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NATIONAL INTELLIGENCE SURVEY

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This chapter was prepared for the NIS by the Central Intelligence Agency. It includes contributions by the Departments of the Air Force, Army, and Navy and the Defense Intelligence Agency. Research was substantially completed by November 1972.

HUNGARY

CONTENTS

This General Survey supersedes the one dated May 1969, copies of which should be destroyed.

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FIGURES

Science

A. General (S)

Science and technology hold a significant and increasingly important position in Hungary. Although seldom considered excellent by Western standards, Hungarian efforts in scientific research and development are highly respected by other Communist countries and have received international recognition in certain areas of medicine, pharmacy, and biochemistry. During the first half of the 20th century, Hungary produced a surprisingly large number of prominent scientists, including the physicists Leo Szilard, Edward Teller, and Eugene Wigner; mathematician-physicist John von Neuman; mathematicians Paul Erdos, George Polya, Otto Szasz, and Gabor Szego; chemist George Hevesy; biologist Albert Szent-Gyorgyi; and physicist-aeronautical engineer Theodore von Karman. Many of these scientists emigrated to other countries, especially the United States.

Although the quality of basic research is good, only limited progress has been made in applied research. The government is aware of the need to improve such research. One of the most important considerations in assigning priority in research and in providing financial support is that the research project be oriented toward applied areas that will benefit the economy in the shortest possible time. A 20-year scientific research plan (1961-80) was drawn up by the government to keep research within economically productive bounds and to concentrate efforts on priority projects in industry and agriculture. A number of governing bodies direct research activities and expedite the industrial application of research results. The Council for Economic Mutual Assistance (CEMA) encourages the coordination of economic and scientific efforts among its member countries and has assigned to Hungary industrial priorities in such fields as chemicals, pharmaceuticals, telecommunications, electronics, and instruments and precision machinery. Hungarian scientific research and development efforts are related to the industrial specifications of CEMA.

Several factors have hindered scientific advancement. During World War II many research facilities were damaged or destroyed. Before the war and following the unsuccessful uprising against the Communist regime in 1956, many talented scientists and engineers emigrated to other countries. In addition, the economy has been unable to provide the financial support for science that larger and more prosperous countries can afford. Scientists have been unable to purchase modern scientific equipment abroad or have experienced long delays in securing such equipment. In some fields of science, laboratory instrumentation and methodology are several years behind those of advanced countries. Considerable difficulty has been encountered in commercializing scientific developments, because government-owned industrial plants are reluctant to accept risk in applying new processes. Political factors also have had an adverse effect on scientific research; the selection or promotion of administrators often has been based on loyalty to the Hungarian Socialist Workers Party (HSWP) rather than on ability. Some researchers are retained in their positions despite technical incompetence because of party pressure.

In an effort to make education and science serve the purpose of its economic goals, Hungary embarked on a highly optimistic manpower training program slated to extend through 1980. Facilities are being expanded to accommodate the anticipated large increases in enrollments in educational institutions. Heavy emphasis has been placed on scientific and technical education at the advanced level. Educational reforms of the early 1960's were aimed at providing the state with a skilled and professional work force and stressed vocational specialization at an earlier age, scientific concentration in curriculums at all levels, and the introduction of the polytechnical concept of student training (combining study with practice).

Because of its inability to compete successfully in all scientific fields, Hungary relies on the results of research conducted in other countries, and, consequently, maintains close relations with numerous foreign scientific bodies. Hungary participates in

numerous international scientific organizations and meetings. In 1965, for example, the Hungarian Academy of Sciences (MTA) sent 400 scientists to various international scientific meetings, 180 of them to Western countries. A much greater number of scientists were sent abroad by universities, ministries, scientific societies, and industrial enterprises. The Institute for Cultural Relations with Foreign Countries, Budapest, concentrates on establishing links with individuals and educational institutions in an effort to expand the Hungarian scientific and cultural presence in the West.

Hungary is a member of the U.N. Educational, Scientific, and Cultural Organization (UNESCO), the World Health Organization (WHO), the International Atomic Energy Agency (IAEA), and the International Astronautics Federation (IAF). Hungary belongs to the principal international astrogeophysical organizations. It cooperates in astrogeophysical efforts primarily with Communist countries and is active in satellite tracking. Hungary is a member of the Joint Institute for Nuclear Research at Dubna in the Soviet Union and contributes financially to its support. It is also a member of the International Center for Theoretical Physics at Trieste, which is sponsored by the IAEA and UNESCO. It is active in the Soviet Intercosmos program, the Vienna—Bratislava—Budapest Triangle on particle physics, the European Center for Nuclear Research (CERN), and the European Physical Society.

Scientific and technical cooperative agreements are in force with other Communist countries, as well as with the West. MTA maintains relations with the scientific academies of the U.S.S.R., East Germany, the People's Republic of China, North Korea, Poland, Czechoslovakia, Romania, and Bulgaria, as well as with the French National Center for Scientific Research and the Royal Society of London. U.S. scientists generally are received cordially by Hungarian scientists at their research institutes, but official policy has been to delay extensive cooperation with the United States in scientific and cultural affairs until political and economic relations between the two countries improve. In 1970 a bilateral agreement was concluded for the exchange of visits by scientists from both countries. In July 1972 a cooperative scientific research agreement was signed by the Institute for Cultural Relations with Foreign Countries and the U.S. National Science Foundation for the development of joint research projects in the physical sciences. Hungarian research institutes have provided technical assistance to developing countries in Latin America, Africa, and the Middle East.

B. Organization, planning, and financing of research (S)

All scientific research and development are under the direction of the HSWP and the government (Figure 1). An extensive organization has been established to administer and coordinate research activities; the main functions of this organization are to insure scientific and technological development in the various branches of science, to coordinate scientific activities, to provide direction in the solution of important research problems, to finance scientific activities in accordance with the national needs, and to encourage scientific communication and the practical application of scientific discoveries. Scientific research is conducted in institutes subordinate to the MTA, the ministries, and institutions of higher learning under the Ministry of Culture.

In November 1967 the Central Committee of the party authorized an extensive study of science policy and the control and guidance of research. The resulting report, representing the efforts of about 200 scientists, research administrators, and government and party leaders, was completed in mid-1969. Although no radical changes in science policy were proposed, the report stressed the need for increasing the effectiveness of scientific research and development to stimulate economic growth and advocated increased research by universities and industry. It also called for greater cooperation among scientists from different branches of sciences and among different types of research installations on important problems and emphasized the importance of international cooperation in science. Although the report pays lipservice to the freedom of science as an important factor in Hungarian science policy, since 1968 there has been a trend toward stronger domination of the MTA by the government and the Communist party. In an effort to bring the MTA under greater party influence, the Industrial Scientific Planning Committee of the party has recommended that some of the power of institute directors be reduced and the number of party members on MTA scientific committees be increased.

The highest coordinating body for all scientific activity is the Council on Science and Higher Education (TFT). Created in 1957, it is composed of about 40 scientists and leading ministerial officials and reports directly to the Council of Ministers. It has the power to make recommendations to the Council of Ministers regarding the coordination, merger, and dissolution of research institutes. It decides on the type

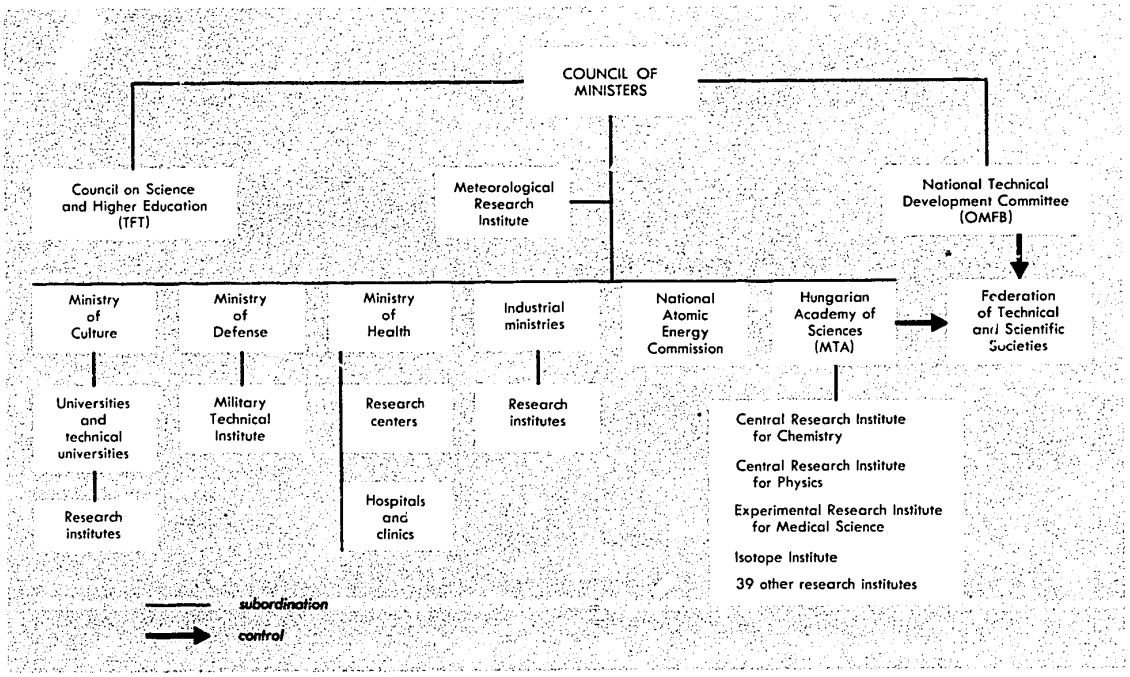

FIGURE 1. Organization of scientific and technical research, 1972 (C)

