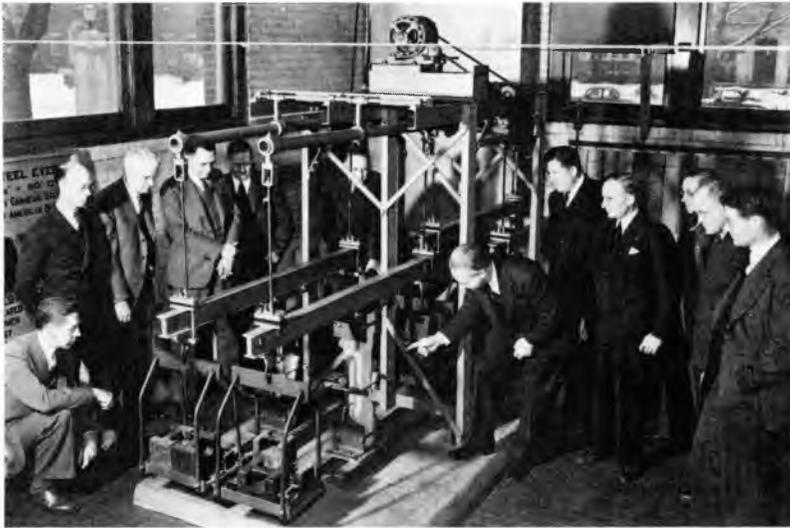


Figure 2. Purdue researchers demonstrate a fatigue test for concrete to State Highway Commissioners in 1940.

engineering with a significant portion of the degree requirements met by conduct of research.

Obviously I cannot here detail the results of these studies nor attempt to summarize in a few moments even the important results. I am confident, however, that anyone who reviews only a representative sample of the findings will be impressed with the value of the results to the State of Indiana, to the nation, and yes even to other nations.

MAJOR BENEFITS OF JHRP

To obtain an evaluation of the benefits of the Joint Highway Research Project these first 50 years I sought a reply from some of my colleagues in civil engineering to the following questions:

1. In your opinion, what have been and continue to be the major benefits of JHRP to the State of Indiana and to Purdue University or others?
2. In your opinion what have been the most valuable two to five research activities to IDOH?

Those questioned typically were familiar with JHRP research and acquainted personally with JHRP research for the past 10 to 30 years. I received 10 replies and wish now to share the major items of consensus with you.

For major benefits from JHRP of the following three were most often stated:

One of the major benefits enjoyed by IDOH through the funding of the JHRP has been the establishment and maintenance at Purdue University of a core of very knowledgeable professionals in the transportation area that are available for immediate consultation concerning problems that arise in the day to day operations in the highway field. IDOH has access to an enormous range of expertise—in engineering, economics, planning, sociology, agronomy, etc. that it could never marshal on its own.

Another major benefit is that Purdue researchers, both faculty and graduate students become familiar with a broad range of significant problems that need solutions. It is focused research of practical value. The result is an excellent environment for development of faculty and training of students to become the leaders of the future in the highway field. One only has to attend any of the national or even international meetings in the transportation field to appreciate the great impact that the graduates of the Purdue CE School with JHRP background have on the transportation field today.

A third major benefit is that JHRP is a model of how a state university can cooperate with a highway agency to perform needed research at the least cost. It has helped the IDOH to maintain a relatively small research and development staff while receiving benefits from a wide range of research through university participation. Many states and foreign countries have used the JHRP framework as a model for their highway research activities.

MOST VALUABLE RESEARCH STUDIES

As to the most valuable JHRP research projects more were mentioned than I have time to present.

One of those most often mentioned was the research in airphoto interpretation applied to transportation engineering, begun in 1939 and continuing to date. The detailed county drainage maps (92 of them), the state map of the perennial and ephemeral stream systems of Indiana, and the county engineering soil maps showing engineering characteristics of the soils are widely used for many development purposes.

