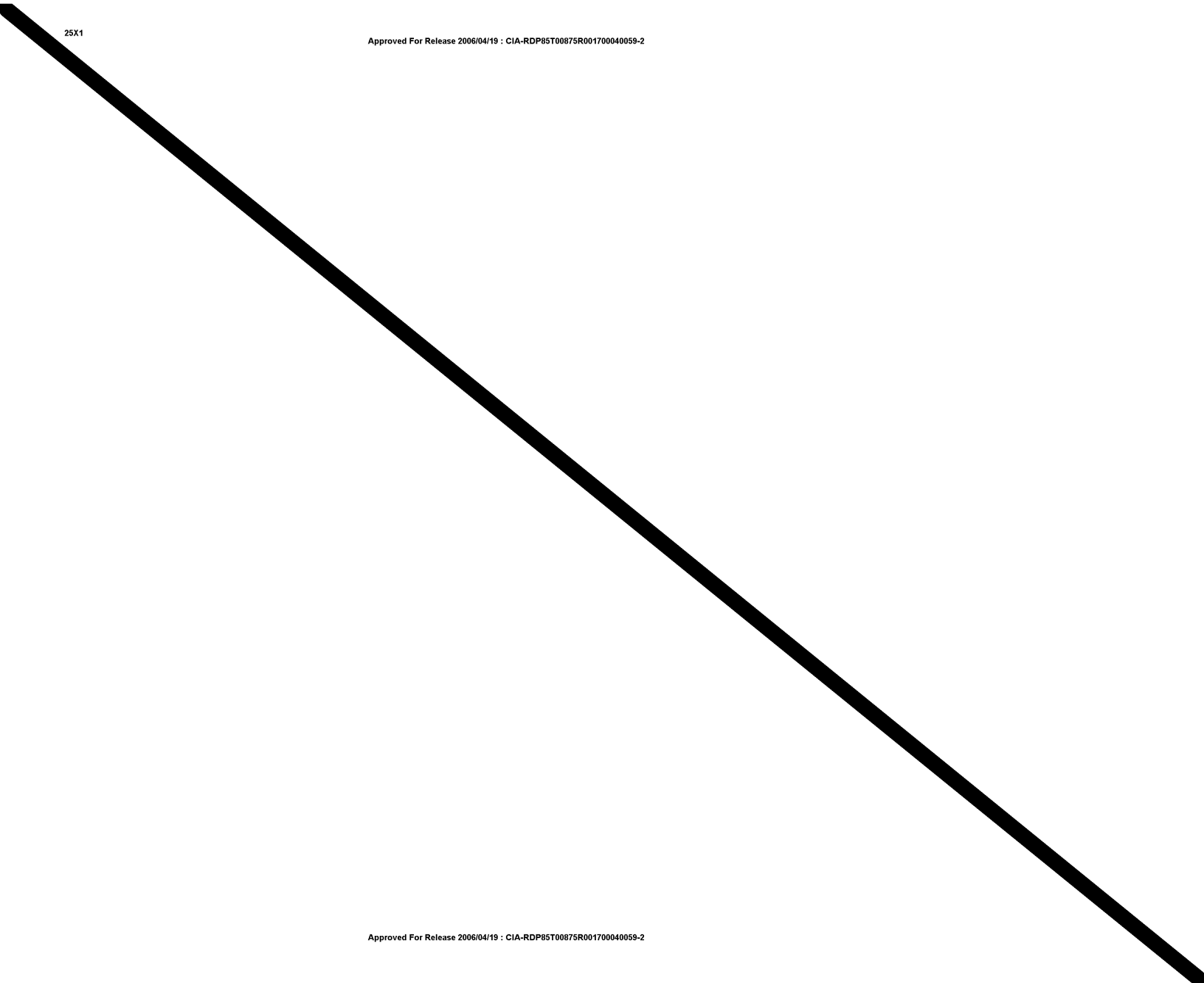

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DIRECTORATE OF
INTELLIGENCE

Intelligence Memorandum

China: Progress in Computers

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December 1972

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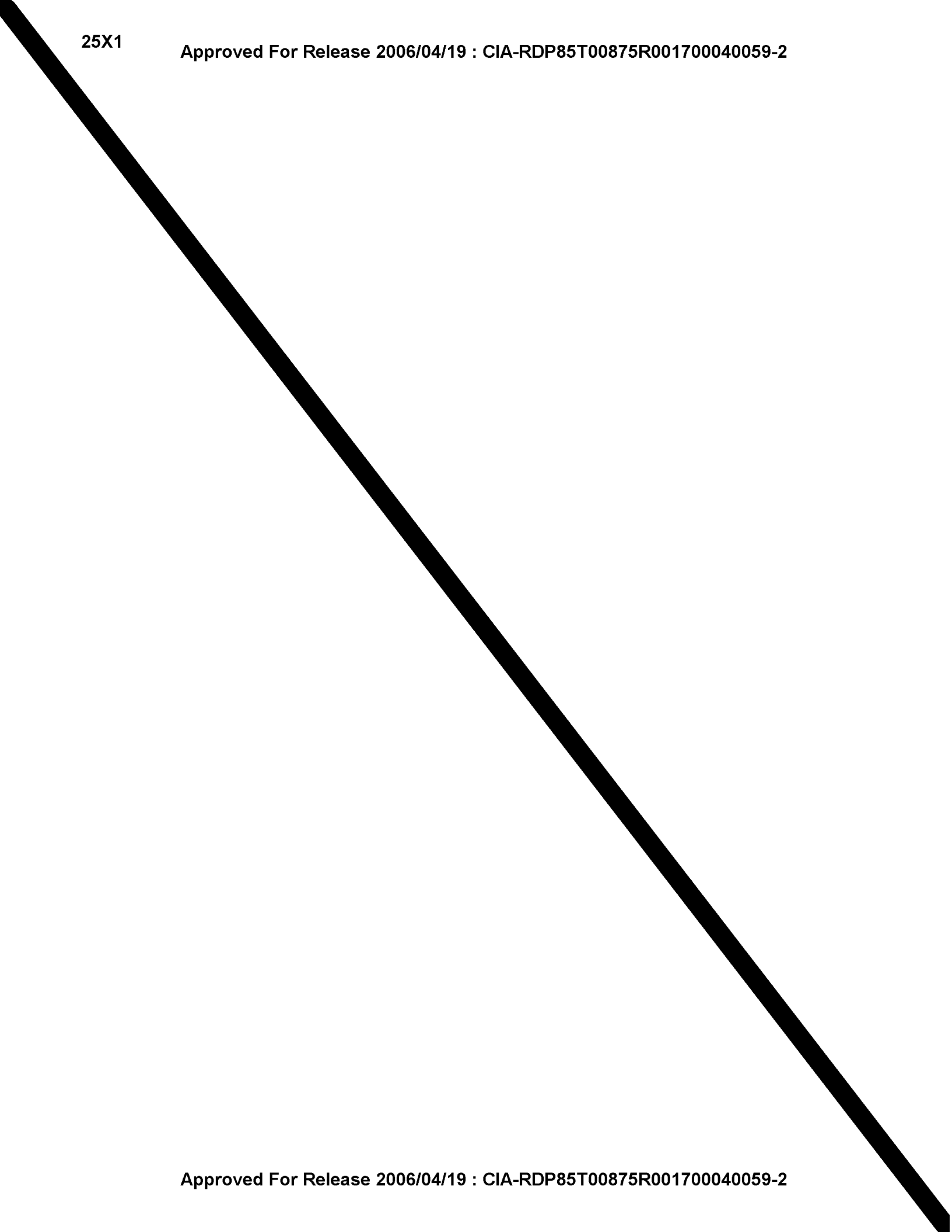

CENTRAL INTELLIGENCE AGENCY
Directorate of Intelligence
December 1972

INTELLIGENCE MEMORANDUM

CHINA: PROGRESS IN COMPUTERS

SUMMARY

1. The efforts of the People's Republic of China (PRC) to establish a computer industry have not yet led to large-scale production or widespread application of computers in the economy. Nevertheless, China has established a viable production base, trained a cadre of computer technicians, and adapted foreign computer technology to Chinese conditions of manufacture and use. Since the beginning of regular production in 1962, continual improvements have been made in the characteristics of Chinese computers, but in many respects, those in production today are only as effective as US computers of 10 years ago.

