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NATIONAL INTELLIGENCE SURVEY

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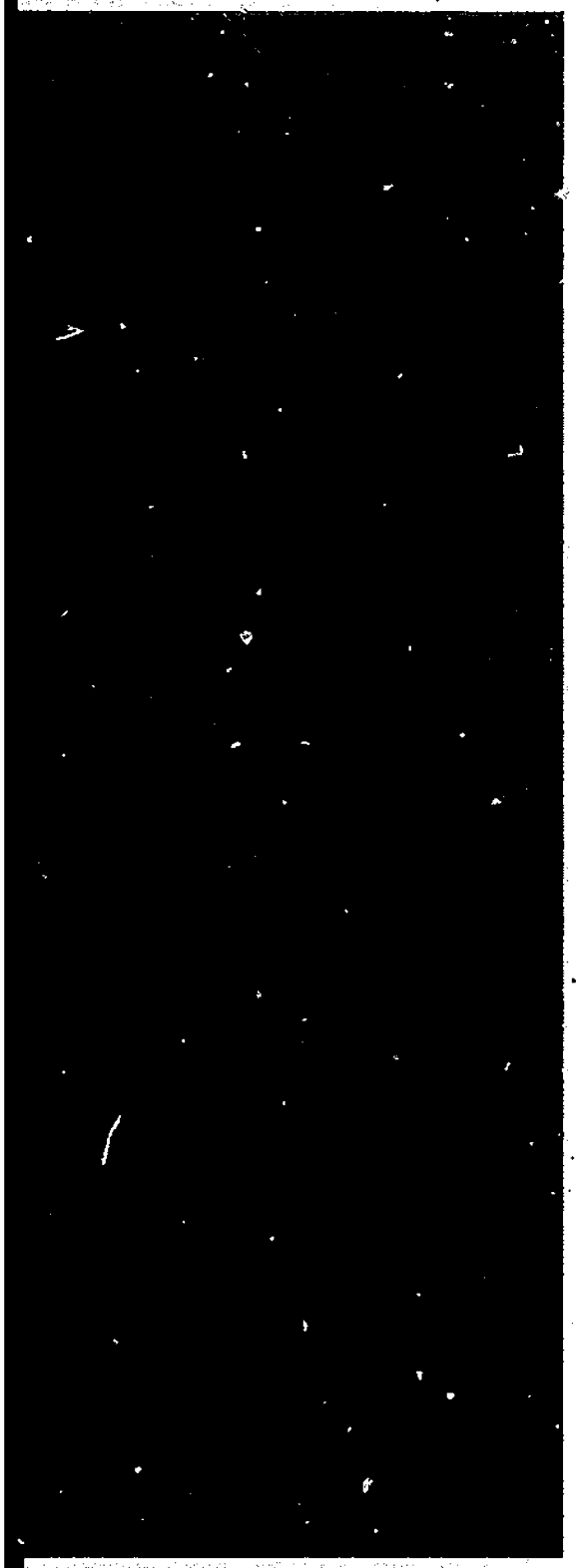

YUGOSLAVIA

CONTENTS

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

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FIGURES

Science

A. General (C)

Yugoslavia has a moderate scientific and technical research capability. The country ranks ahead of Bulgaria and well ahead of Greece in science and technology but substantially behind Austria and Hungary; Yugoslavia's scientific and technical capabilities are regarded generally as lagging behind those of the highly developed European countries. The goals of Yugoslav science and technology have a practical basis: The objectives are to solve the country's economic and social problems, increase the general level and diversity of industrial production, mechanize and modernize agriculture, and maintain an adequate defense establishment. The government encourages science as a means of accelerating industrialization, but the scope of the scientific program is restricted by shortages of funds, qualified personnel, and equipment.

Since World War II very substantial progress has been made in transforming Yugoslavia from a backward agrarian country to a moderately well-developed agrarian and industrial country. During this same period, great efforts have been made to modernize science and technology and, in the process, numerous scientific institutions have been established. Yugoslavia holds a unique position among the countries of eastern and central Europe as a nonaligned nation. Even though the control of the government rests in the hands of the Communist party, the Socialist Federal Republic of Yugoslavia has evolved its own special system; the development and establishment of research institutes show pronounced differences from the Soviet pattern which is in operation in other Communist countries. Unlike many of the Communist countries, Yugoslavia possesses numerous autonomous scientific societies, associations, and research institutes, and their activities and influences tend to be restricted to their particular republics. Since the 1960's, there has been a strong tendency for decentralization in all phases of industrial and technical activities. The keynote of the present national structure is "self-management" at all levels, and this includes work in research and development. Since the implementation of self-management, some of the institutes have had difficulty in funding their operations, whereas others have flourished under the system. For example, the Mihailo Pupin Institute for Electronics and Telecommunications is one of the country's largest institutes and resembles most research institutes that are entirely independent of the government. To finance their work, the laboratories of the Mihailo Pupin Institute not only do research but are active in development and production. On the other hand—and as the government has realized—there are too many research institutes that are unable to function properly because they lack financial resources and because research efforts are uncoordinated. Fragmentation of the science effort also results from nationality problems whereby the republics establish their own organizations similar in scope to the federal organizations for science; for instance, five of the six republics have their own academies of sciences and arts.

Several factors favor the development of the country's scientific effort, such as the benefits of both Western and Soviet assistance, the rising agricultural productivity, and the abundant mineral reserves and hydroelectric power in some areas which provide a potential for industrial development. In addition, the government's attitude toward research is favorable. The factors which hamper research, however, far outweigh those that favor research. The country lacks a scientific tradition, and scientific education is weak. Decentralization and liberalization have made the optimum use of limited funds for scientific development more difficult, and a sluggish political machinery hampers rapid decisionmaking. A substantial part of the prewar scientific talent emigrated to scientifically advanced countries, and the continuing emigration of scientific and technical personnel to the West is of concern to the government. The need to solve immediate problems of importance to the economy has compelled the Yugoslavs to place more emphasis on applied research than on fundamental research, which is neglected in most fields. There also has been little success in transferring

the results of research to industrial needs. Decentralization extends not only to the institutes but even to the separate laboratories within the institutes. Each laboratory is governed by a small, elected council that is in charge of establishing salaries and financing. A large portion of the research conducted by the institutes depends on contracts with industrial firms, and the institutes find that they have to compete with various organizations both within the country and abroad. It is not unusual to find that some of the institutes are better known abroad than they are domestically.

Science and technology are regarded as vital parts of the country's foreign policy and as important areas of international cooperation. The government has stated that it is interested in establishing scientific and technical relations with any country as long as the self-proclaimed policy of nonalignment is not violated. Over the years it has signed about 50 scientific and technical cooperative agreements with other countries, and another 30 agreements establish relations on an institute-to-institute level. Yugoslav scientists are active in international scientific organizations and cooperate with scientific groups of both Communist and non-Communist countries. The academies of sciences, universities, scientific establishments, and scientific societies enjoy considerable freedom to cooperate with similar organizations in other countries, since it is assumed that they will act in the general interest of Yugoslavia. Although there is a substantial exchange of personnel with Eastern European Communist countries, the Yugoslavs prefer to receive training in the West. The Scandinavian countries, West Germany, Italy, and the United Kingdom have special agreements with Yugoslavia to train engineers and technicians. The United States supports a broad research program in Yugoslavia through the P.L. 480 program. In April 1971 a protocol of the 25th session of the Yugoslav-Soviet Commission for Scientific-Technical Cooperation was signed in Belgrade, calling for a continued exchange of experts and technical documentation. In January 1971 France and Yugoslavia signed an agreement for cooperation in scientific and technological research involving joint studies in nuclear energy and grants for university scientists, specialists, and technical trainees. A new agreement on cooperation in scientific activities with Romania went into effect in July 1970. An agreement was signed in March 1969 with Egypt, providing for an exchange of scientific and technical personnel during 1969 and 1970.

Yugoslavia is an associate member of the Organization for Economic Cooperation and Development (OECD) and the Council for Economic Mutual Assistance (CEMA), cooperating with them in matters relating to science and science policy. It participates in such organizations as the World Meteorological Organization (WMO), the International Union of Geodesy and Geophysics (IUGG), the International Association of Physical Oceanographers (IAPO), the International Council for the Scientific Exploration of the Mediterranean Sea, and the European Organization for Nuclear Research (CERN). Yugoslavia was one of the original signatories of CERN; its present status with CERN, however, is as an observer member. The country has been especially active in projects for the International Atomic Energy Agency (IAEA), which has provided grants to various Yugoslav institutes for investigation of radioactive fallout as related to human diet and for studies of sediment movements in rivers.

