

Inventorying Research and Development on Roads and Road Transport

ROBERT O. SWAIN, President, and SIR WILLIAM GLANVILLE, Consultant,
International Road Federation

•COMMUNICATION between individuals, between communities, between nations and between groups of nations is basic to human progress. This has been said many times, but it takes on a new dimension in the context of today.

Communication advances come at an increasingly rapid pace. In science-based activities, such as radio, television and air and space travel, the speed is breath-taking, so fast indeed, that even the trained scientists and specialists find it hard to keep pace. The field of research continually expands, the number of individuals engaged in it grows, the number of centers multiplies, and larger groups are formed to use advanced and increasingly expensive equipment and techniques. Developments in one mode of communication have an influence, often a very direct influence, on progress in another; thus, to give a simple example, the control of aircraft and the control of road traffic depend upon the advances in communication by radio and television.

The road industry is not science-based as that term is ordinarily understood. But a scientific approach is of such fundamental importance and the potential applications of science are so great that road research is now expanding rapidly throughout the world. The movement of the individual and his goods with safety, speed and economy in all climates brings with it many problems in the building of roads, bridges, tunnels and other structures, and in producing safe and fast vehicles and in the discipline and training of the people who use them.

Against this background, it will become increasingly profitable to insure two things: first, that information is quickly recorded and stored, so that all those engaged in research can find out what has been done and is being done, avoiding unnecessary overlapping and costly repetition; and second, that the fruits of research can be put to use with as little loss of time and effort as possible.

To help satisfy these needs in the field of roads and road transportation, the International Road Federation has been working for the past two years with the support of the U. S. Bureau of Public Roads to prosecute a policy of world research cooperation.

This work began in a modest way in 1964, with pilot studies to test the feasibility of conducting an international survey of current research. The project was briefly reviewed at the Highway Research Board meeting in January 1965; later, it formed the subject of a detailed report, "Methodology of International Highway Research and Development Exchange," submitted by the IRF to the U. S. Bureau of Public Roads in January 1965.

The 1964 study was of an exploratory character. It was based upon the results of personal interviews with research personnel in four Western European countries—Sweden, West Germany, Italy and Denmark. Nearly 280 individual projects were reported. This was, in fact, one of its most important results—disclosure that a great deal of valuable research, unknown in the United States, was in progress in Europe, and that research activity was spreading rapidly. This led to the conclusion that an inventory should be actively developed; when in full operation, it would become an essential tool for advancement of research and development on roads and road transport throughout the world.

The Bureau of Public Roads agreed with this view and undertook to help again in an extended effort during 1965 aimed at widening the geographical scope.

The area covered by the new survey was considerably increased above that of 1964. It included 17 countries in three broad geographical areas—Western Europe, the Americas, and the Far East. The countries were Argentina, Australia, Brazil, Canada, France, Germany, Great Britain, Ireland, Italy, Japan, Mexico, New Zealand, Norway, the Philippines, Portugal, Spain, and Venezuela. Note that the inventory was repeated in two countries visited in 1964, Germany and Italy. This repetition was included to produce a comparison between the 1964 and 1965 surveys and to provide information about the desirability and future need for some means of keeping the inventory up to date and for broadening its scope.

The need for cooperation has already been touched upon. Research on roads and road transportation is widely dispersed over the world. It is financed in a variety of ways and is concerned, as already indicated, with a wide variety of subjects. There is at present little attempt at coordination over the whole field in any effective sense; the organizational methods vary widely. To attempt an overall survey, even in the limited area of current research, is by no means straightforward, and depends as much upon the free cooperation of all concerned as upon anything else.

There are advantages to the individual research worker and research organization in such cooperation. They can expect to gain from information obtained from others and, moreover, feel rewarded by the knowledge that their own research is known to others. But whatever the advantages, the key to success must always be cooperation, and the measure of success will depend directly upon the effort expended by each individual, each organization, and each country in giving and in receiving. The greatest rewards can only be achieved and shared if all play their full part.