2. China's computer industry is unlikely to produce more than 70 computers in 1972. Nonetheless, the industry has made the transition from tube to semiconductor circuitry and is preparing to produce "third generation" computers using simple forms of integrated circuits (ICs). Production of third generation computers in significant numbers must await commercial scale production of the IC components, which presently are produced only on a laboratory scale.

3. Digital computers now predominate in China's output mix, although analog computers are produced for special purposes such as process control and solving mathematical problems. Output in small batches of three to six computers per batch is common throughout the industry. Manual methods of assembly prevail. The computer factories must produce for themselves most special components, such as core memories; normally other factories supply common electronics components such as silicon transistors.

4. China is in the hardware stage of computer development. Domestic computers are still programmed predominently in machine

Note: This memorandum was prepared by the Office of Economic Research and coordinated within CIA.

language. To date, little attention has been given to advanced programming languages. In the next few years, production of standardized models of computers should expand sufficiently to justify the preparation of program compilers and other systems software. Then the Chinese will be able to program in higher level languages such as FORTRAN and to build up libraries of standard programs. Some preliminary studies of FORTRAN and PL-1 (both higher level languages) are now under way.

5. The development of computers in the PRC is concentrated at research institutes under the Academy of Sciences and is focused primarily on computers for scientific and engineering applications, particularly those supporting high-priority military programs. Some effort has been given to the application of computers to industrial process control. China continues to be short of computers for high-priority purposes; therefore, the industry has given little attention to designing or producing computers for business use.

6. China apparently employs Japanese and West European computers for its few major data management tasks. These tasks will grow in importance with the increasing complexity of China's economy and ultimately will affect domestic computer design and production. Currently, China lacks the capability to produce the high-quality input-output equipment needed by data handling computers, a deficiency that will probably be corrected by importing technology from Japan, Western Europe, and the United States. Whereas Japan and Western Europe can supply computer hardware and software for most of China's needs, Peking may be interested in certain US equipment and technology at the frontier of the art, particularly rapid access memory systems and fast, reliable input-output equipment.

DISCUSSION

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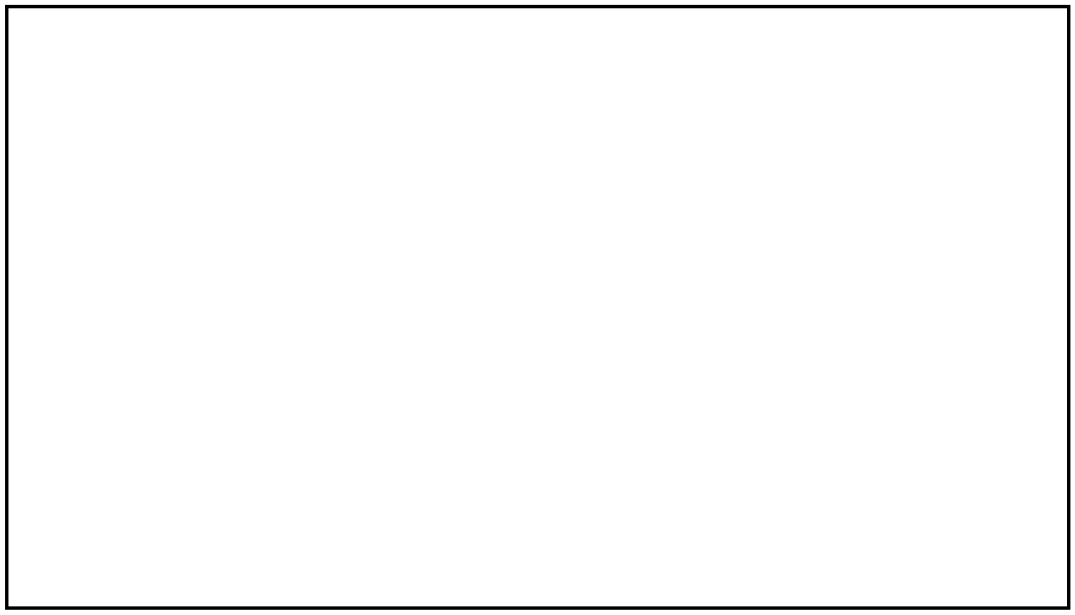