A second project recognized for its significant benefits to the State of Indiana has been the long and valuable study of the durability of concrete, and the effects of coarse aggregate on durability. This work led to the early identification of nondurable aggregates that were responsible for blowups and for freeze-thaw failures. One of the major benefits of this work was the abandonment of expansion joints in pavements, which resulted in great economics for the Indiana Highway Department. Aggregates responsible for freeze thaw failure were identified and test methods were established and refined. More recent work has placed these results on a firm foundation related to the pore structure of the aggregates,

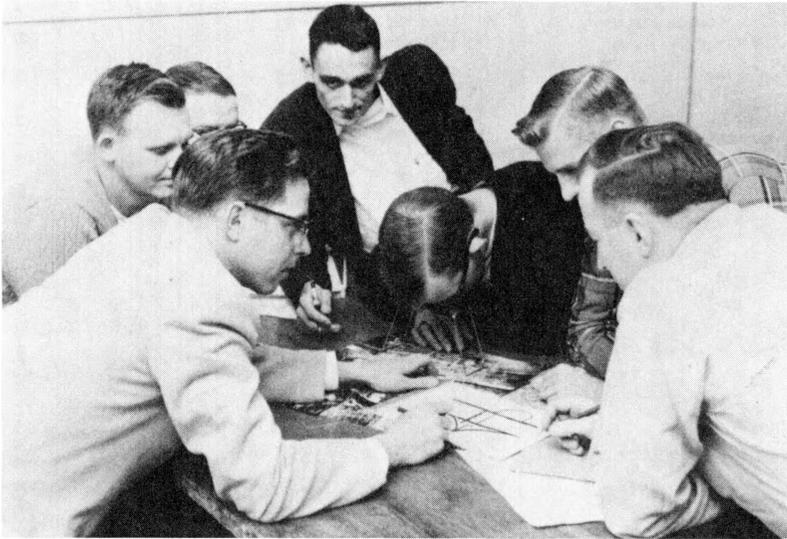


Figure 3. One of the continuing and useful JHRP research activities has been airphoto interpretation applied to transportation engineering.

and offers the probability of a test method that will be truly definitive for this problem.

A third area of significant benefit to IDOH has been the research conducted in the JHRP developed transportation planning procedures for small and medium sized urban areas. These procedures have been widely used throughout the state. In addition, the JHRP staff provided the support function for many transportation planning related activities in Indiana.

Numerous research studies have investigated various traffic problems and provided solutions. For example, a multi-disciplinary study several years ago developed appropriate countermeasures for 20 most hazardous intersections on the state highway system. These countermeasures prevented many accidents and reduced associated costs. Traffic research has also established appropriate guidelines for traffic signals, signs, and other control devices.

In maintenance and construction—a project initiated in 1972 and conducted over three years—pinpointed the critical factors which contributed to the poor performance of the CRC pavements in the state. Recommendations made as a result of this study were used in maintaining and repairing hundreds of miles of pavements constructed prior to 1972, thus saving a large sum of money each year.

A recently completed study on maintenance management has established the economic importance of preventive maintenance and



Figure 4. Research to predict erosion losses from highway embankment slopes is one of 27 current JHRP research projects.

estimated that even a small increase in pre-winter crack sealing activity can result in a large saving in post-winter patching activity resulting in a substantial net cost saving. Furthermore, the same project has provided much needed detail cost and fuel consumption data on various maintenance activities that can be used for effective management and control. Yet another project has developed a simple procedure that can be used to identify and implement areas where maintenance productivity can be improved. Current work is underway to improve the maintenance productivity can be improved. Current work is underway to improve the maintenance planning and management process.

Many other research projects have produced benefits far exceeding costs. Chemical weed control, chemical control of grass growth, pavement design models, controls of earthwork to improve stability, improved skid resistance, durable concrete, efficient bituminous mixtures and cost allocation for financing purposes are a few examples. There are many others in the 50 years of activity.

One of the research studies perhaps most widely implemented to date by the counties was the county road naming and marking study. The results of this study have been adopted by a very high percentage of the 92 counties in the State of Indiana.

But enough of the past, what about the future?

RESEARCH IN ACADEMIA

More than 100 years ago, the land grant universities began training

young people in agriculture, science, and the mechanic arts to make our country a world leader in agriculture and manufacturing. Old hands in these areas derided the young graduates claiming that they could do little to improve that which already existed. But, they did. They were innovative, creative, and not afraid to break away from tradition. And the genius of the land grant experiment is reflected in our growth as a nation.

I know many in the highway engineering profession question the wisdom of research in universities. Many ask why do research in a university? Why promote research in academia? Let me try to answer those questions.

In the early years of this nation, Thomas Jefferson noted, “An enlightened citizenry is the only safe repository of control over the ultimate processes of society.” Americans then and for many years after looked to science as the way to progress and strength. In the recent two decades or so, however, more and more of our fellow citizens have become skeptical of science, as they have of many other things. They appear to have forgotten that science and technology play an increasing role throughout our society. In business, in government, in the military, in the professions, science is clearly an important key to success.

