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China: Instrumentation Capabilities

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An Intelligence Assessment

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SW 83-10021
April 1983

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An Intelligence Assessment

This paper was prepared by
Office of Scientific and Weapons Research. Comments and queries are welcome and may be addressed to the Chief, Science and Technology Division, OSWR,

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This paper was coordinated with the National Intelligence Council.

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Secret
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Key Judgments

Information available as of 1 January 1983 was used in this report.

As China moves from an agrarian-based economy to an industrialized economy, adequate instrumentation, diagnostic procedures, and standards become more important. China's scientific leaders recognize the important role of instrumentation in the development of an advanced economy. We believe that they are anxious to assimilate recent advances in measurement and calibration procedures and in related instruments into China's advanced S&T development efforts, and they are attempting to catch up with the rest of the world in these critical areas. At present, Chinese basic instrumentation capabilities are barely sufficient for current research and production programs. Although these capabilities are improving, prospective industrial and military requirements for unprecedented sensitivity and precision in research and production will outdistance these improvements. As a result, we believe, the limited precision of measurement standards and equipment, a shortage of personnel, and poor quality control will constrain many of China's scientific, industrial, and military projects for at least the next 10 years.

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The demand for instruments in China is spread among three classes of users: research institutes, production units, and universities. Generally, Chinese Academy of Sciences research institutes and ministerial research institutes have the best available equipment, production units and factories have the second best, and universities have old and/or very poor equipment.

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Although many instruments used in China are manufactured domestically, most of them are copies of established foreign (US and Japanese) designs obtained either by reverse engineering or from published literature.

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The Chinese consistently accept domestically made instruments that are five to 10 years behind Western state of the art rather than purchase and attempt to copy the newest equipment from foreign sources. In most cases, the purchase of older, less expensive instruments is due partly to shortages of foreign exchange funds and especially to past failures in Chinese attempts to copy more advanced equipment. Chinese scientists have stated that such risk taking carries no rewards, while a complete or partial failure would lead to severe criticism from other scientists competing for China's scarce resources and research funds.

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A major weakness is lack of a central supply. Too many instruments are made by individual users rather than by instrument factories, with resulting duplication of effort and inefficient use of resources. This has inhibited long-term development and production of instruments. The general shortage of adequate instruments and the limited cooperation among researchers who would rather hoard equipment than risk losing it make it difficult for one institution to acquire or borrow instruments from another facility. [redacted]

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Contents

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China: Instrumentation Capabilities

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Introduction

As China attempts to develop an advanced economy, instrumentation [1] will play a key role both in manufacturing processes and in scientific research. All automated processes and most testing, measuring, and analytical work in industry are dependent upon adequate capabilities in instrumentation and metrology.[2] Sophisticated instruments are critical also to the quality of fundamental and applied scientific research.

Adequate instrumentation and metrology do not, however, require merely the acquisition or development of state-of-the-art instruments; they require also large numbers of personnel fully qualified to use and maintain the instruments.

At present, the Chinese are confronted with a threefold problem in this area. First, they must acquire or domestically develop adequate instrumentation. Their current stock of research and production instruments is seriously deficient in quality and quantity. Second, they must effectively distribute and utilize instruments. To do so, there must be major improvements in the communication links between research and production units. Third, the Chinese must train and maintain sufficient numbers of technicians, engineers, and scientists for designing, fabricating, repairing, and using these instruments. A lack of competent technical personnel is perhaps the most serious constraint on instrumentation in China.

Further complicating the problem is the cause-and-effect relationship between the poor quality of instrumentation and the backwardness of China's scientific and military research capabilities. While we shall be concerned primarily with the effect that instrumentation has on scientific and technological development, some attention, conversely, must be given to the effect that scientific development has on instrumentation development and use.