In Europe, a high degree of cooperation has been obtained, despite language difficulties and differences in the modes of organization for research. The Organization for Economic Cooperation and Development (OECD) has played an important part in fostering this cooperation, and the European Conference of Ministers of Transport, an arm of the OECD has given full support. The OECD has indicated its "pleasure in meeting such a fine spirit of cooperation," its view that "the results achieved are very encouraging" and its wish to cooperate in future programs.

Individual countries, too, have shown a spirit of cooperation which, translated into active assistance for the project, has been greater than anything anticipated.

For example, in England, the Road Research Laboratory has collaborated in collection of information and has contributed generously to the tasks associated with the survey. In Germany, the Forschungsgesellschaft für das Strassenwesen has provided much help, and also furnished a center from which the interviewing and correspondence involved could be conducted. In France, the Laboratoire des Ponts et Chaussées and other organizations have provided useful assistance. The three centers mentioned have become the European—English, German and French—centers linking up with the OECD and the HRB.

The IRF-affiliated national road federation in each country has also given generous support in providing introductions and physical facilities which proved invaluable in launching and conducting the survey in each area.

Some research organizations, however, find difficulty in fully sharing knowledge about current research. This is as might be expected, mainly in commercial undertakings where research is regarded as a business asset and an investment by the firm concerned. Moreover, research workers sometimes dislike giving any information until they are able to announce completed findings.

It is notable that there are few, if any, researchers who really know all that is going on in their own countries. Even where research is nationally coordinated or subsidized, there are many projects being conducted independently, or in areas not directly linked to highways.

It has not been possible, in many cases, to obtain costs of individual programs, particularly where they are subsidized by private grants. Some people fear to excite the interest of the internal revenue authorities. There is, too, the difficulty of finding a common basis for costs because of differing methods of accounting. This has not

proved serious, since costs are required only as an indication of comparative activity in different fields—precision is not essential to the success of the survey.

During the course of the work, a growing interest in a usable inventory has been shown everywhere. In the few difficult cases, the desire to cooperate has increased as the work has proceeded. The issue of the HRIS book of abstracts, "Highway Research in Progress," which included information from the 1964 IRF survey, has been particularly helpful in encouraging cooperation.

In conducting a survey covering 17 countries where many different languages are spoken it was expected that special precautions would be needed in translating highly technical and specialized terms. Indeed, difficulties were met, but were largely overcome with the help of technical experts well qualified in both the local tongue and the English language. The network of road associations identified with the IRF and the more than 400 qualified engineers who have participated in the IRF fellowship program, and who hold positions of leadership in some 80 of their own countries, have helped to spread the use of common terms. It is, by the way, most encouraging to see what these and other trained professional engineers have achieved in the last twenty years through superior planning, design, construction, maintenance and administration of highways in both developed and developing countries—and under the usual handicap of insufficient funds.

Even with this sort of help, the language barrier is not easy to surmount, although it concerns the mechanics of the job rather than the basic issue. In many instances interviewers have needed interpreters, always a handicap to free conversation and clear understanding. A project abstract furnished in an unfamiliar tongue is not easily reviewed and edited by the interviewer. In further processing, the report must be translated into at least two other languages—three if the original language was not one of those provided for in the Information Centers of the OECD. And the translation of technical material requires a knowledge of technical meanings that are not always the same for similar or apparently identical terms. Local or national usages differ even in a single language. Sometimes there is a lack of a precise equivalent for a term found in another language. These are, at best, inconveniences; at worst, they can lead to very mistaken or misleading reports of research. The need for technically trained translators is obvious.

Language difficulties might be reduced by having the inventory in each country made by a national of that country. But it is important, in so wide a field as roads and road transportation, that the activity should not be inadvertently restricted by employing a person who is experienced in a strictly limited aspect only and may be unaware of the wide field to be surveyed. Indeed in some cases an expert in his country has begun by being certain that research was far more limited than it ultimately proved to be. For this reason, a highly qualified expert from another country is sometimes more effective, although, for obvious reasons, and to avoid misunderstanding, there must be no suggestion of interference with what is, after all, primarily the business of the country itself.