The computer has revolutionized activity everywhere and it still continues. Modern communications govern much of what we do. Travel and transportation leaders find clearly that their future, although heavily affected by financial resources available and environmental concerns, are



Figure 5. The fundamental objective of research is to find new knowledge.

primarily concerned with what can be done through science and technology.

Economists estimate that advances in knowledge have accounted for perhaps three quarters of the economic growth of this country. But the economic impact is probably not as important as the impact on society, although I find it difficult to separate the two. Albert Einstein once said, "Concern for man himself and his fate must always form the chief interest of all technical endeavors—in order that the creation of our minds shall be a blessing and not a curse." He knew that the pursuit of scientific truth was always good in itself but that the uses of those truths may be either good or bad, depending on the moral and political choices that determine those uses. This is where an enlightened citizenry must exercise its control—not in developing barriers to seeking knowledge but certainly in determining uses of that knowledge.

The major functions of a university are three in number:

First, to distribute knowledge, through educational means;

Second, to create knowledge, through research; and

Third, to store knowledge.

All three are important and certainly the creation of new knowledge is an important one. We in academia, do not do research just to get promoted or for the sake of more publications. Real educators do research because that is their function, because developing new knowledge is fundamental to development as a good distributor (teacher) of knowledge, because creation of new knowledge is more likely to occur by someone who has a thorough understanding of existing knowledge in related areas and where intellectual freedom for the pursuit of scientific truth exists.

Our founding fathers established the U.S. as a place where scientific endeavor would be encouraged and honored. The wisdom of that decision is not questioned for as a nation we have prospered. As President Carter said in a 1980 address to the National Academy of Sciences, "We still look to our scientists and to our engineers, our military researchers and to our doctors, to our inventors and to our thinkers, to improve our lives and to improve the lives of our children." President John F. Kennedy noted years earlier to another meeting of the academy, "Progress in technology depends on progress in theory; the most abstract investigations can lead to the most concrete results; the vitality of a scientific community springs from its passion to answer science's most fundamental questions."

Unquestionably a major resource for research on any matter is the academic community. It has a major function to do research; to maintain a high quality faculty to teach, it must do research; to develop the

best minds of this country to be the leaders of the profession in the future requires a strong research component; and all this in an atmosphere where intellectual freedom for scientific truth exists. The probability of developing new knowledge, of innovative development is high in academia.

THE PRIMARY VALUE OF RESEARCH

Several years ago FHWA in one of its R & D Program Manuals noted this definition of research: “Research—the search for more complete knowledge of the basic characteristics of the geometry, traffic flow and safety, structural capabilities, material usage, economics, financing and administration of highway systems, and their effectiveness within the total transportation system. *Theoretical (basic) research* is considered a systematic investigation having as its principal objective a fuller knowledge of natural or socio-economic phenomena related to highway transport. *Applied Research* is considered a systematic investigation having as its principal objective new knowledge for a practical solution to a specific problem in highway transport.”

In a few brief words that statement confirms that the fundamental objective of research is *to find new knowledge*. Let me emphasize here that research does not require implementation within any required time frame. Of course implementation is always desirable if and when it is practical to do so. The *emphasis* in research, however, must be on new knowledge—and on new knowledge only.

In any evaluation of the benefits of research, the measure we use should include an evaluation of the knowledge found—and therein lies great difficulty. Very often the new knowledge developed is not implemented immediately and even if it is, more valuable implementation often results years later when combined with other bits of new knowledge.

The development of some better way of doing things often results from the integration of a bit of knowledge from research here, another bit from research there, etc. If any one of several bits of knowledge had not been found by research, the new development, the better highway, the improved transportation, the better quality of life would not have resulted. It is of course true if I have as an objective the solution of a specific problem, then I can apply the new knowledge quite rapidly. Of course we should do such research, but let me carefully note that if we only do research directed toward known problems, we will restrict research to improving current ways of doing things, current equipment, current activities. And the current ways may not be the way we should go. It will make it much more difficult, perhaps impossible, to develop something entirely new. It in fact stifles innovation.