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Development of Instrumentation Capabilities

Throughout the 1950s and early 1960s, the Chinese in their instrument manufacturing depended largely on Soviet and East European instrument technology to provide complete plants, production techniques, special machinery, designs, blueprints, prototypes, technical information, advice, and training. Aided especially by the Soviets, China's instrumentation industry began to develop on its own. Chinese scientists have stated that China became about 60 percent self-sufficient in instruments during this period. In addition, Chinese open-source accounts indicate that the organization and development of a comprehensive research establishment, effectively supporting the industry, was well under way.

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The biggest factor affecting Chinese development of instrumentation was the Sino-Soviet rift in the early 1960s. this dispute effectively cut China off from Soviet and East European resources. The Chinese responded by trying to develop self-reliance for meeting their instrumentation needs and by seeking new suppliers from the West. In addition to the dispute with the USSR, it was a shift in priorities a little later resulting from the Cultural Revolution (1966-70), we believe, that led China to depend more heavily on domestic resources for instrumentation. This policy brought about a significant expansion in the variety of instruments produced. It caused serious problems, however, since large-scale production of instruments beyond trial development stages was often limited by the scarcity

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[1] An instrument is a device for measuring and sometimes also recording and controlling the value of a quantity under observation. Instrumentation is the design, manufacture, and use of physical instruments or systems for detection, observation, measurement, recording, automatic control, automatic computation, communication, or data processing.

[2] Metrology is the science of measuring. It comprises the development of instruments and methods of using instruments to provide consistent, precise standards and benchmarks for scientific and economic purposes.

of resources. As a result, instrumentation in factories and plants gradually became less sophisticated, and new instruments became more difficult to acquire. Many existing ones fell into disrepair. Priority was given to the defense sector and to a few select industries, such as electronics, space, and agriculture. The rest of the industrial sector suffered from low quality and a poor variety of instruments, a shortage of researchers capable of designing new equipment, a breakdown in mechanisms to introduce new technology into industry, and generally inadequate linkages between research and industry.

The impact of the Cultural Revolution on the S&T establishment aggravated many of the problems that had resulted from the overemphasis on self-reliance. In our judgment, the scientific stagnation of the Cultural Revolution left many of China's S&T capabilities 10 to 20 years behind advanced modern levels. Instrumentation was no exception. it was not until after the Cultural Revolution that small specialized plants were set up to meet industry needs for high-precision instruments. Most of these instruments were supplied either to large plants producing new, more sophisticated products or directly to the military. In addition, some foreign instruments and related technologies were acquired from the United Kingdom, Japan, and West Germany.

By 1971 there were about 50 major plants producing instruments in China, the major centers being located in Beijing, Nanjing, Tianjin, and Shanghai. Some 15 countries, with Japan foremost, supplied China with $10 million (US) of instruments annually. most of these imported devices were used as prototypes for domestic production. From the early 1970s through 1977, China imported whole plants and test facilities in an attempt to catch up quickly with advanced world levels of instrument technology and manufacture. We believe that this practice proved to be less than successful because of delays in the domestic manufacturing system, underutilization of existing plant capacity, and duplication of imported equipment and effort. poor project management and a lack of qualified personnel were the major factors in these problems.

In 1978 China began an ambitious modernization program on a broad scale designed to bring the Chinese economy and S&T capabilities up to modern Western standards by the year 2000. In support of the program, the Chinese reaffirmed previous efforts to acquire or develop a wide range of instruments. We believe that many of their purchases proved ineffectual because of mismatching of the imported items with actual needs. Domestic development was handicapped by the low quality of production and research capabilities at most facilities, which to a large extent was caused by a lack of instruments. By 1979, however, the Chinese began to recognize the shortcomings of their modernization strategy. Several major readjustments were instituted. A large number of scientific and industrial projects were scaled down, postponed, or canceled completely because the Chinese lacked much of the ancillary equipment and know-how required. Chinese press releases reported an overall shift from heavy to light industry and a greater concentration on the acquisition of technology rather than purchases of large quantities of equipment. The development and application of sophisticated instruments were given greater priority.