and method of training of scientists and engineers and the number to be trained by the universities in relation to the manpower needs of the national economy. The TFT drew up a 20-year research plan, approved in March 1962, which directs research goals to the planned technological advances of Hungarian industry. The plan enumerates 73 priority problems on which funds and efforts are to be concentrated during the period of the plan. The MTA and the governmental ministries draw up 5-year research plans within the framework of the long-range plan.

The National Technical Development Committee (OMFB), established in 1961, is concerned with expediting the application of research results in industry. Subordinate to the Council of Ministers, it has a membership of approximately 45 scientists and technologists and a chairman of ministerial rank. The OMFB has three major functions: 1) to study major technical problems related to the development of the economy; 2) to cooperate with the National Planning Office, TFT, MTA, and the ministries in the preparation of long-range technical development plans; and 3) to advise the Council of Ministers and other governmental agencies on the improvement of technological development. It has the power to disapprove import licenses for the purchase of major equipment, such as computers, which help to determine the course of technological development.

The MTA is the most important scientific body in Hungary and holds ministerial status. It was formed in 1825, and since 1949 has directed the country's scientific effort. Its main responsibility is organizing, directing, and coordinating basic research, but it is also involved in those aspects of applied sciences which are concerned with the promotion of the national economy. The MTA is supported by the state and enjoys considerable prestige since the intellectual level of its members is even higher than that of the universities. It includes many of the country's leading scientists and technical experts, and the MTA's decisions in scientific matters are important, although final authority rests with the Council of Ministers. In 1966 the MTA had a membership of 210, including 87 regular members, 74 corresponding members, and 49 honorary members. It is organized into 10 sections: Mathematical and Physical Sciences, Agricultural Sciences, Medical Sciences, Technical Sciences, Chemical Sciences, Biological Sciences, Earth and Mining Sciences, and three sections concerned with the social sciences. The work of the MTA is directed by its president, as head of the presidium, while the secretary-general is responsible for implementing

decisions and for routine administrative matters. Sectional secretaries are elected from the members.

The MTA directs the research activities of 43 research institutes, 30 of which are concerned with natural and technical sciences. Each of the sections and each institute reports periodically to the Academy's presidium. The presidium has many subordinate committees, including ones for meteorology, geology, geophysics, geochemistry, and astronomy; the last committee includes a subcommittee for space tracking. Although the MTA's funds have not been sufficient to provide adequate housing for all research facilities, some of the institutes, particularly the Central Research Institute for Chemistry in Budapest, the Central Research Institute for Physics in Csillebere,[1] and the Experimental Research Institute for Medical Sciences in Budapest, are well housed. A new biological research institute under the MTA is being built at Szeged at a cost of US$8 million. The MTA publishes a large number of scientific journals and periodicals and translates foreign scientific literature, most of it of Soviet origin. It also maintains contact with over 100 international scientific organizations and has been participating increasingly in international conferences.

The most important physics research institutes are the Central Research Institute for Physics, the Institute for Nuclear Research at Debrecen, and the Institute for Technical Physics in Budapest. All are subordinate to the MTA, which also has other, smaller research groups engaged in physics research. The MTA's Mathematical Research Institute and Center for Computation Techniques, both in Budapest, carry out investigations in pure and applied mathematics, respectively. The academy also has an institute to conduct research in automation. Four major laboratories under the MTA are engaged in chemical research. It also maintains research groups in 10 university departments for chemical studies. Its important center for research in pure and applied chemistry is the Central Research Institute for Chemistry and in biochemistry the Biochemical Research Institute in Budapest. Three institutes engage in medical research, of which the Research Institute for Experimental Medicine is the most important. The academy's Veterinary Medical Research Institute in Budapest engages in research in infectious and parasitic diseases of animals. In the field of agronomics, the Agricultural Research Institute at Martonvasar and the Research Institute of Soil Science and Agricultural Chemistry in Budapest are doing the most notable research. The former is involved in research on plant genetics, physiology, and breeding. The latter is concerned with soil physics, chemistry, and microbiology; reclamation; conservation; and plant physiology and biochemistry.

Individual ministries have established their own specialized research institutes for applied research and technical development. Nearly 90 of these institutes operate in many fields related to industrial, agricultural, and public health research. The industrial ministries supervise 50 research institutes and employ about half of the country's scientific manpower. They receive a substantial portion of the total funds available for research. About 127 industrial firms have laboratories for product development, but the government prefers that all industrial research be carried out in ministerial research institutes to insure easier supervision and coordination. The Ministry of Health has 12 research centers and also conducts research at hospitals and clinics. Medical research also is conducted at several institutes under the MTA.

Both basic and applied research are carried out in universities and specialized higher educational institutions. Most university departments have been concerned primarily with fundamental research in the past but are gradually undertaking considerable applied research. Research at the universities has concentrated on projects covered in the national long-range plan, as well as on projects involving the development of various branches of science being encouraged by international bodies. Although the government maintains that scientists are free to conduct research of interest to them, actual priority in university research is decided by a group of academicians who have considerable influence in Communist party circles. Projects favored by these scientists receive good financial support. Management, supervision, and financing of scientific research at higher educational institutions are handled by the ministry that oversees them. The MTA also provides funds for research and has authority over its researchers within the framework of university departments.

The National Atomic Energy Commission, established in 1956, is subordinate to the Council of Ministers. It functions at the ministerial level and is composed of various ministers, high-ranking governmental officials, and leading scientists. The commission acts as an administrative body which coordinates and essentially controls all activities directed toward the utilization of nuclear energy

[1]For diacritics on place names see the list of names at the end of the chapter.

within the country. It is charged with planning the development of nuclear power; making provisions for the use of radioactive isotopes in research, agriculture, industry, and medicine; promoting the production of instruments used in nuclear research; and undertaking other tasks arising in connection with the peaceful application of atomic energy.

The Federation of Technical and Scientific Societies, Budapest, is important in scientific and technical activities. It is a voluntary group of 25 professional societies and has as its main objective the promotion of science and technology. It is engaged in preparing a long-range technical development plan and has set up work commissions for this purpose. In all, there are about 500 permanent and short-term commissions dealing with various problems of science, industry, and technology. The federation does not have any research institutes of its own nor does it actively participate in research. Although nominally independent, the federation is controlled by the MTA and the OMFB. Half of its funds are provided by the government, while the balance is secured from membership fees and contributions.

The government's continuing awareness of the importance of science and technology to the country's growth is reflected in the fairly large proportion of the national income allocated each year for scientific and technical research. Expenditures for scientific research in 1964 amounted to about 1.5% of the national income; during 1970 expenditures reportedly amounted to $425 million or about 2% of the national income. Technical research projects have priority and in 1966 received 55% of research funds, while natural science research received about 18%; agricultural research, 12%; medical research, 9%; and research in the social sciences, 5%. Industrial ministries have received about half of the available research funds, and the remainder has been divided between the MTA and universities.

The MTA operating budget has grown about 10% annually in recent years and amounted to approximately US$39 million in 1968. About 10% of the budget was spent for administrative purposes; 25% to finance research projects in universities; and 65% for research, primarily basic, in its own institutes. Funds available to the MTA in 1971 amounted to $64 to $68 million, including both operating budget and funds for capital investment in new buildings and equipment. In 1968 the MTA's Central Research Institute for Physics had an operating budget of approximately $8.5 million. During 1964 the OMFB had a budget of $3.2 million and the Federation of Technical and Scientific Societies' budget amounted to $3.4 million.