B. Organization, planning, and financing of research (U/OU)

The organization for science has undergone various changes as a result of 1971 constitutional reforms affecting the organization of the federal administration. A move to decentralize the government structure is at the heart of the reforms. Since the early 1950's there has been a strong trend toward decentralization with emphasis on self-management at all levels. Recent moves have increased authority in the republics to make scientific and technical policy, while reducing financing of research. The federal government exercises jurisdiction over research and development through the Federal Executive Council (FEC), the highest administrative body in Yugoslavia, federal secretariats; federal administrations; and federal institutes (Figure 1).

Pivotal organizations for federal authority in science and technology have been the Federal Council for the Coordination of Scientific Activities and its subordinate Federal Fund for the Financing of Scientific Activities. The Federal Fund was abolished by the Federal Council in late 1970, and in early 1971 the council itself was replaced by a Coordinating Committee for Science Activities. The new organization is made up of representatives of the republics (three each from the six republics, two each from the autonomous provinces, and one representative of the army). The Coordinating Committee, a nonfederal organization, is expected to involve scientific workers and interested self-managing agencies in developing science policy. The FEC has a voice in the committee's discussions.

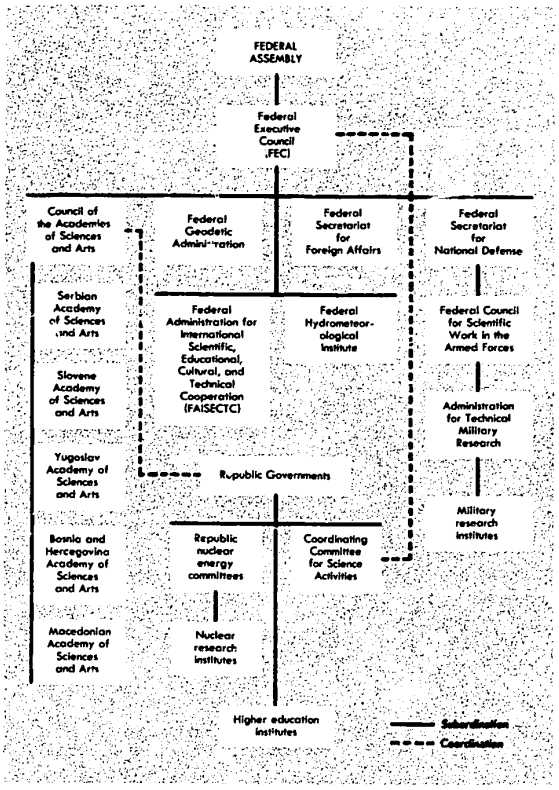

FIGURE 1. Organization of scientific and technical activities, 1972 (U/OU)

The Federal Commission for Nuclear Energy was abolished during 1971, and responsibility for the nuclear energy effort was dispersed among the republics. Federal funding of the nuclear energy program has ceased. The three nuclear research institutes were transferred some years ago to the supervision of the nuclear energy committees of the republic governments where they are located. The Nuclear Energy Personnel Training Center, Hercegnovi, however, will remain an independent center. Federal support for certain federal institutes also has ceased, although some federal institutes continue to receive federal funds. The federal government has withdrawn its support of the Institute of Geological Mining Research, the Institute for Nuclear and Other Mineral Raw Materials, and the Institute for Technology. Funds continue for the Geomagnetic Institute at Grocka and the Federal Hydrometeorological Institute in Belgrade. The Federal Geodetic Administration, in charge of land surveying matters, remains under federal control and is subordinate to the FEC.

In its international dealings, the government added the responsibility for scientific, educational, and cultural exchanges to the mission of the former Federal Institute for International Technical Cooperation. The institute was abolished and its duties absorbed by the Federal Administration for International Scientific, Educational, Cultural, and Technical Cooperation (FAISECTC). The FAISECTC supervises the cooperative activities of Yugoslavia with 85 countries and has taken over the international nuclear energy matters once under the purview of the Federal Commission for Nuclear Energy. It also has assumed the responsiblities for international cooperation held by the now defunct Federal Council for Coordination of Scientific Activities, Federal Council for Education and Culture, and Federal Commission for Cultural Relations with Foreign Countries. The FAISECTC works closely with counterpart administrations in each of the republics, as well as with the universities and the large number of scientific institutions.

While the fragmentation of the scientific effort is in part the result of policies followed after World War II, much is due to the country's historic nationality problems. One of the unusual features of Yugoslav science is that the country has five academies of sciences and arts. With the exception of Montenegro (Crna Gora), every republic has its own academy. The Yugoslav Academy of Sciences and Arts, Zagreb, was founded in 1866 and is the oldest academy; it serves Croatia (Hrvatska) and, despite its name, is not a nationwide organization. The other academies are the Serbian Academy of Sciences and Arts, Belgrade, founded in 1886; the Slovene Academy of Sciences and Arts, Ljubljana, founded in 1938; the Bosnia and Hercegovina (Bosna i Hercegovina) Academy of Sciences and Arts, Sarajevo, founded in 1966; and the Macedonian Academy of Sciences and Arts, Skopje, founded in 1967. Although the government has never forced the formation of a single national academy, it has attempted to bring some measure of coordination among the academies. In 1959, a Council of the Academies of Sciences and Arts was established to coordinate research and other activities of the academies; it is a voluntary association, with the president chosen on a rotating basis from among the republics. In 1969 the council organized a Coordination Committee for Chemistry. Unlike other Communist countries, the academies operate only a few research institutes; many of the institutes established by the academies have become autonomous. The Yugoslav academy has a small number of institutes which specialize in mathematical sciences and physics, medical sciences, biology and chemistry,

and social sciences, while the Slovene academy includes institutes for biology, geology, medicine, and geography. The Serbian academy has sections for natural sciences and mathematics, medical sciences, and social sciences.

Research facilities of higher educational institutions make a modest contribution to the scientific effort, particularly in chemistry. A major weakness in the university research program is the lack of coordination among similar university institutes. Each university is directly subordinate to the republic in which it is located, and its revenue and expenditures are a part of the budget of that republic.

In some special areas, industrial enterprises are beginning to recognize the value of research and development. As a result, approximately 50 industrial laboratories, some quite small, have been established as a part of the industrial sector. As such, these laboratories do research primarily on particular problems of an industrial nature, although some do basic research as well. Large industrial concerns, in addition to conducting their own research, provide scholarships for promising workers to attend universities or technical colleges. In general, very little research is undertaken by the industrial sector, although industrial support of scientific research and development has shown significant gains since 1958. The nationalized industries are free to plan their own production research without sanction of the federal government.

Yugoslavia has never had a central body responsible for planning and implementing research programs. Research has been planned at various levels, ranging from federal government agencies to business organizations and their associations. The units which participate in the planning of scientific research prepare individual research plans and are expected to provide funds for the realization of the plans. In 1968 the now defunct Federal Council for the Coordination of Scientific Activities proposed a new approach to the programing of science. Instead of a large number of scientific projects, the plan called for the creation of a much smaller number of large-scale programs, so-called macroprojects, which would be financed by federal funds. These projects, reduced to 19 by 1970, included such subjects as information systems in management, immunology, neurobiology, biosynthesis, and exploration of the Adriatic Sea. The macroproject scheme apparently has been suspended.

The government recognizes the need for adequate financing of research but is hampered by conflicting national social and economic demands. The government's policy since the 1960's has been to reduce state funding of scientific research and technical development and to increase the contribution of the end users of research and development. The goal is for research organizations to become self-supporting by independently earning and controlling their income, primarily through contracts, and by using part of the income for their own expansion and development. During 1971 about 60% of the funds for research were derived from the economy, including contracts by business enterprises, and about 25% from social funds for research, including funds from governmental bodies, administrative agencies, and public services. The remaining 15% included funds received from foreign sources, such as U.S. P.L. 480 funds, and from the research organizations' own budgets. Funds for new obligations were sharply curtailed in FY72. With the dissolution of the Federal Fund for Financing Scientific Activities, the republic governments will have a greater part in financing research. The theoretical justification for the decentralization of financial responsibility is based on eliminating etatism in the financing of research, as well as on requiring scientific institutions to conform to the principles of self-managed socialism.