Currently, China continues to engage in widespread, open acquisition of instruments and related technology from the West. the Chinese have expressed greatest interest in equipment and technologies that do not represent state of the art in the West. It is our judgment that the Chinese want foreign instruments that are three to five years behind Western state of the art, because of lower cost and greater ability to copy and manufacture such devices in China and integrate them into existing research facilities. In most cases, however, the purchase of older, less expensive instruments is due partly to shortages of foreign exchange funds and especially to past failures in Chinese attempts to copy more advanced equipment. China's scientific leaders also recognize that the most modern instruments are not required for all industrial and research applications.

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Capabilities and Deficiencies

Currently, the Chinese find themselves with instruments varying widely in quality and quantity. Many of the instruments used in factories are based either on Soviet technology of the 1950s and 1960s or on Japanese technology of the early 1970s. Most instruments used in scientific laboratories are copies of Western designs from the mid-1960s to the mid-1970s. Truly Chinese-designed and Chinese-built instruments—much costlier than their imported counterparts would be—are available only for limited, special applications, predominantly in the military sector, where the need for specialized instruments and for a dependable supply of spare parts often overrides economic factors. We estimate that the Chinese currently depend on imports for nearly 40 percent of the total number of instruments that they need. These instruments are typically of late 1970s design but still are advanced devices having a degree of sophistication and precision otherwise unavailable to the Chinese.

The Chinese also have severe problems in supporting, maintaining, and properly using the equipment and instruments that they have. We believe that these problems result in part from the diversity and lack of standardization of instruments.

We believe that key factors hampering China's instrumentation sector include the following: (1) There is no readily available supply of basic instruments in China. What is considered in the United States to be off-the-shelf equipment must in China usually be either designed and built or imported by individual institutes or even researchers. The lack of cooperation or coordination with other facilities or researchers leads to duplication of effort and inefficient use of already scarce resources. In fact, the scarcity of resources has led many institutes into rival or adversary relationships with institutes that they should be working closely with. (2) The lack of a pool of technicians trained to maintain and properly use existing instruments has resulted in inefficient and, at worst, ineffectual use of these instruments. We have even seen Chinese press reports that instruments have been damaged or destroyed by improper maintenance and use. (3) poor quality control has been found in the design and manufacture of new instruments. 25X1 25X1 25X1

China's instrumentation sector shares many of the deficiencies of the entire Chinese S&T system, including overcentralization of authority, poor communication between research institutes and between research and production facilities, and high compartmentalization. As a result, the Chinese have difficulties translating prototype instruments, whether of domestic or foreign origin, into serial production. 25X1

The Chinese instrumentation industry cannot meet customer needs for sophisticated, state-of-the-art devices in terms of either quantity or quality. Even though foreign assistance is needed to increase design and production capabilities in the instrumentation sector, China remains dedicated to eventual national self-sufficiency. Often, if an electronics plant needs sophisticated test equipment, the plant will make it instead of purchasing it from a domestic supplier or from foreign sources. As a result, production processes are retarded and standardization of precision equipment among plants is difficult. Of even more importance, new, more sophisticated instruments are not introduced concurrently with state-of-the-art advances. As a result, the Chinese fall further behind in practical accomplishment even as they are increasing their long-run capabilities. 25X1 25X1 25X1

In sophisticated S&T instrumentation and technology-intensive products such as integrated circuitry, we judge China to be anywhere from two to 10 years behind world levels. However, this lag probably does not mean much in terms of China's current industrial needs. Actually, China's manufacturing and research needs continue to be met in a minimal manner using available instruments and equipment. We believe that inadequacies in Chinese instrumentation first will become apparent in basic research, in the development of sophisticated electronics, in automated manufacturing processes, and in efforts to expand or improve currently backward and outdated production

capabilities. Where present instrumentation is not sufficient, China in the short term is aggressively seeking outside help, in the form of license agreements, joint ventures, and purchases of foreign technology, to upgrade specific deficiencies.

A good example of this process is the Quality Assurance Project in Beijing. This project will establish an applications and quality assurance center in Beijing

The center would also be able to test domestically made products. Through this program the Chinese will obtain needed high-quality integrated circuits at reduced cost and will acquire know-how in setting up and running an effective testing and quality assurance program for instruments.