8. This memorandum evaluates the current level of output and the state of technology in China's computer industry, and it assesses the need for computers at the present stage of development of the PRC.

Production

9. China's computer industry is still in its infancy. Production in 1972 is not likely to exceed 70 units. Of these about 50 will be digital computers and the rest analog. This level of output is small compared with the production in 1971 of more than 1,000 computers in the USSR and more than 20,000 in the United States. Including imported computers, China probably has fewer than 1,000 computers in operation, compared with more than 100,000 in the United States.

10. Of the seven identified computer plants, four produce digital computers and three produce analog computers (for plant names and a brief description of Chinese computers, see the Table). Peking Wire Communications Plant No. 738 has the largest output, between 20 and 30 computers annually. These consist of models DJS-7 and D S-6, the latter being one of China's largest and fastest digital computers. The overall performance of the DJS-6 is superior to that of the IBM 1410 (first produced in 1961) but inferior to the IBM 7040 (first produced in 1963). Plant No. 738 also recently exhibited a prototype of model DJS-17, a general purpose digital computer with IC circuitry. [redacted] the plant probably is preparing to produce the DJS-17 when integrated circuits become available.

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China: Computer Production Facilities
1972

	Model	Initial Year of Production or Date Prototype Completed	Characteristics of Computer
Digital Computers			
Peking Wire Communications Plant No. 738 [a]	DJS-7	1968	Transistorized central processing unit (CPU). Performs 2,700 operations per second (OPS). Has two magnetic memory drums of 12,000 words each, punched paper tape input.
	DJS-6	1970	Transistorized CPU. Performs 100,000 OPS. Has 16,000- to 32,000-word core memory, punched paper tape input. China's most advanced computer now in production. Performance falls between IBM 1410 (1961) and IBM 7040 (1963).
	DJS-17	1972	Integrated circuits in CPU. Performs about 100,000 OPS. Prototype general purpose computer, probably intended for eventual production.
Peking Radio Plant No. 3 [a]	Unknown	1965	Transistorized CPU. Performs 6,000 OPS. Has ferrite core memory.
Shanghai Radio Plant No. 13 [a]	Unknown	1968	Transistorized CPU. Prototype general purpose computer.
	TQ-3	1972	Integrated circuits in CPU. Process control computer with 8,000-word core memory, performs about 80,000 OPS. Performance comparable to PDP-7 (1964).
	TQ-11	1972	Integrated circuits in CPU. Process control computer with 16,000-word core memory, performs about 50,000 OPS. Performance comparable to PDP-6 (1964).
Tientsin Electronic Instruments Plant [a]	441-B-1	1971	Transistorized CPU. This is a general purpose computer designed for scientific applications and process control. (Formerly, this plant produced analog computers.)