Precise figures on total expenditures for science are not readily available. Yugoslavia is believed to be spending about 0.8% of its national income for research and development, exclusive of military research expenditures. Until the recent constitutional changes, the most stable sources of funds for providing continuity of scientific research were the federal funds earmarked for science by law at the rate of 0.2% of the national product. In recent years, the relative amount of financing of research and development from public funds has been falling, while the amount from production enterprises has been rising. Total expenditures for research and development have risen. The total expenditure on research and development in 1968 was an estimated US$73.6 million, of which $25.6 million were from public funds and $48 million from industrial enterprises and other sources. The total expenditure increased from $58.8 million in 1966 and $64 million in 1967.

During 1969 the Federal Committee for Coordinating Scientific Activities proposed to allocate about US$28.8 million for research activities. The greatest portion of the funds, about 72.1%, was to be used for financing research concentrated on key projects of high priority to the economy. Research in the nuclear sciences and technology received about $14.15 million in 1969. With the abolition of the Federal Fund, federal financing of nuclear energy research has ceased. The amounts budgeted by the federal

government had been declining in recent years as nuclear research lost importance, and the republics assumed responsibility for the operation of the nuclear research institutes.

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

Yugoslavia has seven universities which offer training in the sciences or engineering. The quality of the education, however, is not generally on a par with that of the more advanced European countries. The universities are located at Belgrade, Ljubljana, Nis,[1] Novi Sad, Sarajevo, Skopje, and Zagreb. Courses of study are offered toward three independent but related degrees. The courses leading to the first degree are designed to qualify the individuals primarily for jobs of a practical nature in industry; this degree requires 2 years of study. Courses leading to the second degree also require 2 years of study and emphasize theory. The third degree corresponds to a U.S. master's degree. Its curriculum is intended to train scientific and engineering personnel with the highest qualifications. Candidates must possess knowledge in scientific and technical fields and do independent scientific research to receive a degree in science at this level. Many students who have acquired the first and second degrees do not continue their studies to receive advanced degrees. Some of the university faculties have abolished the first degree and grant a single degree at the end of 4 years.

The universities also offer courses of study leading to a doctor's degree. Since 1966 candidates for doctor's degrees have been required to complete the third 2-year course and to write a thesis. Because many students lack the qualifications to meet the requirement, enrollments in doctoral studies have decreased. In 1967 only 132 doctor's degrees were awarded in all fields: 40 in the exact and natural sciences, 36 in social sciences, 21 in medical sciences, 19 in agricultural sciences, and 16 in engineering and technology.

Since 1961 the number of graduates has increased in engineering sciences, but the number in natural sciences and mathematics has decreased. The authorities are concerned, because graduates in the natural sciences and mathematics are important to the advancement of research and development.

Most universities have associated research institutes, and some of these provide advanced training in research. For example, the Josef Stefan Institute is closely associated with the University of Ljubljana, and by the end of 1969 about 60 persons had received doctor's degrees based on research work they had done at the institute. Many of the teaching staffs of the universities also engage in research at the institutes, often to the detriment of the teaching function.

Although the supply of scientific and technical manpower has been inadequate to meet the needs of the country, as recently as December 1969 many specialists and skilled workers with technical degrees were having difficulty in finding work in Yugoslavia. Mechanical engineers are in demand, but there are few jobs for chemical and agricultural engineers. Many of them leave Yugoslavia for Western countries, especially West Germany, where opportunities are greater. Certainly, the departure of scientific and technical personnel has drained the country of much needed talent. The planned increases in production will require large increases in the numbers of technically trained workers. Although expansions have been made in the universities and vocational schools to increase the supply of qualified personnel, shortages may develop or continue in some fields. In 1966 Yugoslavia was estimated to have had about 9,000 professionals involved in research and development. The number of personnel in scientific institutions in 1967 was about 27,000 workers, including about 6,600 scientists and engineers. In 1965, there were 25,000 scientific workers: 1,159 in natural sciences, 1,952 in engineering sciences, 732 in medical sciences, 854 in agricultural sciences, and 1,403 in social sciences and humanities.

The country has over 600 research establishments and units, about 480 of which are concerned with natural sciences and applied research. Many of them are very small, however, employing less than 25 people, and efforts are being made to reduce the number of these facilities by reorganizations and consolidations. Many of the research units in the industrial sector are among the smaller facilities, either because they are attached to small industrial enterprises or are newly established. The average number of research workers at large institutes is about 450. The Josef Stefan Institute employs about 100 scientists and 300 technicians; the Boris Kidric Institute of Nuclear Sciences has 1,150 scientists, engineers, and other personnel, including 50 workers with master's degrees and 80 with doctor's degrees. In 1969 the Rudjer Boskovic Institute employed approximately 700 persons, 300 of whom were scientific personnel; it also had 150 scientists with doctor's degrees. The Institute for Chemistry and Metallurgy in Belgrade, an outstanding research facility, was organized in 1961 with the aid of the

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

federal government and the government of the republic of Serbia (Serbija), assisted by about 20 chemical and metallurgical companies. It has a staff of about 400 professional personnel and about 200 technicians. Its equipment, exclusive of buildings, is valued at approximately US$1 million. Although the laboratories of the institute are scattered throughout Belgrade, most of the institute is located in buildings of the University of Belgrade. Plans are underway to construct a laboratory complex outside the city to house the institute.

In general, research and development facilities are inadequate. Several universities suffer from cramped quarters, small budgets, and poor equipment, and some do not have adequate facilities or staff to carry out meaningful research. The three nuclear research institutes are well equipped and relatively well finance, although the Boris Kidric Institute has had a major budget cut. From the quality of its work, the Rudjer Boskovic Institute appears especially outstanding. It has published numerous papers, most in foreign journals, and many members of its staff have studied abroad. The Josef Stefan Institute is well equipped with X-ray, nuclear magnetic resonance, and high-energy equipment; mass spectrometers; and an electron microscope. The Mihailo Pupin Institute has a fairly well-equipped solid-state laboratory for producing and shaping crystal filters for industry.

D. Major research fields

1. Air, ground, and naval weapons (S)

Yugoslavia does not have the scientific and technical competence to develop sophisticated and complex air, ground, and naval weapons. Since 1969, however, the Yugoslavs have shown a growing interest in revitalizing the country's aircraft development and production capability. Under government prodding the major aircraft manufacturer, *Preduzece Soko* at Mostar, is vigorously trying to develop new markets for the sale of its jet trainer and fighter aircraft. Emphasis is on the sale of aircraft to non-Communist countries, and special attention is being directed toward establishing a clientele among the emerging nations of Africa and the Far East.

The aircraft being marketed include a jet trainer, Galeb (Seagull) (Figure 2), and its strike/reconnaissance variant, Jastreb (Hawk) (Figure 3), and a single-seat counterinsurgency aircraft, Kraguj. The Galeb went into development in 1957 and was first test flown in 1961. The latest modification was displayed at the 1971 Paris Air Show. In addition to improvements being made in the aircraft's performance, the avionics installed in the Galeb are being upgraded. Combat-configured Galebs have been sold to Tanzania and Zambia. The Galeb and Jastreb are powered by Rolls Royce Bristol Viper turbojet engines. Development activity is continuing on both aircraft. The Kraguj is a comparatively small, low-wing, counterinsurgency aircraft that was developed primarily for the Yugoslav Air Force. Since 1960, however, sale of the aircraft to other countries has been pushed. In addition to the winged aircraft, *Preduzeco Soko* has developed and is producing a four-place helicopter, designated the H-210. The firm gained helicopter experience in fabricating the Sikorsky S-55 under a British license.

Yugoslavia and Romania have a joint program for the development of a twin-engine jet fighter that is intended to replace the Jastreb. The Yugoslavs apparently will undertake design and development responsibilities of the aircraft, while Romania will share in its manufacture.