The Chinese appear to be compensating for many of their instrumentation problems. Individual scientists, and some workers at production facilities, have become adept at making and repairing their own equipment and, where necessary, acquiring through informal channels many devices that they cannot build themselves. Some institutes have sent personnel to the United States and other countries on shopping excursions that included buying from ordinary retail outlets.

Metrology and Standards

Without adequate metrological and standards capabilities, instruments cannot be developed or properly used. During the early years of Chinese instrumentation development, individual, institutional, and regional separations made implementation of national standards for measurement and calibration a difficult task.

the Chinese have begun to address the problem and are making progress in establishing, and obtaining adherence to, a set of national standards. The majority of Chinese metrological efforts, are based on designs and theories already well established in the West. 25X1 25X1 25X1

According to Chinese open sources, the State Economic Commission (SEC) is responsible for metrology and standards in China (see figure). Under the SEC are two bureaus concerned with various aspects of metrology and standards. The Bureau of Metrology (BM) ensures that standards, calibrations, and other services are available to scientists, engineers, and technicians across the economy. The Bureau of Standards (BS) is responsible for developing and promulgating standards that will promote efficient industrial production. We believe that the integration of these two bureaus in May 1982 into the SEC was an attempt to facilitate development and application of a set of national standards throughout China's research and production sectors. These same sources indicate that the Bureau of Standards develops policy and manages standards in all areas of the economy, including agriculture, commerce, and industry. The bureau deals with standards at the national level, setting some 1,800 "national" standards, over 13,000 "ministry," or "professional," standards (used by various ministries), and numerous other standards for factories and individual (usually small-scale) production units.[3] National standards are intended to apply to technologies directly involved in production on a nationwide basis. Ministry, or professional, standards govern only products within certain divisions of some ministries. 25X1 25X1 25X1 25X1 25X1 25X1

we have determined that each of the 29 provinces of China has its own provincial bureau of metrology, which receives standards and technical leadership from laboratories under the Bureau of Metrology.

[3] Perhaps 60 percent of these standards cover hardware items (screws, nuts, rivets, and so forth) rather than specifications used directly in measurement and/or calibration. 25X1 25X1 25X1

The provincial bureaus in turn transfer metrology and standards to the countryside. Each provincial bureau is responsible to the Bureau of Metrology but is funded by the province.

the National Institute of Metrology (NIM) under the BM maintains primary measurement standards for the whole of China. NIM comprises two laboratories, one in Beijing and one in Chengdu. The principal tasks of these national laboratories are to maintain primary and reference standards, to do research on standards, and to transfer standards to local authorities, such as provincial bureaus of metrology, and to industrial ministries. We believe that the laboratory at Chengdu was established to provide a backup metrological capability for defense purposes and to better provide standards throughout the country by reason of its southwest location, which saves on transportation costs to and from large parts of China. For the 29 provinces, NIM currently maintains 120 calibration standards and from them provides secondary calibration standards. According to open-source Chinese news reports, more than 15,000 instruments are calibrated each year with these standards.

the Chinese do not seem to be developing new devices or techniques at either of the NIM laboratories.

highlight a heavy Chinese dependence on Western published literature for designs of equipment and methods of mensuration.

The Beijing laboratory of NIM has a staff of some 1,600, of whom about 830 are research scientists. It is subdivided into 11 labs: Time and Frequency, Chemistry, Optics, Quantum Metrology, Length and Angle, Mechanics, Temperature, Electricity and Magnetism, Microwave Measurements, Radioactivity, and Large-Scale Integration. NIM-Beijing has its own machine and instrument shops, and the majority of the test equipment used is made there. It is of sufficient quality to accomplish day-to-day industrial metrology requirements. The instruments include high-temperature-resistance thermometers, optical pyrometers, stabilized dye lasers, a ring laser for angle calibration, laser interferometers for gauge blocks, combustion calorimeters, a Krypton-86 luminosity standard, standard cells and resistors, a cesium clock accurate to 1 part in a trillion, and microwave power and impedance standards. The Beijing laboratory has made excellent measurements of the gyromagnetic ratio of the proton, a fundamental measurement demonstrating, even by US criteria, a high degree of precision and sophistication in electromagnetic metrology. 25X1