In its earlier planning the International Road Federation felt that it would be logical and highly desirable to have one comprehensive international storage and retrieval center. Experience with the difficulties of translating technical language—even between "English English" and "American English"—has clearly indicated the need for national or at least regional centers where professionals familiar with local usage can produce technically correct texts. Such regional centers for Europe are being provided, as already mentioned, by the Organization for Economic Cooperation and Development.

One of the important aspects in compiling an inventory is to identify what should and should not be included. There is scarcely a branch of science that is not involved in some way, and in the broadest sense it could be said that there are virtually no barriers. For example, advances in electronic research of the most basic kind may be found to have direct bearing on the control and handling of vehicles. Profound advances in medical science may lead to a better understanding of the human problems in relation to highway usage. There also may well be basic mathematical research which leads to a better appreciation of traffic problems. Studies of principles of soil mechanics, geology, structural characteristics—all of which have broad application to the general

field of construction—also should be closely related in any inventory compiled for the use of road designers, especially in those areas where these subjects are investigated primarily in relation to other fields.

It seems inevitable, in view of this, that the first requirement should be a link between the road and road transportation problem and the research conducted, and generally, therefore, that the research be conducted with the aim of improving conditions in roads or road transport.

The application of existing knowledge to highway problems in a routine manner can be expected, in the majority of cases, to be of very limited interest. The design of a conventional bridge, based on known principles applied to a specific location, is equally doubtful. Routine planning in a given situation, even though it requires the compilation of much background data, can hardly qualify as research, unless some new principle or new technique emerges which in itself is worth recording.

In fact, it is clear that the inventory cannot maintain a distinct line of demarcation. Omissions will be found about which opinions differ, but it is hoped that research workers and others will understand the difficulties if they note inconsistencies in the recording of their field of interest. Borderline projects generally have been included where reasonable doubt has existed.

Now a few words about where research is found and who is doing it. Generally speaking, research is found in three types of agencies—governmental, academic and commercial. The organizational arrangements vary widely, and time does not permit my describing them here in any detail. The three categories are by no means distinct. For example, universities often undertake research under contract to a government, or have direct affiliations with highway departments. Some receive funds from commercial agencies. Some engage in strictly independent engineering research. Highway authorities often have their own research laboratories for their own personnel. Some commercial agencies find research a valuable means of finding new applications for their products and of producing new materials and processes. Independent research laboratories may operate on a wholly commercial basis. Foundations are endowed to conduct their own research or to make grants in support of research.

In each country, one of the responsibilities assigned to field representatives in the research inventory was to observe and report on the research agencies in that country, their organization, the extent of their coordination, their sponsorship, and the nature and quality of the forthcoming research. These appraisals are in some degree, of course, a matter of personal judgment. This will be fully covered in the final report.

The national organization or administration of research is of little direct concern insofar as it influences the quality of the work, but it must be understood if the interviewer is to be efficient in tracking down all sources of useful information. It may also have a bearing on the willingness or ability of research personnel to discuss their programs freely, particularly on incomplete or unpublished projects. It is hoped that the program and the publicity given to it will help to overcome habits of secrecy or reticence in highway research by demonstrating the advantages that follow the spreading of knowledge.

Some of the resistance appears to stem from a reluctance of the individual researcher to act without authorization from his supervisor or his sponsors. In such cases, approach at a higher level has frequently overcome the difficulties, particularly when it is realized that highway research is a field where free exchange of knowledge is to the advantage of everyone, and that it will usually advance national or personal prestige. The individuals directly engaged in research are not always those to whom official credit is to be given—there is sometimes a sort of hierarchy in government or academic circles in which the responsibility for and the basic ideas themselves derive from a superior official. It is, therefore, difficult to assign responsibilities, but it would seem preferable to include the names of the actual workers, if for no other reason than they may well be the ones who can best discuss the work in detail in response to subsequent inquiries.