The capability in aircraft propulsion research and development is improving with the experience gained in the production of small aircraft engines and the use of foreign engines. Research and development activity on aircraft engines is centered at the Engine Research Institute in Kragujevac. Most of the analysis at the institute is performed on engines of foreign manufacture and is directed toward modifying or duplicating components. The Institute for Testing Materials and Structural Parts, Ljubljana, has the ability to perform extensive static and dynamic tests on various structural materials. Present research on advanced structures and materials is confined mostly to academic review of available literature. The Aluminum Combine in Titograd produces aircraft-grade aluminum for domestic needs and the Military Technical Institute in Belgrade has shown much interest in the production of filaments for composite materials.

Yugoslavia has no significant capability to design and develop missile systems; early developmental work in the missile field ended in 1965. Since that time, it has relied on imported technology and hardware from the Soviet Union. The missile-associated activity that is underway is confined to the manufacture of the Soviet-designed antitank missile SAGGER and to the training firings of Soviet-furnished SA-2 surface-to-air missiles.

There are two test ranges, one located in Hercegovina and the other near Zadar. The Hercegovina range has been used for test firing of the Japanese Kappa rockets, and the Zadar range has been used for Soviet SA-2 launches. Both ranges are under

FIGURE 2. Galeb (Seagull) jet trainer (U/OU)

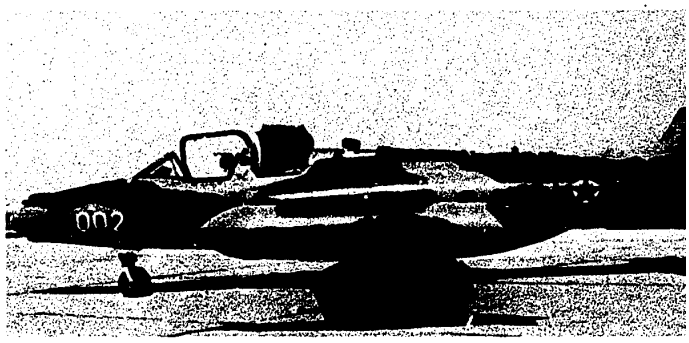

FIGURE 3. Jastreb (Hawk) single seat attack version of the Galeb (U/OU)

the control of the Institute for Space Technology under the Federal Secretariat for National Defense. The institute also has coordinated the meager research and development effort on missile and space hardware. Since the cancellation in 1965 of all indigenous missile development activity, the responsibilities of the institute have been confined to producing studies of an academic nature.

The Yugoslavs excel in the development and production of plastic explosives derived from nitrocellulose and nitroglycerin, but no known significant advanced research programs are being conducted which could apply directly to chemical rocket propulsion.

There is a restricted research and development program for ground weapons and other combat materiel. Emphasis is on standard weapon systems that are relatively inexpensive but adequate to fulfill the military's requirements. Generally foreign weapons and combat vehicle designs are copied or adapted. Since 1960 engineering efforts have been directed toward developing improved infantry antitank weapons; successes include the 82- and 105-millimeter recoilless rifles. A capability also exists to design artillery, mortars, and antitank grenade launchers and their necessary ammunition. Two variations of a 128-mm rocket system have been developed and produced—one is a 32-tube towed model and the other a hand-carried, single-tube model, designated Partisan. Performance tests of the rocket indicated that the system is not abreast of the state of the art prevailing in other European countries engaged in rocket system development.

The Military Armored Vehicle Development Institute develops and tests engines and armored vehicles and has worked on adaptations of foreign designs of both amphibious and other armored personnel carriers. Reportedly, production of a Yugoslav armored personnel carrier, the M-60, began in late 1969. The capability for designing and producing all types of antipersonnel and antitank mines, smokeless powder, infantry and artillery ammunition, and handgrenades is good. Several nonmetallic mines have been developed, and probably research in this field is continuing.

Automotive vehicle and engine research and development efforts are concentrated primarily on components and improved replacement parts. For several years, Italian and Yugoslav engineers have been collaborating on the design of an automobile that is to be produced entirely in Yugoslavia. A few engines of native design are produced within the country, both for the domestic market and for export, notably to the People's Republic of China. Diesel

engine research apparently has a higher priority than that of spark ignition, and a variety of domestically produced diesel powerplants are turned out, including turbocharged types. The engines are used for marine and automotive propulsion and in combat vehicles.

Yugoslavia has a limited research and development program on engineering equipment. Two major developmental projects in military bridging are underway, one a tank-launched scissors bridge and the other a truck-mounted scissors bridge. During 1968 the Institute for Armament in Belgrade built a prototype tank-launched bridge for testing purposes. In 1970 a new truck-mounted scissors bridge, similar to the Soviet TMM multiple-span truck-launched scissors bridge, was displayed in a military parade for the first time. This bridge is the first TMM-type bridge ever developed outside the Soviet Union. The bridge is probably now undergoing testing.

Military engineers have been active in the development of techniques and materiel for defense against nuclear attack and have developed portable reinforced-concrete beams for use in the construction of fortifications and shelters.

Shortages of funds and technical personnel have generally restricted naval research and development essentially to adapting and improving appropriate models of foreign equipment; however, small naval surface craft and submarines have been designed and developed. The Ship Research Institute in Zagreb (Figure 4) has conducted hull research, chiefly of a commercial nature involving routine experiments.

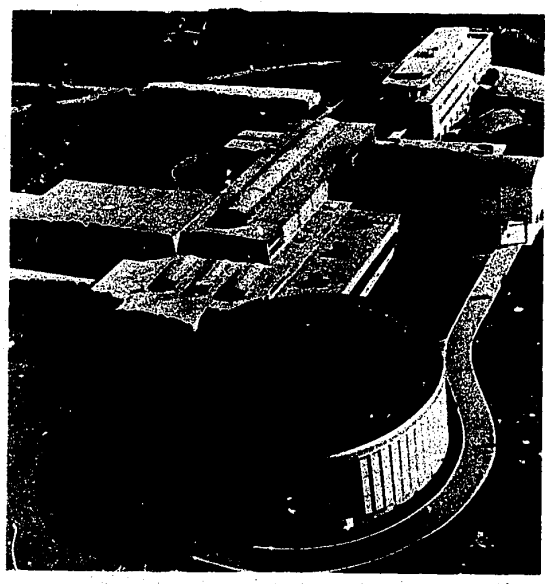

FIGURE 4. The Ship Research Institute, Zagreb (U/OU)

2. Biological and chemical warfare (C)

Yugoslavia has a minimal capability to conduct biological warfare (BW) research and development and is not known to have an offensive BW program. Some research which could be related to offensive BW is underway on rickettsia and viruses and the attendant public health problems created by these agents. Research with defensive BW applications, especially in the areas of antibiotics and vaccine development, is of good quality. The Yugoslav People's Army has active training programs in defense against biological attack, especially protection and decontamination procedures.

Chemical warfare (CW) research and development are done on a modest scale, although Yugoslav scientists are acquiring considerable information on CW through the exchange of scientific personnel and information with Warsaw Pact countries and through exploitation of publications from Western countries. There are no indications that work is underway on V-agents, the development of new lethal agents, or the improvement of existing agents. A number of toxicity studies are conducted on organophosphorous compounds, chiefly the G-series nerve agents, but these are presumably done in connection with antidote research. Research with a military potential has been conducted on incapacitating agents and has concerned the characteristics of ergot alkaloids, which are source materials for LSD-25. Compounds of the LSD-25 type had been considered for development as incapacitating agents, but the cost was prohibitive. More recently, such compounds have been studied to obtain a clearer insight into their physiological mechanisms with the anticipation that such studies may lead to the equally effective but less expensive compound. Research also is underway on compounds which may have potential as candidate CW agents, including muscarine, a highly toxic alkaloid which produces symptoms similar to that of nerve agent poisoning and various curare-like compounds which cause paralysis. It is quite possible that Yugoslav scientists have correctly identified the chemical structure of the U.S. standard incapacitating agent BZ. No known research is being done on chemical munitions or weapons to disseminate toxic chemical agents, smoke, incendiaries, or flame.

Considerable emphasis is being placed on defensive CW research in the field of nerve agent antidotes. A large staff at the Military Medical Academy, Belgrade, is working with 2-PAM and TMB-4 to determine their pharmacological effects, their ability to reactivate inhibited cholinesterase, and the inherent toxicities of the antidotes themselves. A combination

of atropine, the standard nerve agent antidote, and toxogonin also has been investigated, but specific conclusions concerning its effectiveness have not been made. There is no indication that work is continuing on the modification of defensive equipment supplied by the U.S.S.R. and Eastern European Communist countries.