A major source of research funds used primarily for development purposes has been the Technical Development Fund, which was set up in 1958 to give impetus to the Hungarian drive for developing technology to the level of the West.

C. Scientific education, manpower, and facilities (S)

The Hungarian Communist regime places considerable emphasis on the education of scientists, engineers, and technicians. The quality of scientific education is good. The country has nine universities, six technical universities, three agricultural universities, four agricultural colleges, and four medical universities. The 650 departments within these schools constitute important research and training centers. Several colleges also have facilities for research. Four of the universities have an important role in scientific training and research. The Lorand Eotvos University in Budapest, Jozsef Attila University in Szeged, Lajos Kossuth University in Debrecen, and the Technical University of Budapest.

Through a series of educational reforms, Hungary has attempted to meet its industrial and professional manpower requirements. Advanced schools for technical and engineering training were established in the early 1960's to provide polytechnic education to more than 100,000 students. However, courses of study at these schools were aimed at producing engineering technicians with training in a narrow field and with a minimum of theoretical education. The curriculums of the country's universities and technical institutions have not been affected significantly by the educational reforms since the 1956 uprising. Students pursue a 5-year academic program which includes on-the-job training in their major fields of study. Scholarships are available and in addition industries will subsidize students under a contract which requires them to work for a number of years for the industry providing the grant.

Facilities at the university level are crowded, competent teachers are scarce, and admission to higher educational institutions is difficult to obtain. Nevertheless, the quality of scientific education in the basic sciences has remained at a high level. Good chemical training is available at the major universities and at the Technical University of Budapest and the specialized Technical University of Chemical Engineering in Veszprem.

Scientists, academicians, and professors are highly respected and enjoy considerable political immunity because of their valuable talents. Promotions, however, often are influenced by political considera-

tions, and preferential treatment is given to loyal party members. As a result, many highly competent scientists are restricted to routine work, and the morale of researchers has suffered. Although the income of scientists and engineers is only marginally above that of skilled industrial workers, educated persons receive preferential treatment that favorably affects their standard of living. Faculty members of higher educational institutions also are not well paid, and it is customary for them to take jobs as consultants to supplement their income. A professor receives additional compensation if he is a regular or corresponding member of the MTA or if he has an advanced degree. Scientists and professors enjoy lifetime job tenure under normal circumstances.

There is a slight shortage of research personnel, particularly in the engineering field. In 1967 approximately 41,000 or 0.8% of the wage earners were employed in some form of research activity as scientists, engineers, technicians, administrators, or in services. At the present time, between 6,500 and 7,000 researchers are employed at research institutes; 7,000 persons at universities teach and conduct research, and about 800 others are engaged in nonteaching research projects. Some 2,000 to 2,500 researchers work in the laboratories of industrial enterprises and ministries. Of the total number of researchers, about 7,000 have professional degrees. The research staffs of the MTA have grown significantly since the early 1960's, and more than 5,000 individuals are employed in its institutes. The MTA Isotope Institute has approximately 1,000 people engaged in the production of isotopes. The Central Research Institute for Physics has a total staff of 1,300, of whom more than 250 are scientists and engineers. Since 1964 the Research Institute for Telecommunications, Budapest, has grown significantly, increasing its staff from 300 to 1,200.

Because of the limited possibilities, many scientists are reluctant to go into research or, especially, to conduct basic research at a university. The low salaries paid by the Technical University of Budapest are supplemented by income from contract research. The research worker thus tends to abandon basic research and to concentrate on work with immediate industrial application. Researchers participating in contract research at the Technical University of Budapest are appointed by the deans. The participating scientists receive about 50% of the income from contract research, while the remainder goes to the university. The project chief, often the dean of the department, receives a major share of the funds.

With a few exceptions, scientific research institutes are small, particularly most of those affiliated with the MTA. The average institute has a staff of only about 100 persons. These small institutes often are handicapped by inadequate documentation services, a lack of modern equipment, and insufficient supporting personnel. Research institutes vary in quality according to the field of research. The Central Research Institute for Chemistry of the MTA is new, and attractive in appearance, but it is not as well provided with scientific equipment as the better laboratories in the United States. The Central Research Institute for Physics has impressive buildings, but much of the equipment is homemade and of poor quality. The Experimental Research Institute for Medical Science has a very modern 11-story building. The Industrial Research Institute for Electronics, however, does not have adequate equipment or facilities to carry out a productive solid-state research effort. The general lack of instrumentation has caused an upsurge in its development, and industries are producing fairly modern equipment. However, many of their best items of apparatus are earmarked for export to the U.S.S.R. and other countries for the purpose of improving Hungary's poor foreign exchange status.

D. Major research fields

1. Air and ground weapons (S)

Weapons research and development capabilities are meager. Since World War II the country has concentrated its technological resources in fields other than the design and development of weapons systems and remains dependent on the U.S.S.R. for weapons for its operational forces. The Soviets monitor all indigenous research being performed by Hungarian researchers for possible military value. For the most part, military research consists of modifying weapons and vehicles of foreign origin to meet domestic requirements. One of the military-related research efforts known to be underway is a Soviet-directed program concerned with investigating the properties of Soviet rocket propellants. This work includes a study of the long-term stability of ammonium perchlorate crystals (probably for prediction of the shelf life of solid propellants), and a study of various solid-propellant formulations that exhibit the best extinction characteristics following ignition shutdown. The results of these investigations are used to supplement the Soviet Union's research program.

Hungary has a modest research and development effort in the fields of transportation vehicles and engine technology, [illegible] and stream-crossing, construction and [illegible]-moving, and materials-handling equipment. Current research efforts include the development of a 3-axle truck tractor for the military and improved components for existing vehicles, including power steering, powered axle assemblies, and transmissions. The number of high-quality components being introduced into worldwide markets reflects Hungarian success in this field. In addition, reinforced plastic materials have been developed to replace sheet metal in truck cabs. Experimental results show reduced weight and lower noise levels in the cab. A rudimentary air cushion vehicle project is underway with one prototype thus far produced, but no significant developments are expected in the foreseeable future. Engine research of military significance is primarily aimed toward the eventual production by the Raba-MAN Company in Gyor of a 150-horsepower, 5-cylinder diesel engine, currently in development testing. Research is conducted on foreign truck designs to find ideas that can be taken up in domestic manufacturing and, in addition, to partially satisfy military requirements for such vehicles. Hungary has collaborated with Czechoslovakia on the design and manufacture of two versions of wheeled armored reconnaissance vehicles.

Most automotive research is carried out by the Military Technical Institute in conjunction with engineers of the Csepel Motor Vehicle Plant in Budapest. The Technological University of Budapest has a department for motor vehicle engineering which is capable of providing a small number of technically qualified personnel for automotive design work. All automotive design facilities have come into existence since World War II. They are still not adequate to support an indigenous industry capable of supplying the military services with an adequate range of motor vehicles.

Although the country's aeronautical industry dates back to 1928, its activities since World War II have been restricted to the development and limited production of small general-purpose type aircraft and gliders. There is no current development and production activity on air weapons in either the aircraft or missile fields. Space-related activity is mostly confined to satellite tracking and data collection on foreign systems in earth orbit. Some space-related research of an academic nature is accomplished at universities. The country's four satellite-tracking stations are located in Budapest, Baja, Miskolc, and Szombathely; all are operated under the direction of the MTA. Hungary has membership on both the Soviet Intercosmos and Intersputnik programs.

The capability for the design and development of some types of instruments, especially field survey (except photogrammetric) equipment, is excellent. The country is close to world leadership in the development of gyrotheodolites, six models of which were successfully developed during the 1960's. An automated high-precision model is in an advanced stage of development and may be the highest performance gyrotheodolite built anywhere in the world. Several thousand gyrotheodolites have been exported to the U.S.S.R. and reportedly are to be used in Soviet missile survey operations. Three models of electronic geodetic distance-measuring instruments have been designed; the GET-B1 is in use by the Warsaw Pact armies, but the others have not reached the production stage. A code theodolite, Ko-B1 (Figure 2), possibly developed for military application, can function either as an automatic recording geodetic survey instrument or as a high-precision recording code cinetheodolite. It is the most advanced instrument of this type developed in any of the Communist countries. The code theodolites, gyrotheodolites, and numerous models of conventional optical equipment (theodolites, levels, auto-reducing levels, tachymeters, alidades) were developed at the Hungarian Optical Works, Budapest, in collaboration with the MTA's Geodetic Research Laboratory in Sopron. The latter facility has a special underground laboratory for testing gyrotheodolites.