It now appears that one of the significant findings is that valuable research can be discovered in seemingly impossible places, and that only a most searching inventory can bring some of it into the open. And there is always a danger that a systematized

inventory of "official" projects can further obscure some independent and sometimes apparently unrelated research. Who can tell where pure research in physics, or in the biological sciences, or even in the exploration of the mind may have impact on our highways? Such fringe projects, even when advanced to the point of application to the highway problem, can easily get lost, particularly if the research inventory is made through a central authority that is circumscribed in its interests. A means of insuring wide coverage is, therefore, necessary. Methods of bringing the research agencies together for discussion on how to accomplish this need further consideration. To some extent this is being attempted in Europe.

Our estimates for current research in the 17 countries inventoried last year indicate a total of some 2400 projects. While all of these are in the process of analysis, we have been able to cite certain activities that may be of general interest—bearing in mind the preliminary status of our work. These are projects which for the most part are new to the U. S. Four hundred and sixty of these come from Germany and 350 with a total valuation of \$4 million come from Japan.

Those who have been concerned, directly or indirectly, with the AASHO Road Test will be interested to know that three comparable tests, on a more modest basis, are being conducted in Mexico, under actual traffic, to obtain data for pavement design and performance. Mexico is one of the leading countries in the field of Seismic Engineering. Its "Engineering Institute" is considered one of the best research centers in Latin America.

A major undertaking in Venezuela seeks theories and methods essential for evaluating economic impact and feasibility of highway projects in developing areas. Elsewhere in the nation, the Venezuela Institute of Technological and Industrial Research is overcoming a lack of natural mineral aggregates by the manufacture of clay aggregates and the use of blast furnace slag from steel mills. The Catholic University "Andrés Bello" is engaged in a reciprocal research project with the Massachusetts Institute of Technology on "Load-Settlement-Time Characteristics of Deposits of Saturated Soils."

Brazil is reviewing its construction specifications, with a view to establishing the statistical value of acceptance and rejection of work performed. Electronic non-destructive testing is the main concern of many research agencies in Brazil.

Low cost measurement systems and equipment for industrial use in laboratory testing of portland cement concrete is the objective of the Institute of Applied Mechanics and Structures in Argentina, and in recognition of orographic problems, Argentina is deeply involved in research of soil stabilization and soil mechanics.

There are 42 organizations in France dealing with research and development in the areas of road and road transport.

Spain also has a test road. It is claimed that a unique feature of the test is the use of radio isotopes to measure the inclination of the German type tension meter "Ventilgaber" when placed in concrete pavements. This cell should be vertical in order to measure stresses in a pavement. By seeding its upper and lower edges with radio-activity it is possible to measure the angle it makes with the vertical and thus correct its reading.

The test road has different combinations of pavement and bases resting on subgrades with different Atterberg values. In some localities the subgrade had a liquid limit of 43.7 percent and a plasticity index of 21.9 percent while in other localities it has a liquid limit of 90 percent and a plasticity index of 57 percent. This differs from the AASHO test road which had a uniform subgrade. It will be possible here to study the behavior of the pavement as affected by the quality of the subgrade.

Germany has two notable types of research—one carried out by engineers and the other by learned societies and non-engineers. The problem of road transport and road traffic is so much the question of the day that many German learned and professional societies have working committees on roads and traffic. The Medical Society has a committee on Traffic Medicine; the German Psychological Society has a similar working committee. Their work was published for eight years in the Journal of Traffic-Medicine and Traffic-Psychology until it stopped publication in 1962. Since then, it has appeared in the German Traffic Safety Journal. The Psychological Society has found that a change in type of accidents over the past 10 years caused by drinking may be traced to the general economic advances that have made car ownership more common.

German economic and legal societies also have working committees. The legal staff of the Kuratorium of "Wir und die Strasse" went through all traffic violations in Germany for the last two full years and found that only 10 percent of the violators had more than one brush with the law in this period. This shows, they claim, that troubles on the roads are not caused by a small minority and that strict measures are not the answer.