3. Atomic energy (S)

Yugoslavia has established a modest nuclear energy program confined to basic research, the use of radioisotopes, and the development of the economic uses of nuclear energy, particularly for the production of electric power. The country does not have the capability to develop nuclear weapons and has no plans to expend any effort in this field. The nuclear energy program has been carried out with the assistance of other countries and probably will continue to be dependent on foreign aid.

The three major nuclear research institutes are the Boris Kidric Institute of Nuclear Sciences in Vinca, the Rudjer Boskovic Institute in Zagreb, and the Josef Stefan Institute in Ljubljana. The Institute for Nuclear and Other Mineral Raw Materials at Belgrade was established to exploit domestic uranium resources.

Most reactor research and development is being conducted at the Boris Kidric Institute (Figure 5), which has as its major facilities a bare critical assembly constructed by the Yugoslavs and a Soviet-supplied research reactor. The critical assembly originally went into operation in May 1958 using 4 tons of natural uranium and 7 tons of heavy water supplied by the Soviet Union. The assembly was shut down in October 1958 following the accidental irradiation of six persons which resulted in one death. The heavy water was removed from the assembly for use in the Soviet-supplied reactor. Subsequent operation of the assembly has been with heavy water purchased from Norway through the IAEA. The Soviet-supplied research reactor went into operation in 1959 and has a power level ranging from 6.5 to 10 megawatts. This reactor is fueled with 2% enriched uranium and uses heavy water for moderator and coolant. The principal use of these facilities is for research, training, and the production of isotopes.

In addition to the reactor at the Boris Kidric Institute, a U.S.-supplied research reactor was constructed for the Josef Stefan Institute under the auspices of the IAEA. The reactor is a 250-kilowatt (kw.) TRIGA-II type which also is used for training, research, and the production of isotopes. A trilateral agreement between the United States, Yugoslavia, and the IAEA for the construction and fueling of this reactor was concluded in 1961, and the reactor went into operation in 1966 at the village of Podgorica pri Crnucah, near Ljubljana.

For a number of years Yugoslavia has been interested in the possibility of constructing nuclear power stations. Because the federal government has lessened its control in favor of greater autonomy for the republics and provinces, the nuclear power program now is the responsibility of the various republics. The two republics with the greatest power shortage are Slovenia and Croatia. In October 1970 the premiers of these two republics concluded an agreement for the construction of a 600-megawatts electrical (MWe) nuclear power station to be built on the north bank of the Sava river near the village of Videm-Krsko, also called Krsko. This village is about 30 kilometers northwest of Zagreb just across the border in Slovenia (Slovenija), but both republics will

FIGURE 5. Boris Kidric Institute of Nuclear Sciences, one of the country's three major nuclear research institutes (U/OU)

be provided power from the station. A second station, to be built in Croatia, is being planned for construction, probably in 1976.

On 8 April 1971, general data for bids for the construction of the Krsko nuclear power project were published, and requests for bids were sent to two U.S. firms, a West German consortium, Atomic Energy of Canada, Ltd., and the Soviet Union's *Tekhnoprom-export*. The deadline for submitting the technical portion of the bids was July 1971, with the deadline for the commercial portion to be fixed later. On the basis of the technical bids, the two U.S. companies and the West German consortium are preparing for the submission of the commercial bids. The planners of the Krsko project are interested in the largest possible participation in the construction of the nuclear power station by Yugoslav industry, and the extent of Yugoslav participation and the conditions for foreign financial assistance are expected to have a major bearing on the selection of bids. The state utilities of Croatia and Slovenia have set a target date of 1972 for concluding a contract for the construction of the power station to be operational in 1977.

Uranium reserves amount to about 1,300 tons of uranium oxide (U_3O_8), mostly in uneconomic types of deposits. Small mining operations are carried out in the Balkan Mountains area near Kalna. A concentrating facility with a capacity to process 100 tons of ore per day was constructed in this area but shut down in 1966 because of the low grade of the ore. Larger deposits of uranium have been discovered in the Zletovo-Kratovo mining basin of Macedonia (Makedonija) and in Slovenia (Slovenija) where two mines were opened in 1968 at Zirovski Vrh in the area between Idrija and Skofja Loka. The Geologic Works of Ljubljana has a contract with a U.S. company to conduct a technical and economic feasibility study of uranium mining and possible concentration plant construction near Gorenja Vas, Slovenia. The Institute for Nuclear and Other Mineral Raw Materials has conducted considerable research on methods of economically processing uranium and established a small pilot plant in Belgrade for reducing the uranium oxide from concentrates to metal.

4. Electronics (C)

The level of electronics research and development in Yugoslavia remains low when compared with that in the more technologically advanced countries. Most of the effort has been directed toward copying or adapting foreign equipment to domestic needs. Government, industry, and the armed forces are working together to improve the present electronics research capability which is limited by a lack of funds and a shortage of personnel. Research is aided by longstanding agreements for scientific and technical cooperation with other Communist countries and with France. Military electronics research and development are the responsibility of the Military Research Institute in Belgrade.

Most electronics research and development concern microwave equipment, radio telecommunications, television, and computers. Universities and autonomous institutes have done research on semiconductor materials, and a process for the manufacture of germanium transistors has been developed. The Yugoslavs also have begun production of silicon transistors and diodes necessary for the production of modern radio and electronic instruments. The Boris Kidric Institute has designed a transistorized portable electronic teleprinter, which is adaptable for military use.

Research on lasers and laser devices is underway. The Yugoslavs have nearly completed construction and assembly of a high-power ruby laser at the Institute of Physics in Belgrade. A helium neon laser and a carbon dioxide laser also are under development. The ruby laser is to be utilized as a precise measuring instrument; the carbon dioxide laser is to be used in controlled thermonuclear research. Research in the use of lasers in communications also will be undertaken.

The Yugoslavs have constructed a parametric amplifier for use in civil aviation, which increases radar sensitivity by about 40% through a reduction of internal noise, resulting in a corresponding major improvement in radar effective range.

Yugoslavia has a good start on the development of a computer industry. Although the industry is very small, even by East European standards, a number of different digital computer models have been manufactured, including desk types, a general-purpose machine, and a process control machine. A prototype of one of the desk-type digital computers, the MIKA ALAS, was completed in 1965 and is the first all-electronic computer designed and manufactured domestically. The computer manufacturing facility is the Electronics Works in Nis. The Mihailo Pupin Institute is engaged in computer research and in 1965-66 developed the CER-200, a solid-state, digital, desk-top machine for business applications; production of the machine began in 1967. The institute also developed the newest and smallest of the CER series, the CER-202, which is used for data processing purposes. An earlier development of the institute, the SAVA, controls operations in a rolling mill. The Boris

Kidric Institute of Nuclear Sciences has designed and built small analog and digital computers. A few experimental computer models have been built by competent university researchers and are used mainly for teaching purposes. The Kraj Enterprise in Ljubljana has in production a transistorized computer, the ISKRA-Z-23V, based on a licensed version of the West German ZUSE-23. Most of the components for the ISKRA are of domestic origin. Although early second generation, the ISKRA is a significant production item for the country's fledgling computer industry. Yugoslavia has imported some of the most modern small-to-medium size machines from the West and in 1971 had 340 computers in operation, most of which were imported. Large computing needs are handled by such models as the CDC-3300 at the Stegne Computer Center in Ljubljana. Other computing centers have been established, including ones at Rijeka, Karlovac, Cakovec, and Split. The Boris Kidric Institute of Nuclear Research has made its computing center available to outsiders. In mid-1970 the Institute for Space Technology of the Yugoslav People's Armed Forces installed a computer.

A small but important ferroelectric research and applications effort is underway. Research appears to be confined largely to Ljubljana University and the associated Josef Stefan Institute, although some work also is being done at the Boris Kidric Institute of Nuclear Sciences. The country has produced probably the best-known research scientist in ferroelectrics outside of the Soviet Union, Prof. R. Blinc of Ljubljana University. A specialist in hydrogen-bonded materials, he has published extensively in U.S. scientific journals and has held a position at the University of Washington in Seattle. Yugoslavia is a source of supply for a number of ferroelectric and piezoelectric crystals. Quartz and Rochelle salt are produced at the Mihailo Pupin Institute, the physical laboratory of the Electrical Industry (*Industrija za Electroveze*) in Ljubljana, and the Radio Industry (*Radioindustrija*) in Zagreb. Yugoslavia is attempting to build its domestic production of these materials to decrease its dependence on foreign imports, and by the mid-1970's should be able to produce quartz and Rochelle salt of the quality needed to meet its requirements. Electronic and acoustic applications of ferroelectrics are being emphasized, but no important results have been achieved.