I am certain many secrets still exist in this world and research should be managed to seek those secrets. A requirement for all research projects that they have probabilities of implementation of research findings within

a time frame—and evaluation of research which measures value of research only by dollars of benefit resulting during the first few years following completion of the project—stifles research. Some research should have this requirement but a substantial amount should not. Research can search for unknown secrets only if the primary objective of such research is to seek new knowledge. Such knowledge may not be immediately useful but it may also be that bit which when added to other bits someday opens brilliant opportunities. The day we start requiring immediate application from every part of a research project or evaluate research by a measure which considers only immediate implementation benefits will be the day we begin killing real progress in transportation and significant development in the quality of life.

The primary value of research then is *new knowledge*.

OTHER MAJOR BENEFITS OF UNIVERSITY RESEARCH

But there are also other values. Perhaps I can best emphasize one of these by using as an example the research financed over the last 50 years by the Indiana Department of Highways through the Joint Highway Research Project at Purdue University—an organization with which I have been associated for 36 years.

During the 50 years more than 800 research studies have been completed. They consisted of basic research and of applied research. The results of these studies have been reported in many technical publications. The technical results of these studies have influenced highway development in Indiana, throughout the United States, and in many foreign countries. Our researchers work closely with personnel of the Highway Department and develop new projects from problems that are encountered by them in the planning, design, construction, maintenance, and operation of the highway system. Our researchers utilize highway department personnel as advisors on the research as it progresses. They keep them informed of progress, of findings as they occur, of results as quickly as possible, and of the possible impact on highway activities.

Although the direct benefits of the research have been sufficient to justify the continued investment of the Highway Department, I am certain there have been and continues to be even greater benefits. Obviously, involvement in current activities of the highway department assists our faculty to maintain technical competence and knowledge of current problems. The opportunities of discourse with other experts such as at technical meetings expands the continuous development of our faculty and permits them to be better distributors of their knowledge to students at all levels—undergraduate, graduate, and continuing. Having such a program permits us to attract a highly competent faculty for the opportunities of teaching, research, and national participation. This also improves our capability to provide quality educational programs, enhances



Figure 6. Perhaps the greatest benefit of an academia-government research program is the number of young men and women who are attracted to the profession, educated in the profession, and retained in the profession—the future leaders in civil engineering.

our reputation as a University, and expands the loyalty of our alumni—all so valuable to a university today.

Perhaps the greatest benefit of such an academia-government research program as I am discussing is yet to be mentioned. The greatest benefit to society in my opinion is the number of educated persons that such a program produces. The young men and women who will be the future leaders in engineering are attracted to the profession, educated in the profession, and retained in the profession because of the research they conduct in the university.

Our highway research project at Purdue has graduated about 500 such young men and women, many of whom were attracted to this field because of the opportunity to do research in the transportation area. They were educated at the graduate level in the best possible way, through involvement not only in academic courses but also in a transportation research project. Anyone who conducts such a project becomes an expert upon completion, at least in some small area of transport. He or she is probably as good an expert in their area of study as anyone anywhere. Such graduates are confident in their field. They are enthusiastic to continue work where they are the best. It is very likely they will continue their career in an area very closely associated with the subject of that initial research. If they cap their formal education by the Ph.D., they are likely to enter the profession of university teaching and doing research in transportation or go into the research and development field in transportation.

Of our roughly 500 graduates in the last 50 years, about 150 have obtained their Ph.D. More than 80 of these are teaching transportation in universities throughout the world. I frequently attend meetings of university professors involved with transportation. Recently 39 such individuals were present representing 31 universities. Ten of those individuals at nine universities were graduates of the JHRP program. All did research in highway transportation funded by the Indiana Department of Highways through the Joint Highway Research Project. There is no better way to provide value to society, to the economy, and to the researcher than to be involved in the development of any nation's greatest resource, development of human minds. Research in the universities can be of great assistance in such development and in attracting the best men and women to the areas of needed research. It is my belief that development of the leaders and teachers in transportation of the future is the greatest value that can be provided from research at universities. It also helps solve many of the engineering education crisis problems which exist today.

CONCLUSION

Unquestionably the tremendous mobility system we have today—the U.S. transportation system—is a major accomplishment of highway research. It is the product of knowledge developed heavily by the research of many individuals and organizations over many years.

The development of this great system we have would not have been possible, however, without another great benefit of research—the development of capable leaders in highway transportation. One of the great accomplishments of research is the development of the finest minds to become the leaders of tomorrow and the developers of additional new knowledge about highway transportation through research.

JHRP is 50 years old. I am convinced it has proved by its production of research results and the development of a major share of the leadership in highway engineering today that it has had a successful 50 years. It is ready to begin the next 50.