The German Government Winter Services Station in the Bavarian Alps is experimenting with more than 20 types of equipment for snow removal and deicing. They are fitting a special truck chassis with a 125-HP engine for driving and a 250-HP engine for operating experimental snow-removal equipment (suckers, blowers, etc.).

Another interesting project mentioned in the 1964 IRF report is the work of Dr. Eisenman of the University of Munich on highway capacity. One of his findings is the need to alter the German law that requires for trucks a power-load ratio of 6 HP per ton of total weight. Changing this to an 8:1 ratio will alleviate conditions on the over-worked roads of Germany.

An interesting example of research by industry is the one of Nordlabor in Pinneberg, near Hamburg. Recent German government roadbuilding specifications require constant and rigid quality control by accredited laboratories. State and institutional laboratories could not cope with the amount of work entailed, so some six or seven laboratories with first-class equipment were created to provide the service. The one at Pinneberg is doing so well that it can also indulge in research. Among its noteworthy facilities is a climate chamber of about one cubic meter capacity, coupled with computer programming. A program for climatic changes (rain, heat, dampness, freezing, thawing, etc.) can be fed to a computer indicating cycles, time of duration and other data. Recording apparatus checks on the computer program and also records the behavior of the sample or samples under investigation (volume changes, stresses, temperature at various depths of sample). This apparatus is used extensively to study asphaltic concrete, its aging and stripping characteristics.

In Australia, where a large road mileage serves small volumes of traffic, it is essential that roads be built and maintained at the lowest possible cost. Several projects are under way involving analysis of characteristics and best methods of processing of locally available granular materials and soft rock, and the best binding or stabilizing agents for road base material. Other highlights in Australia include many studies correlating flexible pavement design with wheel loads imparted by actual traffic. An extensive investigation is being made of the brittle fracture of welded steel in bridges at low temperatures. Teams of engineers, sociologists and medical workers are analyzing the causes of highway accidents, with particular attention to drivers' abilities and skills. A long-range program is devoted to city transportation planning. An interesting local study is that of the economics of operation and road capacity requirements of cattle road trains (two or three trailers in tandem pulled by one truck) in common usage in the out-back Northern Territory.

In Japan almost all types of research can be found, reflecting problems peculiar to the country. Investigations are being made of the working capabilities of various types of compaction equipment, and of optimum soil conditions for compaction. An indoor concrete pit has been constructed, large enough to accommodate full-sized machines working on material up to one meter in depth. "Kanto loam," a disintegrated volcanic ash, offers unusual difficulties as a base for roads, and is the subject of numerous research attempts at stabilization. The design of structures to resist earthquakes and storms is a significant problem. Many studies of stability are being made for a major suspension bridge, including tests in an excellent wind tunnel. Several universities are applying computers to problems of traffic, and to the engineering design of structures. There are numerous studies of long-range industrial development, land use and transportation demands. In the densely crowded areas of Osaka and Tokyo some viaducts are being built along and over rivers, calling for interesting studies of foundation and waterway problems. Research on tunnels is concerned with earth pressures and lining, and with problems of lighting and ventilation. A full-scale lining ring has been constructed for testing.

In New Zealand, the roadway approach to a toll tunnel has provided an excellent research laboratory for the study of flexible pavement behavior. On a uniform sub-grade of rather poor quality, short sections were built in several different base and pavement designs, varying especially in the thickness of layers. With accurate information on the volume of traffic and the sizes and weights of all vehicles available from the toll records, periodic checks are made for surface deflections, cracking and other signs of stress. In quite another field, experiments are under way for the stabilizing of bank slopes through the establishment of vegetation. Methods tried have included the spraying of seed and fertilizer into place with an admixture of size, gelatin, asphalt emulsion or other adhesive agents, with promising results.

In the Philippines, studies are seeking to develop better techniques for building roads and structures out of locally available materials, including investigations into the use of bamboo as reinforcement in portland cement concrete.

Ireland is trying to find answers to soil problems, particularly the drainage and stabilization of peat and boulder clay. There is also a wide range of other research, from the design of highways and bridges to psychology of the driver and transportation planning.