5. Medical sciences, including veterinary medicine (S)

Biomedical research is limited by insufficient financial resources and inadequately trained personnel. Primary emphasis in biomedical research is in fields concerned with public health medicine and such related areas as industrial toxicology, occupational health, and the rehabilitation of the injured and chronically ill. Research carried out in collaboration with the United States and supported by P.L. 480 funds since 1962 is producing results, especially in neurophysiology and radiology. Modest progress has been made in microbiological research for the control of viral and parasitic diseases.

There has been a striking increase in government support and encouragement for research in neurophysiology. The United States has established a neurophysiological research laboratory at the Kotor Institute for Brain Research and has initiated research at the laboratory. In addition, productive studies are underway at other facilities on physiological reactions to stressful environments, impaired function of breathing in persons with respiratory diseases, neuropathology of brain injury, brain survival in anoxia and hypothermia, and medical problems of divers. Improvements are being made in the Belgrade hand prosthesis, which is myoelectrically controlled.

Work in rehabilitation is outstanding. Assistance to the physically handicapped and the prevention and treatment of all types of occupationally related disorders are emphasized. Some attention is given to abnormal absorption of pollutants, including dusts, metals (especially lead), solvents, pesticides, and radioactive elements in ore.

Microbiologists are doing competent research on the control of tickborne encephalitis and other arboviruses, development of experimental vaccines for enteric diseases, isolation of type-specific antigens for streptococcal infections, typing of phages, identification of resistance to antibiotics, and combating parasitic diseases. Studies in immunology are concerned with the biochemical, radiological, microbiological, and economic aspects of the subject. Researchers have made advancements in food technology and have established firm microbiological specifications for the control of food. Epidemiological research has been aimed at the perfection of survey techniques.

Radiology has received considerable emphasis. Radiologists have developed a good, practical system of multiparametric measurement of environmental radioactivity. Biochemical investigations conducted in support of radiology include the study of the kinetics of enzymes and the effect of radiation on protein metabolism. An outstanding team of researchers at the Rudjer Boskovic Institute is studying the effect of radiation on muscle tissue, cells, and subcellular particles. Other important research in biochemistry has concerned the study of lead poisoning, the effect

of pollution on sea organisms, the character of urinary proteins in endemic nephropathy, indicators of fat and carbohydrate metabolism associated with the incidence of diabetes, and the transport of metabolites by neural membranes. Funds have not been adequate to support any significant research and development of pharmaceuticals, and emphasis is placed on the production of familiar drugs developed abroad.

Research in nutrition, which had lagged behind other fields, is improving under competent guidance from foreign scientists. The relation of proper nutrition to optimal growth is being investigated under the auspices of the World Health Organization. The Yugoslavs are collaborating in studies on coronary heart diseases with scientists from the University of Minnesota and the National Heart and Lung Institute of the U.S. National Institutes of Health. Modern biochemical techniques are employed in carefully designed surveys of the nutritional status of the population. The Yugoslavs have introduced vitamin enrichment of foodstuffs.

The military medical research effort is generally not significant. Most of the research that is underway is conducted at the Military Medical Academy and the Aviation Medical Institute, both in Belgrade. The development by the academy of a vaccine against dysentery has received international recognition.

Yugoslavia has made significant advances in applied veterinary research through the adaptation of foreign research to local conditions and by enlisting technical assistance from international organizations. Although there is an imbalance in favor of the applied aspects, the program has resulted in increased livestock production. Emphasis is on adequate nutrition, the husbandry of domestic animals, and the prevention of diseases. The development of more effective vaccines against viral diseases has received much attention. Foot-and-mouth disease is of great importance. Efforts are underway to eradicate bovine tuberculosis, hog and fowl cholera, rabies, anthrax, and bovine tuberculosis. Other research is being done on the etiology and control of respiratory and enteric infections in calves and swine, infectious equine anemia, and the parasitic diseases of domestic animals. Artificial insemination and infertility of animals are of major concern, and research leading to the effective preservation, storage, and distribution of semen have resulted in greatly expanded artificial breeding programs. Federal veterinary research facilities exist at Belgrade, Zagreb, Sarajevo, and Skopje.

6. Other sciences (S)

a. Chemistry and metallurgy

Although the Yugoslavs actively engage in chemical research, their capabilities are not strong. They rank ahead of Bulgaria and Greece but behind Austria and Hungary in overall chemical capabilities. A modest amount of good-quality research is being done in several branches of chemistry, but there are few indications of outstanding work in any subfield. Although industrial chemical research is growing at several facilities, the total effort is still small and relatively unimportant. Yugoslavia is highly dependent on imported chemical technology.

Most chemical research is done in the Universities of Belgrade, Zagreb, and Ljubljana and the three nuclear research institutes. Although many branches of chemistry are studied, the research lacks depth. Some good work is underway at the universities in organic chemistry, particularly on synthesis and structure determination of organic nitrogen and sulfur compounds. For example, two members of the Faculty of Natural Sciences and Technology at the University of Ljubljana, Mika Tisler and B. Stanovnik, are studying thiosemicarbazides, thioamides, benzothiazoles, thiadiazoles, and triazines. Organic chemists at the Rudjer Boskovic Institute are competent in the synthesis of C-14 labeled organic compounds and are doing work on C-14 labeling of indole compounds and on metabolism of amino acids in plants. Physical organic chemical research also is underway at the institute, and work is being done on strained rings and on isotope effects in organic reactions. Dr. Dusan Hadzi, head of the laboratory of structural chemistry and analysis at the Boris Kidric Chemical Institute of the University of Ljubljana, is highly regarded for his research on stereochemistry, infrared absorption spectra, and hydrogen bonding. He is the country's leading research spectroscopist.

Analytical and inorganic chemistry are subjects of substantial interest. The University of Belgrade is particularly active in developing analytical techniques involving polarographic, coulometric, spectrographic, interferometric, and other methods. In inorganic chemistry, substantial research is underway on xenon fluorides and other inorganic fluorides at the Josef Stefan Institute. Researchers at the Rudjer Boskovic Institute are concerned with studies on coordination complexes of various metals with organic compounds and in conjunction with the University of Zagreb are studying complexes of niobium and tantalum. Work on the preparation and properties of silicon-containing

pyrolytic graphite reportedly has been done at the Boris Kidric Institute of Nuclear Sciences, which engages in many aspects of inorganic chemistry related to nuclear technology, including ceramic fuel elements, sintering of uranium oxide, and nuclear fuel reprocessing. The Josef Stefan Institute has a large chemistry department, which is studying high-temperature refractory materials, gas-solid reactions, preparation of uranium dioxide, and problems of solvent extraction.

Miscellaneous studies in physical chemistry, including some work on catalysis, are carried out at several institutes and universities. Electrochemistry is an important subject of research. The University of Belgrade and its associated Institute for Chemistry and Metallurgy are particularly active in this branch of chemistry and engage in studies on fuel cell electrodes, electrochemical oxidations and reductions, and electrocrystallization of metals. Polarographic studies and work on electrochemical reduction are carried out at the Rudjer Boskovic Institute.

Research in biochemistry is generally weak, although some work in ribonucleic acids and deoxyribonucleic acids is pursued at the University of Belgrade and at other locations throughout the country.

Although most of the metallurgical research is applied, since about 1968 some emphasis on basic metallurgical research has been noted. The major part of the basic effort has been directed toward the electrochemistry and electrometallurgy of nonferrous metals. Interest in the field has been a natural outgrowth of the country's growing nonferrous metals industry, which is based on refining by electrometallurgical methods. The Institute of Chemistry and Metallurgy at the University of Belgrade has done some work in electrometallurgy and has developed a good competence in research on the kinetics and thermodynamics of metal deposition reactions. This institute and the Institute of Physics of the University of Zagreb engage in studies on the causes of oxide and passive layers in metal deposition. The latter institute also has conducted research on phase analysis and precipitation in aluminum alloys. Research has increased on electroplating and corrosion. Corrosion research is undertaken at the Institute for the Protection of Materials against Corrosion at Dubrovnik. The Institute of Nonferrous Metals in Belgrade has done considerable research on the pyrometallurgy and hydrometallurgy of copper and nickel ores. In powder metallurgy, good work is being done on sintering phenomena and powder characterization under Prof. D. Kosler of the Josef Stefan Institute and Prof. M. M. Ristic of the University of Nis.

