presentations. Coherence in the large and precision in the small—both intimately connected with the nature of v. Mises' work—reappear in his style and give depth and clarity to his writing. With the *Differential- und Integralgleichungen der Mechanik und Physik,* he gave to those who wished to apply modern mathematics to physics and engineering problems, a lucid account of the mathematical fundamentals. This work, which first appeared in 1925, was reproduced (in German) in the United States during World War II for the benefit of all those working in defense research. In *Probability, Statistics, and Truth,* v. Mises offered a brilliant presentation of his general ideas on probability to a wider class of readers; it is perhaps still the best book to make a general scientist or, for that matter, any well-educated person familiar with the conception of probability and its applications.

In *Positivism, a Study in Human Understanding,* v. Mises gave us a summary of his views on many topics in science and life. In this book the word *positivism* is not meant to designate a sectarian doctrine of some philosophical school; v. Mises used it, rather, to characterize a way of presenting his views that takes its cue from the methods of science and should establish understanding among those willing to drop prejudice and accept what experience and reason suggest. Throughout the whole book, v. Mises did not fail to emphasize that the role played by human imagination is not less important in the invention of scientific theories than it is in the works of art and in religion. Perhaps it is best to characterize this book by the author's own words:

> Positivism does not claim that all questions can be answered rationally, just as medicine is not based on the premise that all diseases are curable, or physics does not start out with the postulate that all phenomena are explicable. But the mere possibility that there *may* be no answers to some questions is not sufficient reason for not looking for answers, or for not using those that are attainable.

He stressed the point that too many people interpret the present world struggle as a battle between two ideological systems of extremely metaphysical character:

> If this goes on, the predictions of those who believe that the next step toward the solution of the basic sociological problems must come from physical annihilation of one of the two groups of people will be borne out.
>
> In our opinion, the only way out is less loose talk and more criticism of language, less emotional acting and more scientifically disciplined thinking, less metaphysics and more positivism.

A Golden Anniversary

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ENGINEERING research in our nation's colleges and universities has become a multimillion dollar operation. But still more important than its magnitude have been its effects. This research effort has been and is influencing the engineering education of both undergraduate and graduate students. Furthermore, the results of engineering research programs being conducted in our educational institutions represent valuable contributions to the growth of industry and to the national defense effort.

This year both the University of Illinois and Iowa State College are celebrating the 50th anniversary of their Engineering Experiment Stations. These research organizations, the first of their kind in the nation, were founded in the academic year 1903–04. They have been active and growing in size and concept ever since.

Before 1903, such research as was conducted in engineering colleges was done on an informal basis. In keeping with the systematization of agricultural and forestry research at the turn of the century, and with the industrial efficiency movement, the faculties at both Iowa State and Illinois believed it was necessary to formalize their research activity and provide a means for conducting research programs under the sponsorship of industry, state organizations, and engineering societies. In addition to furnishing useful information to these sponsors, they recognized that such research projects would provide graduate and undergraduate students with training in research methods and that the knowledge gained by them would represent advances in the science and art of engineering. Both schools also recognized the necessity for publishing research results in order to obtain the maximum benefits from their research programs. This is evidenced by the fact that each station issued its first bulletin during its first year of operation. In the course of the past 50 years, both stations have published numerous bulletins and have contributed, through their research staffs, a still greater number of papers and articles to the technical press.

Today both industry and government recognize the importance of research in the growth and security of our highly technical society. Three groups—industry, technical societies, and the government—have continued to support research programs in engineering experiment stations and other university-affiliated research organizations.

Industry, either as private companies or through its trade associations, has supported applied research in a variety of fields. Recently a number of industries, recognizing the importance of basic knowledge to their progress, through gifts and grants have supported projects of a fundamental nature.

Technical societies for many years have supported research programs in their areas of specialization. Furthermore, through their technical advisory and research committees, they have served as coordinating agencies for industry-sponsored research being conducted by universities.