2. Biological and chemical warfare (C)

Hungary has adequate personnel, technology, and facilities to conduct biological warfare (BW) research and development. There is no evidence to show that the country has an organization which controls a program for the development of BW agents or munitions, but sophisticated research is underway in modern laboratories on potential BW agents which cause anthrax, brucellosis, cholera, tularemia, and arthropod-borne encephalitides. The etiology, pathogenesis, diagnosis, treatment, and prevention of these diseases have been studied. Candidate antianimal BW agents studied include those which cause hog cholera, swine fever, foot-and-mouth disease, and Aujeszky's disease. An excellent pharmaceutical industry which produces high-quality vaccines, sera, and antibiotics for human and animal use could contribute to a defensive or offensive BW program. Large quantities of pharmaceuticals are

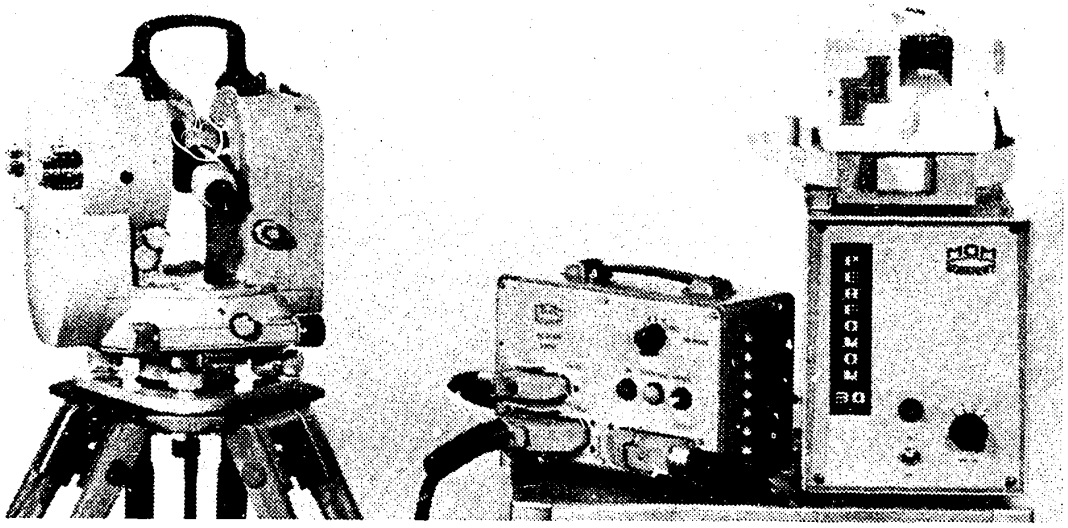

FIGURE 2. Ko-B1 code theodolite (U/OU)

exported to the U.S.S.R. and other Communist countries, indicating a stockpile capability. Original research on microbiological fermentation technology and agent purification provides increased production potential. Work in anticrop BW-related research appears to be superior to that of the U.S.S.R. and other Communist countries. Studies have continued on antifungal antibiotics for application on grain diseases, on organophosphate insecticides, species-specific pesticides, and biological control of insects. Although these studies appear to be strictly in the public health or agricultural domain, the findings from some of them could be used for defensive and offensive BW applications.

Scientists are familiar with techniques for detection of BW agents and have evaluated modern methods of identification including fluorescent antibodies, infrared absorption, membrane and soluble filters, and selective media. At least one nonautomated device, a testing kit utilizing selective media, has been developed for field use.

Organizations for chemical, biological, and radiological defense for military and civilian personnel follow Soviet counterparts. Defensive BW equipment is obtained either from the U.S.S.R. or is indigenously produced based on Soviet design. Military publications and official directives discuss potential hazards of BW and contain detailed descriptions of protective measures to be taken in event of BW attacks. Training, however, appears to have less emphasis than in other Warsaw Pact countries.

The chemical warfare (CW) research and development program is primarily defensive and is modest when compared with those of other East European countries. Research on toxic agents is limited, largely because of Soviet restrictions. Nevertheless, Hungarian scientists are knowledgeable of World War II types of toxic CW agents and prior to the 1956 revolt had experimented with a number of nerve agents. Research has been conducted on the role of acetylcholinesterase on the autonomic nervous system which could have CW defensive (therapeutic) or offensive (nerve agent) implications.

The Military Technical Institute in Budapest, under the Ministry of Defense, is considered the primary center for research on CW agents, particularly nerve agents. Since 1967 few articles on organophosphorous research applicable to CW agent development have appeared in Hungarian literature. Cyclosarin, a nerve agent similar in structure to sarin, the standard U.S. nonpersistent nerve agent, has been mentioned briefly and is claimed to have a higher toxicity than that of sarin. Ergot production research is emphasized, probably because ergot, from which lysergic acid diethylamide (LSD-25) is derived, is a Hungarian export. It is doubtful that this work is related to the study of the properties of LSD as an incapacitating agent since the characterization and physiological effects of ergot alkaloids apparently have not been investigated.

The Hungarians reportedly are developing an automatic chemical alarm, the CHPN, presumably for

the detection of nerve agents; it is to replace the Soviet GSP-1 automatic alarm which detects G-type nerve agents such as sarin and the PKh-54 detector kit which, with the inclusion of a special tube, detects both V- and G-agents. V-agents include VX which acts primarily through the skin rather than through the respiratory tract, the primary route of entry for G-agents.

3. Atomic energy (S)

Hungary has a small nuclear energy program which is administratively controlled by the National Atomic Energy Commission. However, the Soviets essentially dictate the limits of the research which may be conducted. The growth of the nuclear program is restricted by the stringent Soviet controls, as well as by limited scientific manpower, research facilities, and financial resources. The program is directed primarily toward basic nuclear research, and the production and utilization of radioactive isotopes. Nuclear scientists receive token assistance from the Soviets, specifically through nuclear training at the Joint Institute for Nuclear Research at Dubna, U.S.S.R. Since 1967 Hungary also has received some assistance from IAEA.

Most of the nuclear research is conducted at the Central Research Institute for Physics and at the Institute of Nuclear Research in Debrecen. The Central Research Institute for Physics has a research reactor provided by the Soviet Union in 1958 and a zero-power reactor which has been operating since 1963. The research reactor, originally a 2-megawatt thermal (MWt) reactor, was modified to increase its power level to 4-5 MWt; its isotope production capacity also was increased significantly. Hungary also has several accelerators ranging in energy from 200 Kev to 4 Mev. These are used in basic low and intermediate energy physics research.

A high-flux materials testing reactor was reportedly under construction during 1966 at the Institute of Nuclear Research; however, nothing is known of its status. Also during 1966 a 10-kilowatt research reactor was under construction at the Budapest Technical University. Although scheduled for completion in 1967, this reactor did not achieve initial criticality until mid-1971.

The MTA's Isotope Institute stores and distributes isotopes produced in Hungary and imported from abroad. It also promotes the use of isotopes for industrial control and testing.

Only a moderate effort has been directed toward the development of nuclear power. Hungary and the Soviet Union signed an agreement in 1966 whereby the Soviets would provide a two-reactor, 880 electrical megawatts (MWE) nuclear power station to be built at Paks on the Danube. At the request of Hungarian officials construction of the station has been delayed, and the first reactor, scheduled to become operational in 1975, is expected to become operational in 1980.

4. Electronics (S)

Hungary has demonstrated the ability to produce significant results in electronic research and development but is handicapped by lack of funds, shortages of materials, and conflicting priorities. The country has the know-how and resources to exploit foreign designs as well as the capability for the manufacture of high-quality components and equipment. The main center of electronics research and development is the Telecommunications Industrial Research Institute, Budapest, where a broad range of activities is underway.

Semiconductor and transistor research and development continue to be stressed in all areas, from basic research in transistor technology to manufacturing techniques. Nevertheless, difficulty in obtaining such semiconductor materials as gallium arsenide has impeded research in this field. The Telecommunications Industrial Research Institute has under development ultra-high-frequency silicon transistors and diodes. The Research Institute of the Electronic Industry in Budapest is involved in studies relating to the production of high-grade silicon carbide for semiconductor use, thyristor development, and semiconductor control devices. Power diodes of 20- and 60-ampere capacity at 600-volt operation are being developed.

Vacuum tube research and development generally are based on work done in the West. The Hungarians have done some major work in developing microwave tubes and materials. Cathode bases have been made from tantalum and titanium instead of the usual active nickel. Also developed was a special high-temperature L-type cathode with the same emission characteristics as an ordinary L-type. The Hungarians have developed E/F-band reflex klystrons, G/H-band and E/F-band traveling wave tubes, and G/H-band triodes.