Some basic research on the physical metallurgy of stainless steels is undertaken at the Institute of Metallurgy in Ljubljana, although most of the research is applied and directed toward solving production problems of the small steel industry. Typical programs have included the reduction of iron ore, the heat treatment and vacuum metallurgy of steels, and the extractive metallurgy of zinc. The institute also has studied fracture mechanism in lead-bismuth alloys. Considerable research on welding, specifically on electroslag welding, is done at the Welding Institute associated with the University of Ljubljana.

b. Physics and mathematics

The main subjects of research are nuclear, plasma, and solid-state physics. Nuclear physics receives the most attention and support, while only a modest amount of research is done in solid-state and plasma physics. Much of the physics research underway is common in advanced countries, but the Yugoslavs are conducting the research in order to gain experience and to train cadres.

Most of the research in high-energy nuclear physics is being performed by a few theoretical physicists at the Rudjer Boskovic Institute. Their basic studies involve multiple scattering spin structures, formulations associated with three-nucleon ground state wave functions, classifications of vector mesons, and studies of the basic concepts of the shell model and excitation modes in nuclei. Some studies are underway at the University of Ljubljana concerning hypotheses associated with faster-than-light particles. The Boris Kidric Institute of Nuclear Sciences is the most advanced of the nuclear facilities in physics research and concentrates on nuclear physics, radiochemistry, radiobiology, reactor engineering, reactor materials, and radiation effects. Neutron generators at this institute are being used to make comparisons between activation and integrated cross sections for the radiative capture of 14 Mev. neutrons. The institute has been active in lattice studies of heavy-water-moderated cores and investigations related to neutron scattering by iron. At the Rudjer Boskovic Institute angular distributions of tritons from boron-barium reactions at 14 Mev. are being measured and compared with previous work done in other countries. Some research also has been underway for a number of

years concerning studies of tellurium isotopes to obtain values of energy levels, wave functions, and electromagnetic transitions.

The Yugoslavs have developed an entire series of detection instruments, such as beta, gamma, and nuclear magnetic resonance spectrometers; particle counters; scintillators; rate meters; scalers, and other nuclear instruments for researching nuclear concepts and for furthering their experimental research and training programs.

The Yugoslav Federation of Manufacturers supports reactor research applicable to the development of an atomic powerplant. Some of the work involves the development of nuclear batteries, and some success reportedly has been achieved in producing 1-kilowatt cells of low current capacity.

The scope of solid-state physics research has expanded significantly during the past few years. Researchers at the nuclear research centers and the university laboratories are active in experimental research in semiconductors, properties of solids, ferromagnetic and ferroelectric properties, and the development of superconductors and the study of their characteristics. Other semiconductor studies have involved the measurements of conductivity and Hall coefficients in germanium, and photoconductivity and photovoltaic effect of cadmium-telluride. Physicists at the Rudjer Boskovic Institute have studied the electrical and optical properties of indium selenide thin films after they are formed through vacuum deposition phases. Some good experimental results have been obtained at the University of Ljubljana on double hysteresis loops obtained with ferroelectric crystals. The study of superconducting properties has increased considerably at the University of Zagreb. Efforts are being directed toward examining the results in terms of superconductivity enhancement caused by rapid quenching of aluminum alloy specimens.

A sizable portion of the plasma physics research is being done at the Electrotechnical Institute of the University of Belgrade. Some research results indicate that the Yugoslavs have been able to produce a true plasma waveguide and a magnetron that will operate at 2,200 megahertz frequency. The Physics Institute of the University of Belgrade has increased its studies and experiments dealing with plasma phenomena. The experiments involve ionized gaseous media and include measurements of electron densities and velocities of arc plasmas. Research at the Josef Stefan Institute involves spectroscopic observations of plasma behind shock fronts in electromagnetic tubes.

An insignificant amount of research is being done in quantum electronics. A few physicists at the Boris Kidric Institute have conducted experiments on the application of gas magnetron diodes for use as a laser pump. Other studies are underway on the means for amplification obtained through the use of helium-neon mixtures in laser resonators to obtain an understanding of geometrical optics theory.

Capabilities for mathematical research lag behind those of neighboring countries. Although the research has improved in recent years, the effort apparently lacks depth. Yugoslav mathematical research covers all fields of classical mathematics with the possible exception of statistics. About half of the concentration is on analysis, including such subjects as ordinary and differential equations and real and complex variables. The rest of the effort is well distributed through geometry (including topology), algebra, foundations, and applications. The Yugoslavs continue to show an increasing interest in applied mathematical research and in computers and their applications.

c. Astrogeophysical sciences

Capabilities in astronomy, space science, and the geophysical sciences with the exception of hydrologic and hydraulics engineering are generally limited. Yugoslavia is one of the leading Eastern European countries in applied hydrology and hydraulics. The major research facility is the Federal Hydrometeorological Institute, Belgrade. Most studies are directed toward the full utilization of water resources for hydropower, irrigation, drainage, and expansion of the navigation network. Research is supported by model tests and field investigations in connection with studies on stress and deformation of dams, energy dissipation, duration of flood peaks, and scour dynamics at hydraulic structures. Engineers have succeeded in devising methods and instruments for measuring vibration of dams, silt movement, and fluid infiltration. Coastal research is limited and mainly concerns studies of marine dynamics and shore processes applicable to navigation and harbor development and protection.

Geodetic activities are the responsibility of the Geographic Institute of the Yugoslav People's Army and of the Federal Geodetic Administration. The overall capability for geodetic research and development falls below that of the leading countries in the field. The major Yugoslav weakness is in the design and development of geodetic instruments. The strongest research is carried out in the fields of triangulation and leveling. Noteworthy research has

been done on the direction and angle methods of adjustment of triangulation nets, on studies of the local geoid and of a reference ellipsoid to determine a basis for the Yugoslav triangulation system, on the development of methods for the simplification of rigorous computational adjustment of geodetic triangulation and leveling, and on determination of a new vertical datum for the country. Activity in gravimetry has been increasing, but only a small portion of this activity can be regarded as actual research.

Some astronomical research is conducted in the areas of positional astronomy and celestial mechanics. During 1970 an astronomical observatory was being constructed in cooperation with Czechoslovakia on Otok Hvar off the Dalmatian coast. It is being equipped for stellar and solar research and for satellite tracking. Upper atmospheric studies are meager. The Mihailo Pupin Institute for Automation and Telecommunication includes an observatory which contributes to the international collection of ionosonde data. The Yugoslavs have developed a small solid-propellant sounding rocket, designated Senelit, which is patterned after the Japanese Kappa-6 rocket. Research is underway to obtain improved rocket nozzle materials for the Senelit.

Capabilities in space research and systems development are insignificant. Unlike other areas of science, there has been little participation in space and related programs with other countries; Yugoslavia is less active in the Soviet space research projects than any of the other Communist countries. Yugoslavia has become a member of the International Telecommunications Satellite Corporation (INTELSAT). A Communications Satellite Corporation (COMSAT) ground station, to be constructed near Ivanjica, is scheduled to be in operation by late 1973 or early 1974. When it becomes operational, this station will greatly improve communication between Yugoslavia and various countries located in Europe, Africa, and North and South America.

Yugoslavia has a limited meteorological effort that emphasizes weather forecasting, agrometeorology, and climatology. The work in these fields has been largely routine. The Federal Hydrometeorological Institute coordinates both operational meteorological activities and meteorological research. There also is a Hydrometeorological Institute of the Socialist Republic of Croatia in Zagreb. Research is undertaken in the universities and has covered dynamic, physical, and synoptic meteorology and numerical forecasting. In early 1968 a meteorological radar station was established near Belgrade. It is intended to be the center of a small-rocket, antihail network for the region of Sumadija, a rich agricultural area in Serbia; the Soviets are assisting in establishing the network.