The government agencies supported relatively little research prior to World War II. However, the work they did support was very productive. For example, the highway programs they have supported have increased safety and reduced costs of highway systems all over the country. During and immediately after World War II, various defense agencies and the Atomic Energy Commission sponsored a considerable amount of both basic and applied research. Often this research concerned complex problems dealing with defense systems and requiring many research workers from different disciplines. Such "team" operation brought natural and physical scientists and engineers together and provided a very satisfactory method, if not the only method, for solving complex system problems of interest to the defense effort.

This is a golden anniversary in another important sense. The application of research results from these two experiment stations alone has saved millions of dollars. Often the returns have been several hundred times the cost of the project to the sponsor. The results of research on problems related to our national defense are hard to put in terms of dollars saved, but benefits from new equipment, simplification and improvement of existing equipment, and fundamental information needed to make technological advances for the future are vital to the defense program. In these activities, universities, industry, and the government have worked together—each contributing to the over-all program. In addition to conducting comprehensive research programs, our experiment stations, as well as those of other universities, are providing training for research personnel needed to man governmental and industrial research posts.

Research, being a quest for answers to the unknown, has provided new principles of engineering and the sciences on which engineering is based. Even in applied research, where application of known principles is the primary objective, the projects provide a better understanding of fundamentals. By maintaining a close working relationship between the research and educational activities, these new principles and elaboration of known principles that are obtained through the research program provide valuable educational material. In fact, it is largely due to research conducted in engineering colleges that we can attribute our present emphasis on teaching fundamentals and the concomitant decline in student time spent on merely manipulative and descriptive techniques. Nearly all curriculums show the effects of these changed concepts; progress has been especially noticeable in such fields as mechanics, thermodynamics, electronics, and solid-state science. At the present time, the concepts derived from research in solid-state physics are being utilized in various fields such as metallurgical, ceramic, electrical, and mechanical engineering. Plans are now being formulated for the introduction of course material into the curriculums of these departments through conferences sponsored by the American Society for Engineering Education and the National Science Foundation. A similar program is being conducted to introduce the concepts of nuclear engineering to various engineering curriculums.

Technical advances through research have also intensified the need for continuing education for engineering and science graduates. Research results provide material for such adult-education programs as short courses, conferences, and seminars. Publication of research results also provides an educational medium for those who wish to keep abreast of new developments.

The complexity of modern engineering research has introduced several problems that are currently affecting the method of conducting our research programs. One of the major problems has to do with the large amount of technical material published in various fields. Today a comprehensive study of the literature covering past works in a given field of interest often requires more effort than was necessary to complete an entire project on the subject of 50 years ago. This situation has resulted in specialization of research personnel in order to minimize the time required for a survey of background material. A group of such specialists then works as a team to handle the large complex problems. In many cases, the team method of operation produces results that would not otherwise be practicable. However, this method of research is expensive and tends to inhibit individual creativeness. There is need for better support of the individual researcher through computing services, abstracting services, literature-search facilities, instrumentation services, and so forth. There is also a need for better methods of indexing material and for the communication of research results to avoid undesirable duplication of effort and wasted time and motion.

The complexity of research also introduces the problem of maintaining close relationships between teaching and research. As previously mentioned, this is desirable if education is to get maximum benefit from research. An individual research worker can divide his time between his project and teaching without undue complication. However, when he is part of a team working on a large project, it is much more difficult to provide contact time for students to study under him. The experiment stations at Illinois and Iowa State have made a concerted effort to provide for teaching and research combinations and have been quite successful in spite of the difficulties mentioned in foregoing paragraphs.