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the Chengdu laboratory of NIM as being smaller than the one at Beijing, with a staff of some 600, of whom about 240 are scientists. As is true of the Beijing laboratory, research at Chengdu is geared to the development of measurement and calibration capabilities comparable to and consistent with those of other laboratories throughout the world. The Chengdu laboratory is subdivided into eight labs: Length, Optics and Lasers, Temperature, Electricity and Magnetism, First Mechanics, Second Mechanics, Radioactivity, and Cryogenics. 25X1

several of the Chengdu labs largely just duplicate the work done by their counterparts in Beijing. Noteworthy exceptions are the work in measurements of complex decay of radioactive nuclides, hardness testers, national primary electrical resistance standards, an anechoic chamber for acoustic studies, and Josephson junction standards. 25X1

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these standards and equipment represent either unique work for China or the highest quality for such work in China. Most of the test equipment used at Chengdu is made on the premises, using Western published designs in many cases. 25X1

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Activities of the Shanghai Administration of Metrology are nominally coordinated by BM and its functions are similar to those at NIM. 25X1

Shanghai research facilities and industry depend on this laboratory rather than on the NIM laboratories. The Shanghai laboratory is locally funded, by the municipality of Shanghai, and enjoys almost complete autonomy. It is larger and more diversified than a provincial bureau, and with a staff of over 1,200 is second in size only to the NIM laboratory at Beijing. Its labs generally duplicate most of the facilities and work of NIM 25X1

it has better, more 25X1

modern equipment. more imported equipment than at either location of NIM, including instruments from such companies as Fluke, Weinschel Engineering, and Hewlett-Packard. We view the better equipment as being consistent with Shanghai's status as China's most industrialized city.

the continuing rivalry and lack of cooperation among the three major metrology laboratories is a significant factor in China's failure to establish effective national standards. This rivalry has resulted not only in an undesirable duplication of effort, but also in a weakening of national authority. As long as the Shanghai Administration of Metrology views itself as better than the laboratories of NIM and more capable of providing standards on its own, the metrology system of China will never become truly national. It will be up to the central government to resolve this problem.

The provincial metrology bureaus transfer standards of measurement to factories and individual production units, make precision measurements in their own labs, and develop new job-specific metrology techniques. Much of the activity at the provincial bureaus is the calibrating of instruments used in local industrial plants. Most of the funds for running the bureau come from the local government many bureaus charge small fees for local services. This income usually accounts for 2 to 5 percent of their total income. Examples of these services might be: calibration of viscometers for the petroleum industry; calibration of ammeters and pressure gauges; testing of transformers; measuring hardness of steel samples; calibration of standard cells, gauge blocks, and potentiometers; and certification of weights for use by weights and measures inspectors. It is also the responsibility of the provincial bureaus to provide information on metrology to the general public as well as to specialized users.

Several provincial-level specialized research institutes develop new metrological techniques and recommend standards for specific local users. the China Metrology Science Research Institute and the Standards Research Institute provide this support in Chengdu and Beijing. These institutes, however, lack sophisticated equipment and trained personnel. As a result, only rudimentary work, we believe, comes from these institutes. 25X1 25X1

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we believe that the Chinese realize their need for a strengthened national metrology organization. They intend, to pattern Chinese metrology techniques, equipment, and organization after those of NBS rather than develop their own instruments or methods. Several NIM delegations have visited the United States to see how manufacturers transmit requirements to and use the services of NBS. 25X1 25X1 25X1 25X1 25X1 25X1

This situation is reminiscent of the Chinese attempts to acquire modern industries by importing entire plants during the 1970s and probably will entail many of the same problems. We doubt that adopting the technology and organization of NBS will supply the Chinese with an appropriate, or even adequate, metrology system because of the fundamental differences between the US free market system and the Chinese controlled economy and the Chinese inability to carry out extremely sophisticated research. 25X1 25X1