Norway emphasizes economic research, with numerous studies of highway and transport costs and planning. In the field of soils, frost and drainage problems naturally receive much attention.

The countries that were surveyed in Europe in 1965 can be broadly divided into two groups:

1. Large countries with developed programs of road research, e. g., United Kingdom, France, Germany, and possibly Italy; and
2. Smaller countries or countries with less-developed programs, e. g., Spain, Portugal, Ireland, and Norway.

There is no rigid line between these groups, and no two countries organize their research in the same way, although the government, the universities, the local authorities, and industry are involved in one form or another in all cases.

The highest degree of coordination exists in the U. K., where activity centers around the Road Research Laboratory, now of the Ministry of Transport and formerly of the now-defunct Department of Scientific and Industrial Research. This high degree of coordination exists because the Laboratory's terms of reference were drawn on comprehensive lines, covering materials and methods of construction, traffic, economics and planning, as well as road safety in the broad sense, to include vehicle, road, and human problems. The Laboratory was early in the field and it is linked cooperatively by committees and in other ways to practically all organizations concerned with road research whether in universities, in other government departments, or in industry.

The central position of the Road Research Laboratory is unique and, in the United Kingdom, the task of collecting information about current research is basically a more direct and straightforward process than in the other large European countries. Moreover, the language barrier with America is not of significance.

In Germany, responsibilities are more dispersed and there is no central body concerned with all aspects. The Forschungsgesellschaft für das Strassenwesen, which is the main focal point for information on road research, does not concern itself except in a limited way with traffic problems and not at all with road safety. It has been reported, however, that the German government Road Research Laboratory has recently had its scope widened and is in process of reorganization.

In France, the set-up is somewhat similar, the materials and construction research being well covered by the Laboratoire Central des Ponts et Chaussées, while more recently formed organizations are developing research into traffic and planning. Here, the universities play a small part compared with the major part they and their professors play in Germany.

Because of these differences the most appropriate organization for the collection of information is not the same for all countries in Europe, although, in the major countries, a focal point around which the collection can develop seems essential.

In the U. K., the Road Research Laboratory is the obvious center and in 1965 we were fortunate in securing their enthusiastic cooperation; the work has been conducted by Mr. Sparkes, an engineer working inside the Laboratory and making use of the extensive facilities available there.

The Forschungsgesellschaft für das Strassenwesen in Germany and the Laboratoire Central des Ponts et Chaussées in France have participated. But although these organizations have cooperated generously, an officer has not carried out the work as a part of the organization as in the U. K. This needs further consideration in planning any continuing activity. It appears that the first group of countries, the larger ones with developed programs, needs this kind of nucleus.

In the smaller countries, with a less highly developed road research program, a nucleus is still likely to be advantageous, but not equally important at the present stage of development of the inventory. Visiting experts, linked to central bodies such as a government research organization or a national road federation, are able to supply most of what is necessary.

At the center of those cooperating in Europe in the survey is the OECD, which is developing harmonization and cooperation in research with special emphasis on documentation. The linking together of the efforts of IRF and OECD was one of the first things arranged in Europe.

There are a number of interesting points worth mentioning about research in the U. K. The first has already been mentioned—the extent of coordination between central and local government departments, the universities, and industry, all of which work closely with the Road Research Laboratory. The Laboratory works in an advisory capacity to all these groups and is in daily touch in one way or another with individuals from all of them, both formally and informally and at all levels. This has been developed through the cooperative research and the committee and consultative structure that has emerged over the years. A recently formed high-level Advisory Council on Road Research to advise on all research undertaken in the highway field will, it is expected, continue and develop this cooperation, and will help to assure, as the British universities play an increasing part, that the whole structure of research is soundly based and operated.

Another point of interest in the U. K. is the growing investment in research of the contracting industry. For many years the larger contracting firms have been developing and using their own research centers; a big firm may spend several million dollars a year on its own research. In addition they have collaborated with consulting engineers and the senior professional body—the Institution of Civil Engineers—in setting up the Civil Engineering Research Association with the help of the government. In this way the civil engineering industry is becoming infused with a scientific spirit which enables it to approach its problems with an expertise and scientific knowledge which places it on an altogether higher plane than formerly.