China: Computer Production Facilities
1972 (cont)

	Model	*Initial Year of Production or Date Prototype Completed*	*Characteristics of Computer*
Digital Computers (cont)			
Workshops of the Institute of Computing Techniques in Peking[b]	111	1970	Integrated circuits in CPU. Prototype general purpose computer. Performs about 180,000 OPS. Has a 32,000-word memory (to be expanded to 64,000 words, using thin film technique) and magnetic tape input. Performance similar to US PDP-10 (1967).
Workshop of the Institute of Computing Techniques in Shanghai[b]	709	1971	Integrated circuits in CPU. Prototype general purpose computer. 25X1
	Unknown	1972	Integrated circuits in CPU. Improved prototype version of model 709. [redacted] 25X1
Workshops of Tsinghua University[b]	112	1971	Transistorized CPU. Prototype general purpose computer.
Analog Computers			
Ch'ung-ch'ing Geological Instruments Plant[a]	Unknown	1971	Transistorized CPU. Designed to analyze recorded data from seismic prospecting. Reportedly this machine is on a par with similar products of advanced nations.
Peking Radio Plant No. 1[a]	DMJ-3	1966	CPU contains both transistors and vacuum tubes; 98 operational amplifiers. Two units may be connected to permit solution of differential equations up to the 40th order. Accuracy is 1.5%.
	DMJ-2	1968	Transistorized CPU. Thirty operational amplifiers. Solves differential equations up to the eighth order. China's first transistorized analog computer.
Shanghai Electric Relay Plant[a]	Unknown	Uncertain	Probably produces transistorized analog computers. (In 1966, this plant produced a vacuum tube type of analog computer with 24 operational amplifiers.)

a. Major computer plant.
b. Small factories that produce only prototype models.

11. Shanghai Radio Plant No. 13 probably produces fewer than 10 computers annually. Before 1971 the plant produced a transistorized digital computer, but it is now preparing to produce small digital process control computers, models TQ-3 and TQ-11, which contain ICs. Because ICs are not available in quantity and because the production processes are new, the plant probably cannot produce 10 computers in 1973. Tientsin Electronic Instrument Plant produces five or six general purpose digital computers annually. Peking Radio Plant No. 3 is believed to produce between five and 10 small digital computers annually.

12. Production of a small number of analog computers is divided among Peking Radio Plant No. 1, Shanghai Electric Relay Plant, and the Ch'ung-ch'ing Geological Instruments Plant. The Peking and Shanghai plants produce general purpose analog computers for the solution of scientific and engineering problems. The Ch'ung-ch'ing plant produces specialized analog computers for use with seismic prospecting equipment.

13. The workshops of design institutes also make a contribution to computer production. For example, the workshop at the Institute of Computing Techniques in Shanghai completed the prototype third generation general purpose digital computer, model 709, in 1971 and is now assembling a second improved version. Similarly, the Institute of Computing Techniques in Peking recently completed a prototype third generation general purpose digital computer, model 111. In accordance with China's educational philosophy of "learn by doing," a substantial amount of production is performed by students in university workshops. Most such production must be classified as laboratory production, but it exceeds in scope and volume the notion of laboratory production in industrialized countries.

14. Output of computers is still too small for serial production methods. The plants assemble them by hand in batches of as few as three and as many as six. Only Peking Wire Communications Plant No. 738 employs such modern techniques as machine insertion of components, automatic back panel wiring, automatic core testing, and computerized circuit testing. One of the results of low-volume production is the continual introduction of minor changes, either to circumvent parts problems or to improve the design. Consequently, minor but significant differences appear in the architecture of individual machines of the same model.

Level of Technology

15. In most respects, Chinese digital computers in current production have performance characteristics similar to those of US computers produced in the early 1960s. They are not, however, readily adaptable to multiple

access use, time sharing, or the management of large amounts of data. The hardware deficiencies responsible for the relatively low level of performance of Chinese computers are (1) low operating speeds (a maximum of 100,000 operations per second -- OPS), (2) small internal memory size (32,000 words maximum), and (3) inferior peripheral equipment.

16. Considering that China has produced computers only during the last 10 years, notable progress has been made. By 1966, computers with vacuum tube circuitry, first produced in 1962 on the basis of Soviet models, had been supplanted completely by fully transistorized models. Central processing units (CPUs) appear to employ conventional resistor-transistor logic circuits. The DJS-6, which was first produced in 1970, is the most advanced digital computer in regular production. It is capable of about 100,000 OPS and has up to 32,000 words of memory capacity. Another advanced model, the DJS-7, is a transistorized, desk-size, scientific computer that is capable of 2,700 OPS, has 24,000 words of memory capacity contained on two magnetic drums, and employs a punched paper tape input device.