Present Instrumentation

Classes of Users

The demand for instruments in China is spread among three classes of users: research institutes, production units, and universities. 25X1 25X1 25X1

these three S&T sectors often compete for the country's limited instrumentation resources. Generally, Chinese Academy of Sciences (CAS) research institutes and ministerial research institutes (the latter serving the military and/or civil sectors) have the best available equipment, production units and factories have the second best, and universities have old and/or very poor equipment. 25X1 25X1 25X1

While this situation is beginning to change, and there are certainly exceptions, we believe that it will be some time before adequate instrumentation will be 25X1 25X1

found in all three sectors. Production units and factories will increasingly need sophisticated instruments for improving speed, quality, and precision in manufacturing. Universities will need better equipment if they are to provide rigorous training for scientists and engineers. At this time, China does not, we believe, have an industry able to produce instruments of the various types or sophistication needed.

Chinese open literature describes the National General Bureau of Instrumentation Industry (NGBII), established in 1980, as having primary responsibility for the instrumentation sector. The NGBII, which is directly subordinate to the State Council, is described in this literature as being responsible for: (1) coordinating all development of instrumentation and automated devices; (2) organizing and managing the production, marketing, research and development of all industrial processing instruments, scientific instruments, and photographic and duplicating equipment; (3) drawing up and carrying out standards for instrumentation and automation; and (4) examining and approving plans for introducing advanced instrumentation technology and for importing instruments. In our judgment, NGBII is overextended in this role, with poor linkages with other parts of the instrument sector and too many areas of responsibility. As a result, its performance has been less than effective

The other limiting factor, we believe, is the lack of a readily available supply of off-the-shelf instruments found in most Western countries.

individual facilities feel compelled to supply their own instrument needs as much as possible. Limited cooperation and a lack of foreign exchange make it very difficult for an individual facility either to get instruments from other facilities or to purchase foreign equipment. most facilities hoard their equipment and instruments and would rather see them underutilized where they are than let them out on loan to be used more effectively at some other facility, with the risk of losing them for good.

While specialized instrument factories do exist, they are usually affiliated with, and subordinate to, a specific production unit or program and therefore not available to supply other customers. The Zhouzhou instrument plant, which supplies components solely to a First Ministry of Machine Building project assigned by the People's Liberation Army Air Force (PLAAF), is an example of such a relationship. The CAS maintains three special support entities dedicated to supplying instruments for use by CAS institutes: the Dongfang (Oriental) Scientific Instruments Import and Export Corporation, the Scientific Instrument Plant, and the Yanshan Instrument Corporation. The first of these is an import company and the other two design and build instruments. Because of the overwhelming demand and the diversity of research projects, the three entities cannot meet CAS needs. 25X1

In our judgment, most of the scientific instruments currently in use at research institutes are essentially copies of US and Japanese equipment. Many oscilloscopes 25X1 for example, are copies of 10- to 15-year-old Tektronix, Inc., designs. For sophisticated, newer instruments, Chinese officials have indicated a preference for purchasing US and Japanese equipment directly and entering into joint ventures with Western companies to obtain modern technology and equipment. 25X1 25X1

Domestic Instruments

As China moves from an agrarian-based economy to an industrialized economy, adequate instrumentation, diagnostic procedures, and standards will become 25X1 increasingly important. In modern industrial nations, 25X1 instruments and standards play a key role in both manufacturing processes and scientific research. All automated manufacturing processes, industrial testing and quality control, and analytical research depend upon adequate, high-quality instruments and a sound metrological capability. Modern, sophisticated instruments also are the critical tools of scientific research 25X1 and development. The quality of research, the ability

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to innovate, and the capability to compete with other industrial nations all are determined by the quality of instruments and standards.