Hungary is currently dependent upon the U.S.S.R. for electronic warfare equipment and for fire-control and surveillance radars. While there appears to be no significant research and development in these fields, radars have been produced domestically since 1955. In the area of communications, the Hungarians have developed radio-relay systems for use in the U.S.S.R. The stations are designed for communications on super-high frequencies of from 7900-8000 megahertz.

Efforts to develop ferrite magnetic materials and magnetic cores have been successful, and research and development in this area are nearly equal to that of the more advanced Western countries. Nickel oxide is produced for ferrite cores. Other production includes radio-frequency ferrites, computer memory core ferrites, barium ferrites, and printed circuits.

Research in infrared technology includes projects on electron microscopy, photon detectors, image converters, optical materials, and optical properties of films. The Hungarian Optical Works has produced fiber optic illumination units; none of the work is outstanding, but excellent spectrographic equipment for obtaining emission spectra has been developed. Research is underway on a dye for military uniforms that will produce the same infrared absorbence as the foliage that is characteristic of the country.

Hungary has assumed a position of leadership among the Eastern European countries in the development and production of small computers. The Central Research Institute for Physics has developed a model, designated IPA-1, which has been exported to the U.S.S.R. and other Eastern European countries. An improved version, IPA-2, is entering production. The Electrical Measuring Instrument Factory, Budapest, developed and in 1968 began production of the first domestic model of an electronic digital computer, the transistorized EMG-830. Although not competitive with current Western computers, it appears equal to some of the best transistorized computers that have been developed in other Eastern European countries. This factory also has developed and produced several devices for automatic control systems. The most advanced logic circuits known to have been produced in Hungary employ printed circuits with transistors and other discrete components. In addition to the Electrical Measuring Instrument Factory, such facilities as the Telecommunications Industrial Research Institute have conducted engineering research on thin-film hybrid and integrated circuits. Considerable emphasis is placed on the automation of measurement techniques. During 1970 Hungary signed an agreement with France to manufacture under license in Hungary a small, third generation computer to be called the EMG-810.

The number of installed computers increased from 48 in 1967 to 80 at the end of 1969. Hungarian sources say that the goal for the next 5 years will call for the installation of 400 to 600 computers, although others estimate that the country cannot absorb more than 30 per year. Hungary was among the first of the Eastern European countries to establish a central registry for computer programs. The registry, under the Department of Information and Documentation of the National Management Mechanization Control, publishes lists of available programs and disseminates suitable programs to users.

In 1970 the Hungarian Research Institute for Scientific Instruments in Budapest had developed 40 types of instruments for laboratory and industrial use. The range of instruments includes integrated digital voltmeters, circuit testers, gas analyzers, biological simulators, and temperature and pressure transducers. The Hungarian company which handles the sale of scientific instruments is METRIMPEX, which is also located in Budapest and produces a quarterly publication "Hungarian Scientific Instruments" describing domestic developments in the instrument field.

5. Medical sciences, including veterinary medicine (S)

Biomedical research, though limited in volume, is of high quality and compares favorably with the finest in Eastern Europe. Progress is limited by shortages of funds and equipment. Research is undertaken at institutes of the MTA, Ministry of Health, universities, and industry. The inauguration in 1971 of a new Biological Research Center of the MTA, at Szeged, has given Hungary superior facilities for interdisciplinary research in molecular biology. Excellent work is being done in neurophysiology, biochemistry, biophysics, and pharmacology. Pharmaceutical research largely duplicates Western achievements, but the drugs developed meet high international standards. Hungary has made unique contributions in the synthesis of hormones and antineoplastic agents.

Physiologists are making an outstanding contribution to the study of the regulation of brain functions and to the determination of brain circuitry. Hungary leads the Communist world in research on sensory and visual morphology, and good work is underway on the study of excitation and conduction of nerves and neuro-hormonal activity. Excellent models of nerve cell networks have been developed and are being tested on computers and modified according to electrophysiological observations in animals. Neurophysiological investigations are assisted by research on drugs which act upon the central nervous system, particularly in areas of the brain which regulate or organize behavioral reactions.

Research in biochemistry has been steadily expanding in volume. Prospects for major progress in molecular biology have been enhanced with the

opening of the Szeged center. This facility has four research institutes for biochemistry, genetics, biophysics, and plant physiology, which are carrying out good multidisciplinary research in photosynthesis, regulation of enzyme activity, and regulation of genetic activity.

Pharmacology is the most active field in biomedical research and furnishes basic support to the pharmaceutical industry, a very productive element of the national economy. Hungary leads other East European countries in the development of drugs. Most of the research and development is centered in the Research Institute of the Pharmaceutical Industry in Budapest and in the Department of Drug Research of the Research Institute for Experimental Medicine. Research support of the industry is also furnished by the Biological Research Center. Important advances include the synthesis of prostaglandin; the unique synthesis of human adrenocorticotropic hormone, research on the genetics of ergot and isolation of its active components; the chemical and microbiological synthesis of steroids; and the study of plant-derived cancer chemotherapeutics. Extensive research is devoted to exploitation of active principles of medicinal plants. Research also has produced anti-inflammatory agents, contraceptives, tranquilizers, and analgesics.

Research in microbiology is good but is undertaken on a modest scale. Studies are done on the standard development of sera and vaccines, production of monkey kidney cells for agent propagation, and production of three types of cholera vaccine. Careful work is being devoted to the study of arbovirus multiplication in mosquitos and ticks. Other research concerns the induction of interferon in mouse cells and the viral etiology of cancer.

The Hungarians are doing good but not original work on the stimulating and destructive effects of laser radiation, inactivation of enzyme function by ionizing radiation, and the use of radiation to sterilize feeds. Techniques are being developed to improve the control of ionizing radiation dosage and to analyze the homogeneity of radiation energy. With limited resources, the country is developing high-quality equipment, especially optical instruments for brain research, but has not yet regained its international position in the production of medical instruments. Computer technology is exploited to support diagnostic procedures.

The veterinary research capability is comparable to that of other neighboring countries but does not equal that of the U.S.S.R. or East Germany. Research is primarily applied and emphasizes the study of improved diagnostic techniques for and the development of more effective vaccines against animal diseases of economic importance to the country. Individual scientists occasionally embark on sophisticated research which indicates an advanced capability in veterinary science. Studies are underway in bacterial research on the agents producing anthrax, leptospirosis, tuberculosis, salmonellosis, and clostridial infections. Tissue culture techniques and modification of virus strains are investigated. The emphasis in parasitology is on the development of chemotherapeutic agents for the treatment and control of parasitic infestations. The Veterinary Medical Research Institute of the MTA in Budapest is the major veterinary research institute.

6. Other sciences (S)

a. Chemistry and metallurgy

Hungary does a substantial amount of basic and applied chemical research and development. Basic chemical research of high quality is underway in the universities and institutes of the MTA. Despite the government's continuing emphasis on applied chemical research to support the growing chemical industry, this aspect is generally weak except in specialized areas such as pharmaceutical chemistry, which is well supported by the drug industry. The Chemical Sciences Section of the MTA supports several institutes concerned with chemistry, notably the Central Research Institute for Chemistry, the Isotope Institute, and the Research Institute for Technical Chemistry in Veszprem. The Chemical Sciences Section also supports 11 university chairs, each held by a professor and assisted by a research team.

Partly because of strong support by the MTA, organic chemistry has achieved considerable importance. Research on alkaloids and other natural products, chemical transformations of hydrocarbons, pharmaceuticals, and polymers has been encouraged. Lorand Farkas, a leader of the MTA research groups for alkaloid chemistry at the Technical University of Budapest, has done excellent work on flavones, isoflavones, glucosides, and other natural products. Good synthetic organic research has also been done at this university on hydantoins, thiohydantoins, pyrimidines, and other heterocyclic nitrogen compounds. Several of the major pharmaceutical companies, especially the Chinoin Pharmaceutical and Chemical Products Company, Budapest, are doing excellent synthetic organic work related to various types of pharmacologically active substances.

Research on the reactions of hydrocarbons is under investigation by the Hungarian Oil and Gas Research Institute, Veszprem, which also is concerned with petrochemicals, catalysts, lubricating oils, and greases. The Research Institute for the Plastics Industry, Budapest, is the principal facility engaged in polymer research. The effort encompasses studies on resin adhesives, manufacture of polyvinyl chloride, catalysts for ethylene polymerization, polyamides, properties of polymers, and polymer structure. Dr. Gyula Hardy, the director of this institute and also a professor at the Technical University of Budapest, is a capable scientist who has done considerable work on polymerization reactions, including radiation-induced solid-state polymerization. Good theoretical work on the kinetics of polymerization and the kinetics of inhibition of free radical polymerization has been carried out at the Central Research Institute for Chemistry.