The Yugoslavs engage in some geomagnetic and seismic observational activity. The country has one geomagnetic observatory, the Geomagnetic Institute, located at Grocka, and several secular variation stations, which make routine observations. Capabilities in seismology have improved since the Skopje earthquake of 1963, and detailed studies have been made, in part with Soviet assistance, in attempts to determine the cause of the earthquake and its engineering and geological effects. Deep seismic soundings of the Carpatho-Balkan region also have been made, presumably in cooperation with neighboring countries, and Yugoslavia planned to participate in a joint program of seismic measurements in the Swiss-Italian Alps in cooperation with Austria, Hungary, and Italy. There is considerable geophysical and geological activity directed to mineral prospecting. Although the country apparently has a good geological survey in its Institute for Geological and Geophysical Research in Belgrade, geological exploration efforts are poorly organized and coordinated.

Oceanographic capabilities are relatively low but appear to be increasing slightly. Oceanographic research is confined to the Adriatic Sea and adjacent waters of the Mediterranean Sea, consisting primarily of routine studies in support of the country's fishing industry. Although the research is limited by a shortage of funds, the overall program has expanded considerably since 1966, and in 1968 an increase in funds was provided for the support of oceanographic research in the Mediterranean Sea. The research program has suffered from a lack of coordination among facilities concerned with oceanography and from a conflict between senior administrators and managers and the younger, better educated oceanographers. Some improvement in the oceanographic effort should occur with the establishment by the Serbian Academy of Sciences and Arts of a committee to coordinate research in the field. The Institute of Oceanography and Fisheries at Split, sponsored by the Council for Scientific Work of Bosnia and Hercegovina, conducts most of the oceanographic research. Other organizations carrying out marine scientific investigations are the Institutes of Marine Biology at Kotor and Rovinj; the Institute of Sea Research at Portoroz; and the Biological Institute at Dubrovnik.

In 1971 a 1,540-ton Moma-class auxiliary general survey ship (Figure 6), *Andrija Mohorovic* was purchased from Poland. The ship has five laboratories providing facilities for oceanographic, hydrographic, chemical, photographic, and multipurpose studies. A 1,200-ton oceanographic survey ship is under construction at the Tito shipyard in Belgrade. The addition of these two ships should considerably increase Yugoslavia's oceanographic surveying capabilities. The country has developed and produced some submarine acoustic equipment and has been active in sonar and passive underwater defense research.

Yugoslavia has cooperated with the Soviet Union in oceanographic studies and exchanges in the past, but present collaboration is minimal. Czechoslovakia and Yugoslavia have a cooperative marine research agreement. Italy and Yugoslavia are engaged in a joint effort in the adjacent Adriatic Sea, which involves a large-scale oceanographic program. A cooperative agreement between the United States and Yugoslavia also is in effect to study the productivity of the northern Adriatic Sea. Yugoslav delegates attended the 21st meeting of the International Commission for the Scientific Exploration of the Mediterranean Sea held in Monaco during September 1968.

FIGURE 6. Moma-class auxiliary general survey ship (C)

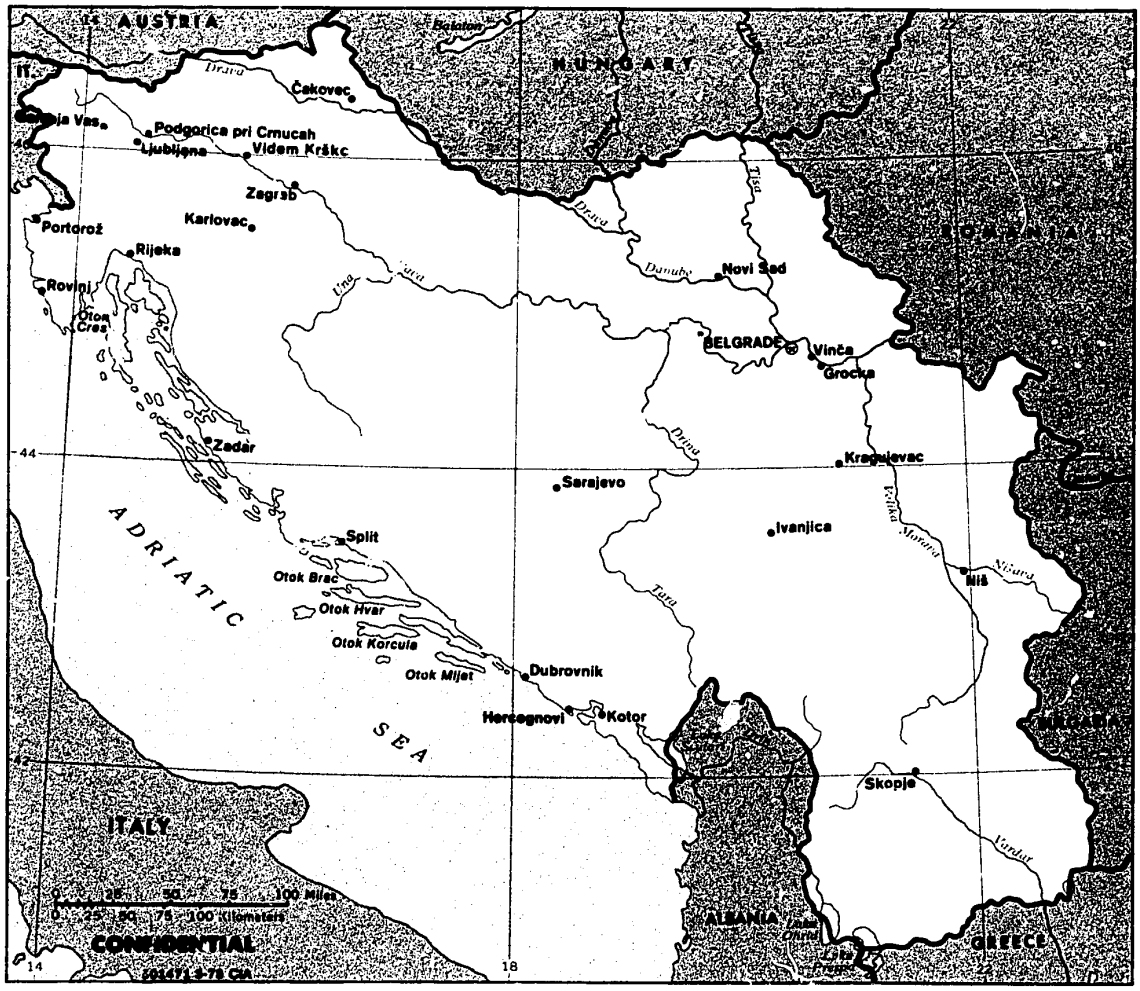

FIGURE 7. Selected sites of scientific activity (C)

Places and features referred to in this chapter (u/ou)

	COORDINATES	
	° 'N.	° 'E.
Balkan Mountains (*mts*)	43 15	25 00
Belgrade	44 50	20 30
Čakovec	46 23	16 26
Dubrovnik	42 39	18 07
Gorenja Vas	46 07	14 10
Grocka	44 41	20 43
Hercegovina (*region*)	43 00	17 50
Hercegnovi	42 27	18 32
Hvar, Otok (*isl*)	43 07	16 45
Idrija	46 00	14 02
Ivanjica	43 35	20 14
Kalna	42 52	22 26
Karlovac	45 29	15 33
Kotor	42 25	18 46
Kragujevac	44 01	20 55
Kratovo	42 05	22 12
Ljubljana	46 03	14 31
Mostar	43 21	17 49
Niš	43 19	21 54
Novi Sad	45 15	19 50
Podgorica pri Črnučah	46 06	14 35
Portorož	45 31	13 36
Rijeka	45 21	14 24
Rovinj	45 05	13 38
Sarajevo	43 50	18 25
Sava (*strm*)	44 50	20 28
Skofja Loka	46 10	14 18
Skopje	42 00	21 29
Split	43 31	16 26
Šumadija (*region*)	44 20	20 40
Titograd	42 26	19 16
Videm-Krško	45 58	15 29
Vinča	44 46	20 36
Zadar	44 07	15 15
Zagreb	45 48	16 00
Žirovski Vrh (*ridge*)	46 05	14 10
Zletovo	41 59	22 15