One matter of great importance to contractors and to government is the degree of control that is exercised on works. This has been the subject of much discussion in the U. S. It is of great moment in the U. K. and it figures significantly in the thoughts of the research workers.

The rapidly developing use of science and the scientist in reaching governmental decisions is also of note in the U. K. This applies markedly in highway matters. For example, the practice is growing for scientific planning and assessment of legislative measures by research personnel, such as, for example, laws relating to speed limits and to drinking and driving.

There are many other matters of interest about the research in the U. K. There is the new research center at Crowthorne which is being built at a cost of some \$10 million. There is the research and development leading to the outstanding suspension bridge across the Firth of Forth, and the advanced aerodynamic design of the box-section, aero-foil type deck and suspension system in the Severn bridge. There is also the active Tropical Section of the Laboratory working as it does on major projects in many parts of the world.

Generally, therefore, in the leading countries of Europe the phase is one of developing, coordinating, and remodeling organizations for highway research. In France, the

Laboratoire Central des Ponts et Chaussées is remodeling its program, and bodies for traffic and safety research have appeared. In Germany, the government has widened the scope of its research organization. In the U. K., the Road Research Laboratory has recently been transferred to the Ministry of Transport and its activities are being regrouped and an overall advisory council is being formed.

In the smaller countries, organizations are being expanded or set up. Without exception they show a keenness to cooperate internationally and to become active in research and its documentation, interest in which is growing fast. For Europe it is therefore a particularly opportune time for the inventory and exchange of information on current research and development on roads and road transport.

The achievements of the past two years clearly justify the continuation of the work, and the study of how it can best be put on a permanent basis. Many countries have yet to be covered and in those countries already covered there is a need to provide the machinery for bringing the inventory up to date on the projects already noted, for including any new projects and for continuing vigilance to insure that relevant material is not overlooked. This is demonstrated by the fact that the two countries covered for a second time have yielded much new material.

There is another reason for pursuing the work as a continuing operation: the more engineers and scientists become involved in this activity, the more they recognize and appreciate the benefits they can give to their profession as well as to their own organization and to the institutions with which they are affiliated. As they realize that a source of guidelines is being provided and that these are helping to stimulate much needed research and development, their own personal interest is strongly aroused. Indeed, it is found that there has been developed, through the two years of work, a most cooperative and friendly relationship.

For the future, therefore, it is hoped to continue and expand this international research and development exchange just as far as it can go. As has been stated, the inventory in 1965 was extended to 15 new countries (plus two previously inventoried), and three Information Centers were created by the Organization for Economic Cooperation and Development through which our findings will be made available. Already plans are being made to cover another 16 countries in next year's inventory. There is no lack of momentum. But it is expected that many improvements will be made from the valuable experience already gained.

Plans are under way to employ permanent personnel to visit countries already inventoried in an attempt to keep current research data up to date. We are also studying other suggestions of high merit to continue the flow of information and the cooperative arrangements.

The main handicap has been shortage of time, and had there been more time, a more thorough job would have been possible in each country. Inevitably, even with the best of advance arrangements, some appointments will be broken, and others will take more than the scheduled time. Personal check-backs are often valuable.

A more defined policy in the selection of "current" research will have to be attempted and decisions made as to how long a completed project is to be kept on file—particularly if that project has been superseded by another in the same agency.

Finally, in planning the next phase of the inventory it is proposed to examine selected research fields and research problems in greater depth, that is, to study in detail some or all of the major projects on a given theme in certain countries, considering how they are sponsored, the techniques and laboratory facilities employed, the types and qualifications of the people engaged in them and the findings and publications. These studies will help, it is thought, in providing useful information about effective research and the conditions under which it is conducted.

In this work the International Road Federation is not engaged in physical research or development. Rather we are attempting to provide adequate guidelines to promote and expedite the exchange of data and to utilize it fully and safely in road communications designed to improve life for all persons.