There is some effective research in physical organic chemistry, particularly on reaction kinetics at the Central Research Institute for Chemistry (Figure 3) and on bond structures of organosilicon compounds at the Technical University of Budapest, but the development of physical organic chemical research has been retarded by the shortage of instrumentation. For example, in 1969 few scientists had access to nuclear magnetic resonance equipment, which was located only at the Central Research Institute for Chemistry, the Central Research Institute for Physics, and possibly at the Chinoin pharmaceutical plant.

In physical chemistry, considerable work is being done in electrochemistry, reaction kinetics, and catalysis. The Central Research Institute for Chemistry is engaged in fundamental research problems in chemical kinetics of inorganic reactions and in fast reaction techniques. There is a concentration of effort on kinetics of catalytic hydrogenation and on electrolytic hydrogenation and adsorption phenomena on platinum electrodes, as well as on oxidation on nickel hydroxide electrodes. Tibor Erdey-Gruz, president of the MTA, and his associates at the Lorand Eotvos University, Budapest, are concerned with ion migrations, adsorption, electrode potentials, reduction of metal ions on electrodes, and the effect of sinusoidal current on electrode processes. A group at the Technical University of Chemical Engineering does research on polarography, polarization, and the effect of alternating current on the corrosion of metals. An outstanding figure in catalysis is Zoltan Csuros of the Technical University of Budapest; he has worked on boron trifluoride catalysis, catalytic oxidations, and particularly on Raney nickel catalysts for hydrogenation. An

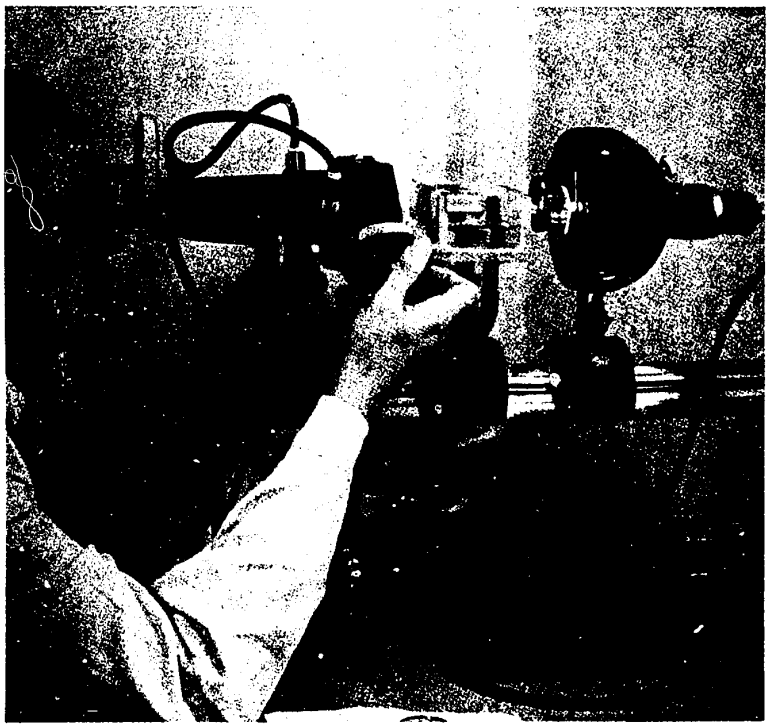

FIGURE 3. Measurement of reaction-kinetics with a Pulfrich photometer at the Central Chemical Research Institute (U/OU)

important study at the Jozsef Attila University, Szeged, is on the thermal stability and thermal decomposition of chlorine and oxygen salts, including work on ammonium perchlorate, an important component of solid-rocket propellants.

Hungary is particularly active in analytical and inorganic chemical research and has some outstanding research personnel in the analytical field. Prof. Laszlo Erdey of the Technical University of Budapest is very well known for a variety of research on precipitation exchange reactions, oxidation-reduction indicators, gravimetric analysis, new analytical reagents, and thermoanalytical techniques. Prof. Erno Pungor of the Technical University of Chemistry Engineering is also outstanding for his research on flame photometry, titrimetric analysis, ion-specific electrodes, and, recently, on heteropolyacids.

A lesser amount of research in biochemistry is being done, but the quality is good. Dr. F. Bruno Straub, director of the Institute of Biochemistry of the MTA, Budapest, is possibly the best biochemist in Eastern Europe. He has done considerable research on ribonucleic acid and enzymes. One of Hungary's leading chemists, Prof. Byozo Bruckner of the Institute of Organic Chemistry of the Lorand Eotvos University, has done excellent work on anthrax polypeptides, polyglutamic acids, and the synthesis of polypeptides and hormones. Because of his advanced age he appears to be no longer active in research. A substantial amount of biochemical research on miscellaneous topics is conducted at the Experimental Research Institute for Medical Science and at the medical universities.

The applied metallurgical research and development program is well balanced and directed principally toward solving the problems of the industries contributing heavily to the economy, especially the steel and aluminum industries. Since about 1967 the amount of applied research has grown, and there has been an increase in the amount of research undertaken at plant facilities such as the Lenin Steel Works in Diosgyor, the Csepel Metal Works on Csepelsziget, and at various aluminum producing plants. The most important metallurgical research facilities are the Research Institute for Ferrous Metallurgy and the Research Institute for Nonferrous Metallurgy, both in Budapest and under the Ministry of Metallurgy and Machine Industries.

The Research Institute for Ferrous Metallurgy, under the direction of Jozsef Vero, has done extensive research on stainless steels and the physical metallurgy of steel and on the development of high-strength low-alloy steels. Research efforts have covered all facets of ferrous metals production and problem solving and have included blast furnace and basic oxygen furnace studies. Other efforts have concerned studies on the continuous casting of steel slabs, the heat treatment of bearing and tool steels, the corrosion of stainless steels, fracture mechanics, fatigue studies, and electron fractography. Efforts also have been directed toward the study of soft magnetic materials and transformer steels.

The Research Institute of Nonferrous Metallurgy, directed by Laszlo Gillemot, has done extensive research on the refining of aluminum and on the metallurgy and processing of aluminum alloys. The research covers all stages of aluminum production from the processing of bauxite ores to the manufacturing of semifinished and finished wrought aluminum products. The institute is also studying precipitation hardening in several aluminum alloys and corrosion and stress corrosion of aluminum alloys. Other research has concerned the extraction of copper and manganese from their ores, as well as the physical metallurgy of copper alloys. Some work was done in the past on the refining of titanium and on titanium alloys; however, in recent years essentially no work has been undertaken on titanium, which suggests a decrease in interest in this aerospace material.

Research on the basic oxygen furnace and on blast furnace practice has been conducted at the Lenin Steel Works and on magnetic alloys and high-purity oxygen-free copper at the Csepel Metal Works. Considerable research on welding technology also is pursued by various research facilities. Extensive research is underway on cast iron and includes the use of oxygen in refining and the physical metallurgy of cast iron. The Machine Manufacturing Technical Institute has concentrated its efforts on precision casting and continuous casting.

Of the little fundamental metallurgical research underway, most of it is on semiconductors and thin metal films for the telecommunication industry. The research is narrow in scope and the most significant is being done at the Central Research Institute for Physics and involves the study of thin films and magnetic domains. The study of the morphology of thin germanium and silicon films and of magnetic domains in magnetic alloys is of high quality. Some basic research is done on the deformation of metals at the Lorand Eotvos University and on ordering in alloys at the Technical University of Heavy Industry in Miskolc.

b. Physics and mathematics

The country's capability to do significant research in physics is limited and concentrated in only a few areas with the emphasis on nuclear physics and solid-state physics, especially semiconductors. The most

extensive research is carried out at the Central Research Institute for Physics Research.

Hungary has a strong base in high-energy physics research, which is localized at the Central Research Institute for Physics. The High-Energy Physics Division of the institute engages in cosmic ray studies. Domestic research in this field has been aided considerably by the presence of a Hungarian staff in the Joint Institute for Nuclear Research, Dubna, U.S.S.R. Other high-energy research has included studies on strong and weak particle interactions on the basis of emulsions and cloud-chamber photographs prepared at foreign accelerators. In addition, work has been done on the preparation and evaluation in Hungary of direct measurements carried out at their own accelerators. Theoretical studies also are done using complex quantum-field theory techniques. Research in particle physics has been aimed at gaining information on strongly interacting particles, the hadrons. However, the country does not possess accelerators of sufficient energy for such studies, and the Hungarians work closely with other physicists at Dubna. The Hungarians have contributed to the complex-analytical and algebraic methods needed to study correlations between data obtained at various high-energy facilities and the scattering and decay of hadrons in their many-particle final states.