Our analysis has shown that, while many of the instruments used in China are manufactured domestically, very few actually represent indigenous development. Most are copies of foreign designs obtained either by reverse engineering or through published literature. This lack of original design exemplifies a conservatism that permeates the Chinese scientific community and can be attributed mainly to lingering effects of the Cultural Revolution. Researchers would rather copy existing technology that might be several years old than risk developing a new concept that might not be entirely successful or yield immediate benefits. Such a failure would be viewed very critically by other scientists competing for limited resources, by government bureaucrats looking to further trim tight budgets, and by political cadres dissatisfied with the current strong emphasis on science and technology.

Generally, problems in the development and production of modern instruments come less from specific deficiencies in apparatus than from inadequate management and insufficient technical personnel. The lack of understanding by managers of the theory and application of process control severely inhibits production. The best instrumentation is useless if it is not properly incorporated into the production process.

The Chinese also have problems in scheduling and utilizing resources.

Control of manufacturing operations was correspondingly weak.

Until such management deficiencies are corrected, the best equipment will be of little help in advancing China's production capabilities. Rather than developing improved capabilities, the Chinese will be doing little more than copying existing technology and trying to force it to satisfy their needs.

While the mass production of microprocessors is currently beyond the scope of Chinese industry, developmental work is proceeding at a rapid rate and serial production should be attained within the next five to seven years. The Chinese realize that virtually all of the next generation of instruments and control equipment will be microprocessor-based devices and that a domestic microprocessor industry will be a necessary base for an effective instrument industry. The real question in microprocessor development is whether China will be able to drive such a technology-intensive endeavor as designing new microprocessors with its present lack of free competition among designers. If not, China may be dependent for many years on Western technology for microprocessor-based ideas and products.

Given the capabilities described above, it is not likely that China will supply complete systems such as airframes, large computers, or integrated heavy machinery to world markets within the next 10 years. Present Chinese capabilities are better suited to supplying selected components and subsystems. In so doing they will have the need and the incentive to build and strengthen their S&T and instrumentation bases, and thereby to advance their industrialization.

In the meantime, in keeping with current economic policies in China and to maximize what resources it does have, emphasis has been placed, on instruments for the aircraft industry, laser research, nuclear research, metrology (frequency and time standards), iron and steel analysis, electronic manufacturing and development, and production units manufacturing consumer goods such

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as clothing and TV and radio sets.

Imported Instruments

Chinese open-source literature describes how instruments are imported by special import-export organizations in China. The Chinese Academy of Sciences has its own such organization, called the Oriental Scientific Instruments Import and Export Corporation (OSI). OSI has two main import departments, one dealing with electronics and computers, and the other with optics, lasers, infrared, and related instruments. OSI represents the CAS in the open acquisition of scientific instruments to support all CAS research institutes.

Educational facilities, non-CAS research institutes, and production units do a small amount of negotiating for instruments, particularly through visiting scholars and exchange delegations. They usually depend, however, on specialized trade organizations to acquire equipment for them. These organizations include the China National Instruments Import and Export Corporation (INSTRIMPEX), China Nuclear Energy Industry Corporation (CNEIC), Northern Industrial Corporation (NORINCO), Chinese Precision Machinery Import and Export Corporation (CPMIEC), and the China Electronics Import and Export Corporation (CEIEC). Recently acquired items include such equipment as aircraft for radar testing and aero-instrument calibration, teleprinters, cathode-ray tube terminals, digital multimeters, microprocessors, spark gap testers, oscilloscopes, spectrum analyzers, acoustic intensity meters, strain gauges, in-circuit digital test systems for MSI printed circuit board devices, laser spectrometers, and a wide range of exothermic property sensors and probes.

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There is evidence of bitter competition between Chinese trade organizations in their pursuit of contracts to purchase Western scientific instruments for domestic customers. Decentralization of authority has effectively stripped INSTRIMPEX of its previous monopoly in the business but has left instrumentation users with inflated prices and unmet demand for equipment. Many of China's trade organizations have staff people with limited technical knowledge. This has often resulted in purchases of insufficient, outdated, inadequate, or unneeded equipment. Scientists and researchers generally display contempt for trade organizations because of their failure to provide them with instruments tailored to their needs and because of overcharging on purchase prices and on subsequent servicing and parts.

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