The present high level of research expenditures is primarily due to government-sponsored defense and atomic-energy research projects. In addition, some projects sponsored by industry are in fact government-supported programs that are being subcontracted to universities. If we are to continue to derive the benefits of engineering research, some means of financing must be provided in order to maintain an active research program within engineering colleges at such time as defense research funds are decreased. The National Science Foundation was conceived in order to provide support for basic research and to encourage the training of scientists and engineers. However, the funds that have been made available to this organization are still very small compared with those now being expended by the Defense Department and the Atomic Energy Commission. It is hoped that in the future additional funds will be made available to the National Science Foundation for support of research grants and graduate fellowships in proportion to the reduction of research funds that are now provided through other government organizations.

Industry is now supporting increased amounts of basic research. In addition to the specialized research program directed toward the direct solution of industrial problems, it is also providing funds for more graduate fellowships to support students interested in research training. These graduate students are in demand for research work in both industry and government. Thus, by means of research grants and fellowships, industry is making possible the training of research personnel as well as receiving the direct benefits of the research program. A greater amount of support by industry of university research is highly desirable; particularly if government support decreases.

News and Notes

Venezuelan Guayana Expedition

The New York Botanical Garden has brought to a close its 14th botanical expedition to the Guayana Highland of Venezuela, adjacent to British Guiana and Surinam. This program of exploration, begun in 1944 with expeditions to the Kaieteur Plateau in British Guiana and the Tafelberg in central Surinam (Netherlands Guiana), will come to a conclusion during the 1954–55 seasons with a second visit, in conjunction with the Chicago Natural History Museum, to Chimanta-tepuí in the Gran Sabana of southern Venezuela in the state of Bolívar, and a visit to Tepequem on the Brazilian side of the Pacaraima range, which forms the watershed boundary between southern Venezuela and northern Brazil. Support for the conduct of this program of explorations as a whole has come from many sources, but the current expedition was carried out under a grant made to the Botanical Garden by the National Science Foundation, the terms of which provide also for the forthcoming trips to the Cerros Tepequem and Chimanta-tepuí.

The expedition that has just returned was conducted by three staff members of the N. Y. Botanical Garden —Bassett Maguire, curator; John J. Wurdack, assistant curator; and George S. Bunting, assistant—who left New York on Oct. 7, 1953, and returned Mar. 4, 1954. This group explored mountains near the remote Brazilian fountier which had been seen by the previous expedition.

The objectives of the trip were two-fold: first, to make botanical collections, which might be expected to yield plants of the character and high endemism that had been previously exhibited by those from the famous Cerro Duida lying 150 mi north; and second, to make inquiry into the geology, determine the proportions, and record the positions of these new mountains.

To facilitate the exploration, the U.S. Ambassador placed the Embassy plane at the expedition's disposal. On Oct. 31, a 7-hr reconnaissance flight of some 1200 mi was made from Ciudad Bolívar across the mountainous and jungled region of southern Venezuela to the Brazilian frontier. This established without question the existence of extensive ranges along the Brazilian frontier and, further, the existence of a system of lofty sandstone plateaus northward of the frontier, well within the limits of Venezuela.

The expedition then embarked that same day at Ciudad Bolívar on the Río Orinoco. It traveled more than 1500 mi by river steamer, outboard motor, and dugout up the Orinoco, down the Casiquiare, and into its large blackwater affluent, the Pacimoni. On Dec. 13, the party reached its base camp, which was established in *guapó* forests (flooded lands) in the headwaters of the Pacimoni. Eighteen days and 5 camps later, on Dec. 31, the group arrived at the summit camp—altitude, 5500 ft—and there it remained until Jan. 23. The base camp was broken on Jan. 30, Ciudad Bolívar reached on Feb. 24, and finally New York again on Mar. 4.

The ornithological expedition of Mr. and Mrs. William H. Phelps, Jr., of Caracas joined the expedition for a period, reaching the base camp on Jan. 12. Alexander Wetmore of the Smithsonian Institution of Washington; James H. Kempton, Agricultural Attaché of the U.S. Embassy, Caracas; and Charles Reynolds, geologist of the Orinoco Mining Company,