A program of low-energy physics is proceeding at a modest pace. Much of the activity is directed toward the applied aspects of reactor power engineering and the production of isotopes. In view of the country's lack of nuclear instrumentation and inability to purchase such equipment abroad, the Hungarians have done well in developing their own instruments. Physicists such as Leonard Pal, Norbet Kroo, and their associates at the Central Research Institute for Physics have developed a time-of-flight spectrometer with a polarized neutron beam capable of providing spectrum measurements with good resolutions and high signal-to-noise ratios. Doctor Kroo has made contributions in studies dealing with inelastic neutron scattering based on high research of the dynamic properties of liquid-gas systems at the critical point. The Isotope Institute is well supported in its work involving the production of isotopes and developing techniques for their use, especially in industry.

The program in solid-state physics, which is oriented mostly toward the support of the domestic semiconductor and electronics industries, is hampered by the shortage of scientists and inadequate equipment and facilities. Activities are concerned with developments leading to the preparation of gallium arsenide substrates, gallium phosphates, and epitaxial layers. Studies are underway at the Applied Physics Institute on impurities and other properties of semiconductors and luminescent materials. Experiments are underway on the purification or synthesis of compounds of tellurium, cadmium, and gallium. The physicists at the institute are able to produce reasonably pure silicon and germanium crystals. Tungsten recrystallization through electron bombardment is underway at the institute, and some research is being done on bulk semiconductor materials for use in Gunn diodes. Research in microelectronics has met with limited success. Development of integrated circuit techniques is being stressed at the Telecommunications Engineering Industrial Research Institute. Although researchers at the institute have probed many of the international developments and in some cases duplicated them, they have been unable to produce microcircuits of acceptable quality for use.

The Hungarians are doing limited research in superconductivity. The Solid-State Physics Laboratory of the Lorand Eotvos University is doing work involving the study of properties of transitions dealing with the critical temperatures associated with diamagnetic and paramagnetic impurities in superconductors. Theoretical research in superconductivity is underway by specialists in institutes of the MTA.

The Central Physics Research Institute is conducting research on lasers for use in various industrial and construction projects. The scope and depth of laser research and development are small by Western standards. Research in the theory and application of lasers is accomplished by the Telecommunications Research Institute and the Central Research Institute for Physics. The latter institute has constructed ruby and helium-neon lasers that emitted visible light. Research is being done on the laser phenomena associated with metallic vapor of cadmium; the Hungarians are studying the photo effects of a nonlinear nature. A liquid laser having an organic base material and a gas laser using cadmium metallic vapor have been constructed. In the case of the liquid laser, some studies have been reported concerning the results of an investigation dealing with frequency tuning of the laser. From the technology standpoint, Hungary has begun production of laser equipment and has been interested in producing laser mirrors using substrates and films. Geodetic laser instruments, under development at the Hungarian Optical Works, are designed to measure distance very rapidly. Machine tools operated with the aid of lasers have an accuracy within the limits of one micron. Investigations are being made at laboratory levels in the use of lasers in surgery and the effects of laser rays on cells and tissues. Consideration also is being given to the use of lasers in communication and computers.

This interest in special laser devices may lead to increased research on laser materials and techniques.

Hungary has a strong tradition for research in mathematics and had produced many excellent mathematicians. Several outstanding U.S. mathematicians emigrated from Hungary, including John von Neumann, Theodore von Karman, Gabor Szego, and Otto Szasz. The country has a good capability for mathematical research in limited areas as a result of the efforts of a few particularly strong or very highly qualified mathematicians. Among the most prolific mathematicians in Hungary are Paul Erdos and his frequent collaborator, Imre Katai. The most pronounced trend in Hungarian mathematics is the emphasis on applied mathematics. The major areas of study continue to be analysis, notably Fourier analysis, algebra, and geometry. There is a growing interest in probability, statistics, and information and communication theory. Some interest has been shown in the classical subject of theory of numbers. The Research Institute for Automation of the MTA was established to conduct research in the field of automatic control, and studies are underway on logic, control theory, use of computers and electronic devices, process control, and automation economics.

c. Astrogeophysical sciences

Although there is an active research program in the astrophysical and geophysical sciences, most of the research is routine and lacks originality and depth. Capabilities in astronomy and upper atmospheric research remain rather low. Although there are too few competent scientists and a limited number and variety of instruments available, some progress is being made in increasing the number of observatories and in installing new instruments. Astronomical research is centered at the MTA's Astronomical Institute, Budapest; at the MTA's Konkoly Observatory; and at the Solar Physics Observatory, Debrecen. The institute has done work in stellar statistics, as well as theoretical research in cosmology. Since 1961 it has published the Information Bulletin on Variable Stars for the International Astronomical Union. The activities of the Solar Physics Observatory have been confined largely to installing instruments and collecting data primarily of the photosphere. The Heliophysical Observatory of the MTA in Debrecen conducts research in solar physics on sunspots, solar cycles, and solar flares. The principal astronomical facility is the Konkoly Observatory, located at Szabadsag-hegy, which is noted for its observational studies of variable stars. The observatory has a station on Piszkes Teto in the Matra Mountains. Established in 1962 it is equipped with a 90-centimeter Schmidt telescope and a 50-centimeter Newtonian Cassegrain reflecting telescope. The station also engages in research on variable stars.

Space activity is limited to satellite tracking at optical stations at Baja, Budapest, Miskolc, and Szombathely. These stations participate in the Soviet-sponsored Interobs program, for which the Baja station is the network coordinating center. The Hungarians are performing research on analytical techniques for determining satellite orbital periods and for deducing atmospheric density therefrom and on the nature of atmospheric density variations. The country also participates in the Soviet-sponsored Vertikal (scientific rocket), Intercosmos (scientific satellite), and Intersputnik (communications satellite) programs.

Upper atmospheric research is routine and concentrated primarily in the area of cosmic rays and the ionosphere. Cosmic ray research is under the direction of the Central Physics Research Institute. Ionospheric research is carried out by an ionospheric sounding station at Bekescsaba under the National Meteorological Institute. Theoretical studies of the ionospheric magnetospheric relationships have been conducted at the Geophysical Research Laboratory of the MTA in Sopron.

Meteorological research is confined generally to climatological and synoptic studies. The National Meteorological Institute, the weather service of Hungary, conducts basic and applied research in addition to its operational functions. The country is primarily interested in the areas of forecasting, climatology, agrometeorology, and biometeorology. Work in these areas has not produced remarkable results but has been sufficient to meet domestic meteorological needs. The observational network is rather dense, and the stations are located to give good distribution of observations. Meteorological research is routine and has not produced any significant studies. This is caused to some extent by a general shortage of meteorologists with advanced training.

The National Meteorological Institute is subordinate to the Council of Ministers and is the central organization controlling meteorological activities in Hungary. It furnishes meteorological information for all military and civilian aviation. With the exception of synoptic stations at airfields controlled by the air force, the institute controls all the observational stations. The institute also has five subordinate observatories: the Gyorgy Marczell Aerological Observatory at Pestlorinc; three agrometeorological observatories at Martonvasar, Kecskemet, and Szarvas; and a meteorological observatory at Pecs. A storm warning center at Siofok near Balaton lake participates in a central European network. In addition to being a focal point of a Transdanubian

station network, it is an element of a sferics network headquartered in East Germany. The center was established because of the sudden severe storms that occur in the area and is equipped with modern instruments and communications facilities to receive synoptic reports from several hundred European stations. The Meteorological Scientific Committee of the MTA coordinates meteorological research and sets priorities.

Hungary has conducted only a limited amount of research in numerical weather prediction. Its research in physical meteorology has been routine and has included studies in cloud and precipitation physics, including condensation of nuclei, growth of ice crystals and ice formation nuclei, microstructure of fog and clouds, atmospheric electricity, turbulence, and atmospheric pollution. Research in synoptic meteorology is focused primarily on short- and medium-range forecasts with some effort directed toward long-range forecasts.

Geomagnetic, telluric current, and related research is conducted at two centers, the Geophysical Research Laboratory and the Lorand Eotvos Hungarian State Geophysical Institute in Budapest. The former has an observatory at Nagycenk, while the latter has observatories at Tihany, near Balaton lake, and at Szarvas. The emphasis in research has been on the pulsating character of the geomagnetic field, and the frequencies of telluric currents with regard to their relation to the structure of the earth's crust and mantle. A telluric current station also is located at Bekescsaba.