17. The present conversion of Shanghai Radio Plant No. 13 to production of third generation process control computers, models TQ-3 and TQ-11, is a new benchmark in the development of China's computer industry. Both the TQ-3 and TQ-11 are small machines that incorporate simple ICs in their CPUs. The TQ-3 is capable of about 80,000 OPS and has a core memory capacity of up to 8,000 words. The TQ-11 is a somewhat larger machine with a core memory capacity of up to 16,000 words, but its speed of 50,000 OPS is slower than that of the TQ-3. US computers with similar characteristics, e.g., Digital Equipment Corporation's PDP-6 and PDP-7, were first produced in 1964.

18. The prototype third generation general purpose digital computer, model 111, developed by the Institute for Computing Techniques in Peking is China's most advanced machine. Its operating speed of 180,000 OPS and core memory of 64,000 words represent a substantial improvement over models in current production. [redacted] 25X1

[redacted] The most complex of the four different ICs used has only five transistors, but there are a total of 15,000 ICs distributed on 1,150 circuit cards of 12 different types. The employment of a large number of circuit cards of a standard design facilitates manufacture of circuit subassemblies.

19. The series production of model 111, or of a computer of comparable design, is probably several years away because the required ICs can be produced only on a laboratory scale at present. Problems of quality

control appear to be the major obstacles to production of ICs on a commercial scale. However, the number of ICs needed for current production of models TQ-3 and TQ-11 can be satisfied by laboratory scale production.

20. Internal memory in the CPUs of Chinese computers is provided by ferrite cores with internal diameters as small as 0.032 inch. These cores, which have access times as short as 2 millionths of a second, perform well in comparison with US cores which typically have internal diameters between 0.018 and 0.024 inch and access times of less and 1 millionth of a second.

21. In sharp contrast to the core memories, Chinese input-output equipment is poorly made, unreliable, and of obsolescent design. This criticism applies particularly to the mechanical drives for paper and magnetic tape, line printers, and external drum memories. The deficiencies stem primarily from the generally lagging development of the precision machine products industry. In addition to problems of quality, the variety of peripheral equipment is limited. Typically, Chinese computers are equipped only for input from paper tape and keyboard, and for output to line printer and keyboard. Input from card readers has not been observed, and neither card readers nor card punch equipment are believed to be produced in China. Currently plotters are produced for graphic output; however, a cathode ray tube which was demonstrated recently in connection with a prototype computer may be produced before long. Because of frequent failure of peripheral equipment and the low rate at which output is printed, domestically produced computers in current use cannot realize the full capabilities of their CPUs.

Programming

22. Chinese programmers customarily use machine language to program domestic digital computers. As computers come into wider use in the PRC, expecially for data handling jobs, people who are not computer experts and who have little knowledge of computer construction will be drawn into programming work. Moreover, the large computers that China is developing will be able to serve more users if they are equipped with software suitable for multiple access and time sharing. As a result, China's computers eventually will have to be fitted with compilers so that they can be programmed by large numbers of users in higher level languages, such as FORTRAN. It is not practical to try to teach large numbers of people to program computers in machine language.

23. Recently, the Chinese have been working on ALGOL-60 compilers for several computers, including the advanced prototype computer

(model 111) under development at the Institute of Computing Techniques in Peking. ALGOL-60 is a high-level computer language, designed principally for scientific and engineering applications. It is not convenient for data processing programs.