The National Seismological Institute, staffed by seismologists of the Lorand Eotvos University, operates a network of four stations—Budapest, Kecskemet, Sopron, and at the Piszkes Teto (astronomical) observatory. Although Hungary is located in an aseismic area, routine observations are made and some research is conducted. The Lorand Eotvos Hungarian State Geophysical Institute has utilized seismic techniques to investigate the crustal structure of the Carpathian basin, partially in cooperation with other East European countries. Small-scale research has been conducted in earth modeling earthquake magnitudes, and microseisms. Very little work dealing with seismic detection of underground nuclear explosions has been published by the Hungarians, and they probably have not conducted research in this area.

The country excels in the area of geophysical prospecting. The work is carried out under the auspices of the Ministry of Heavy Industry and the MTA. Seismic methods predominate, although other geophysical and geological techniques are utilized. Hungary has done considerable geophysical prospecting in foreign countries and in 1967 initiated a general geophysical survey of Mongolia. It also is beginning to conduct geophysical oil prospecting under contract to other East European Communist countries.

The principal center for geological research is the Hungarian State Geological Institute, which prepares geological maps for national and international purposes. The Geochemical Research Laboratory of the MTA also contributes to geological research. Recent efforts have included studies in paleomagnetism and vulcanism, as well as a study of the structure and evolution of the earth.

Geodetic research and development have increased considerably since the early 1960's and, while not outstanding, generally have been adequate to solve problems encountered in the development of national geodetic nets. Hungary is second only to East Germany among the Communist countries in the design and production of geodetic instruments. The Geodetic Research Laboratory of the MTA is the principal facility responsible for the major portion of geodetic research in Hungary. The Geodetic and Cartographic Enterprise, Budapest, is responsible primarily for conducting geodetic and astronomical work. It also supports geodetic research in other facilities. The Hungarian Optical Works continues to excel in the design and development of a wide variety of geodetic instruments and has carried out research and development on laser distance-measuring equipment for geodetic purposes.

Research in triangulation and leveling is centered on measurement methods, measurement error, adjustment error, adjustment of triangulation and leveling nets, and the design and development of geodetic instruments. One of the most noteworthy achievements was the final adjustment of the fictitious first-order fill-net of the Transdanubian area, based on the first-order triangulation points of the principal net. Geodesists have developed several new methods for simplifying adjustment computation in triangulation nets, radial triangulation, traversing, and linear intersection. Although the first-order triangulation net is still adequate for scientific needs, Hungary has begun modifying and improving the net to meet accuracy requirements of the future. The reconstruction of the precise leveling network, which began in 1964, was 80% complete at the end of 1970. Work has continued on the precise leveling net needed for investigating recent crustal movements. Experiments and theoretical research also are being conducted to facilitate the selection of instruments suitable for investigating crustal movements as well as for setting up the measuring and calculation methods. Hungary

is utilizing U.S., Soviet, and Polish electronic data processing equipment to speed up computation and adjustment studies. Activity in geodetic astronomy has been devoted chiefly to the determination of astronomical positions for use in geoidal studies and to establish the proper orientation of the new first-order triangulation network. Hungarian scientists have been active also in determinations of international longitude differences and have conducted national and international gravity surveys using gravity meters and torsion balance. Investigations have been carried out for the determination of the gravity field and the figure of the earth from orbital data of artificial satellites.

As a member of the East European Subcommission for Satellite Geodesy, Hungary participates in geodetic observations and studies based on these observations. The tracking station at Baja is taking part in the International Satellite Geodesy Experiment (ISAGEX) to observe faint satellites for dynamical purposes. Studies have been done on the adjustment and scaling of geodetic satellite networks, techniques of geodetic doppler measurements, and dynamic methods of geodetic applications of satellites. Research activity also has been focused on a new adjustment of satellite and traditional geodetic networks, a method of determining the equatorial coordinates of satellites and the automation of satellite tracking and compilation for geodetic purposes.

The Hungarians engage in hydrologic, hydromechanical, and hydraulic research directed toward solving the problems of flood protection, inland waterways regulation, irrigation, and land reclamation. Extensive use has been made of hydraulic models and field tests for studies of lowhead dams, stream hydraulics, sedimentation phenomena, and the dynamics of filtration under hydraulic structures. The Hungarians are active in the development of instruments for use in hydrologic and hydraulic research.

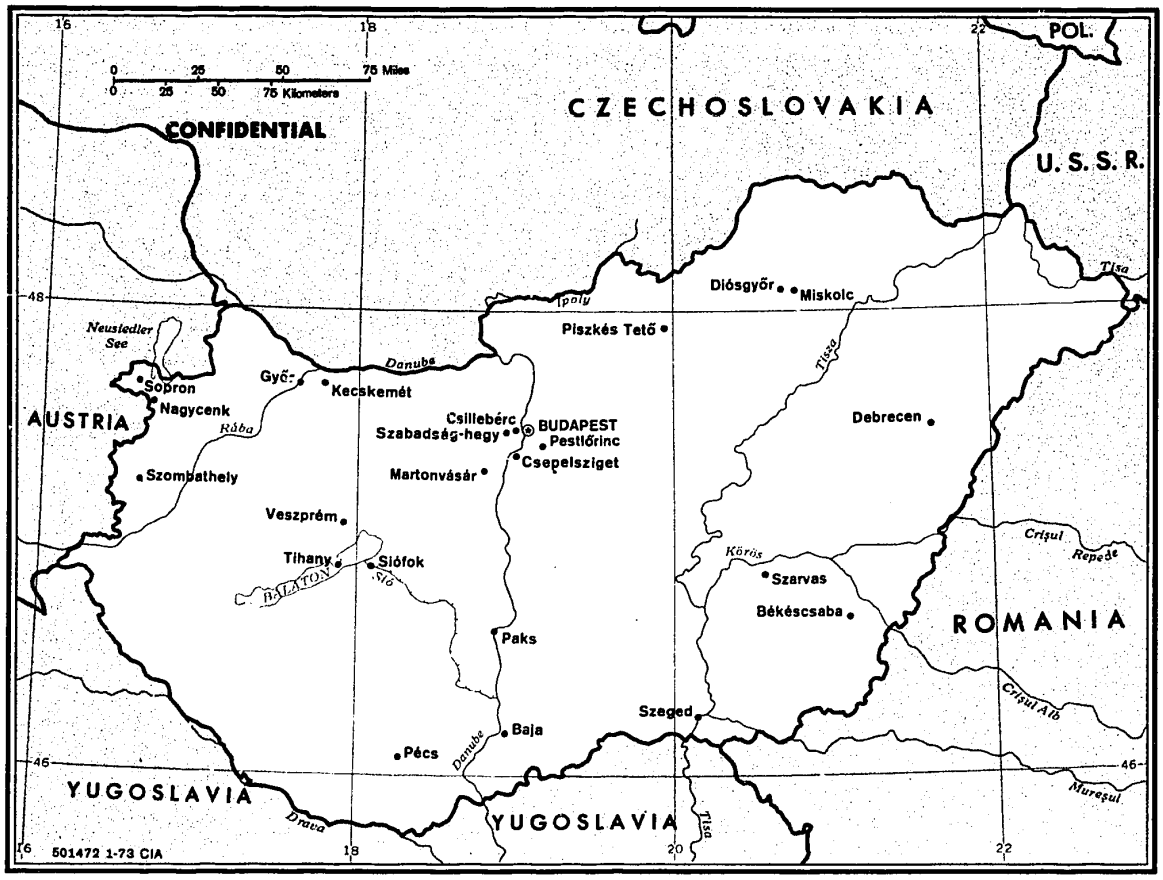

FIGURE 4. Selected sites of scientific activity (C)

Places and features referred to in this chapter (U/OU)

	COORDINATES	
	° 'N.	° 'E.
Baja	46 11	18 58
Balaton (*lake*)	46 50	17 45
Békéscsaba	46 41	21 06
Budapest	47 30	19 05
Csepelsziget (*isl*)	47 15	18 57
Csillebérc (*sec of Budapest*)	47 29	18 57
Debrecen	47 32	21 38
Diósgyőr (*sec of Miskolc*)	48 06	20 41
Győr	47 41	17 38
Kecskemét	46 54	19 42
Martonvásár	47 19	18 47
Mátra (*mts*)	47 53	19 57
Miskolc	48 06	20 47
Nagycenk	47 36	16 42
Paks	46 38	18 52
Pécs	46 05	18 14
Pestlőrinc (*sec of Budapest*)	47 26	19 12
Piszkés Tető (*mt*)	47 55	19 54
Siófok	46 54	18 03
Sopron	47 41	16 36
Szabadság-hegy (*hill*)	47 30	18 59
Szarvas	46 52	20 33
Szeged	46 15	20 10
Szombathely	47 14	16 37
Tihany	46 55	17 54
Veszprém	47 06	17 55