24. The Chinese are beginning to look ahead to the eventual expansion of the use of computers for data handling, as evidenced by their recent interest in FORTRAN and PL-1 programming. Both of these higher level, general purpose languages are suitable for data processing as well as mathematical problem solving. Programming specialists at the Institute of Computing Techniques in Peking are examining FORTRAN and PL-1 with a view to developing a compiler for the third generation computers under development. To justify the effort of developing compilers for new computers, the industry will have to do a better job of standardizing models and avoid the many ad hoc modifications that creep into its product, both in the producing factories and in the user's facilities.

Computer Applications

25. [redacted] 25X1
many of China's computers are at universities and research institutes. They are employed in the solution of scientific and engineering problems both for the civilian economy and for the development of weapons systems. Among the weapons systems that China has developed with the help of computers are nuclear weapons, guided missiles, fighter aircraft, jet engines, and naval vessels. Some of the civilian engineering and scientific problems on which China uses computers are the analysis of structures such as buildings, bridges, and dams; the analysis of electrical networks; and weather forecasting.

26. Industrial process control in China employs a relatively small number of computers, most of which have been imported from Japan and Western Europe for this purpose. For example, process control computers are used at the Lan-chou Oil Refinery and at the Shih-ching-shan Iron and Steel Plant.

27. China has not reported extensively on data processing applications, but has indicated that computers of both domestic and foreign origin have been used for processing census data and for economic planning and accounting. Other applications in China are believed to be central inventory control, central banking, and railroad traffic management.

Factors Affecting Applications in China

28. In its present stage of technological development, China needs hundreds of computers in its universities and technical institutes to spread understanding of computer capabilities and to foster competence in their use among scientists and technical students who up to now have had little or no contact with computers. Except for those scientists at the few institutes engaged in the development of advanced weapons or of computers themselves, most of China's scientific community is just beginning to become familiar with computers.

29. In China the collection, processing, transmission, storage, and arrayment of economic data at various administrative levels are now performed by clerks armed with abaci and desk calculators. At present, with its vast population, China could not rationally allocate computer capacity to replace this legion of clerks. However, as the economy develops, the task of collecting, analyzing, and disseminating economic data with sufficient speed and accuracy will exceed the capacity of manual methods. The successful operation of a centralized system of economic management in China will then depend on, among other things, the speeding up of data preparation by machine methods.

30. In the area of industrial process control, China has made only slow progress despite the large gains in the productivity of capital equipment that can be obtained by the use of computers. For example, process control computers can make decisions and take corrective action in processes such as smelting and rolling steel, petrochemical production, and electric power distribution that result in a greater volume and higher quality of product from a given set of production equipment. To date, most applications of process control are found in whole plants imported from the West, but as domestic computers for process control become available in larger numbers, production processes will be adapted to take advantage of these gains in productivity.

31. At present, the most urgent factor behind China's concentrated efforts to produce bigger and faster central processing units probably is the strategic weapons program. Using computers, China can save time in the development of nuclear weapons and their missile delivery systems, in the calculation of the orbits for space vehicles, and in a variety of other scientific calculations necessary for weapons development. Moreover, a system of command and control that can direct the deployment and engagement of the nascent strategic forces requires the coordination and manipulation of large data inputs -- strong stimuli for developing efficient data handling computers.

Dependence on Foreign Technology

32. In the last eight years, China has augmented domestic production by importing some 50 computers valued at about $20 million from Japan, France, West Germany, and the United Kingdom. Most of these have been medium-scale, data handling computers not yet produced in China and process control computers that have been delivered as integral parts of imported whole plants. In addition, China has imported large amounts of peripheral equipment.

33. [redacted] 25X1

25X1 By reading the foreign technical literature and studying imported computers, the Chinese have kept up with current developments in the computer field. However, they have selected for domestic production only those features of foreign computers that are adaptable to Chinese manufacturing conditions and that provide computers appropriate to current needs.

34. At present, China's greatest need for foreign technology is in the production of peripheral equipment (such as disc and drum memories, magnetic tape drives, and line printers) and of certain advanced components (such as multilayer circuit boards). Because US equipment is preeminent in these areas, China may wish to obtain some of it from the United States to copy, and may even wish to obtain technical advice or complete facilities for its production.