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Scientific and Technical
Intelligence Committee

Chinese Perceptions of Required S & T Modernization

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Chinese Perceptions of Required S & T Modernization (U)

Introduction

The People's Republic of China (PRC) S&T Working Group was established to assess prospects for the modernization of Chinese science and technology. Any such assessment, however, must be based upon a clear and comprehensive understanding of China's S&T goals and priorities. Thus, the working group's charter was limited initially to an identification of China's scientific and technological modernization requirements (as perceived by the Chinese leadership) and the issues most likely to affect the satisfaction of those requirements.

The Working Group's findings are presented in this report which consists of three sections:

- A description of China's current S&T modernization plan in terms of its principal goals and priorities,
- An outline of several issues which appear to be most critical to the success of the modernization plan, and
- A summary of the working group's key findings and conclusions.

This report is not an assessment of China's prospects for modernization. Rather, it is a basis from which to focus analytical efforts on critical aspects of China's technology modernization, its chances for success, and its likely impact upon China's economy, policy, and national defense.

In its review of the PRC's S&T planning, the Working Group availed itself of the expertise and insights of numerous government officials and intelligence analysts, as well as one academician. The personal testimony of these individuals was supplemented with finished intelligence reports produced by the various intelligence agencies on the subject of PRC modernization.

It is emphasized that the Working Group's focus was on China's S&T modernization plan, not the overall modernization program which also encompassed military, industrial, and agricultural modernization. While the latter three areas are occasionally addressed in this report, it is done only in the context of their relationship to S&T modernization.



This report was prepared by the STIC People's Republic of China (PRC) S&T Working Group. Questions regarding the content of the report may be addressed to the STIC Secretariat Members of the

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Chinese Perceptions of Required S & T Modernization (U)

Background

A. The Four Modernizations

Scientific and technical modernization is but one segment of a four-part PRC program, the so-called "Four Modernizations." In order to understand S&T modernization, it is first necessary to understand the interrelationship of the four modernization areas: agriculture, industry, national defense, and science and technology. [redacted]

Agriculture is considered China's number one modernization priority; there appears to be general consensus among the PRC leadership on this point. With 80 percent of China's population (approximately 1 billion) employed in agriculture, Chinese leaders see modernization in this sector as the principal means of acquiring capital to finance overall modernization and as the quickest means of improving the quality of life for most Chinese. Success here is the key to success of the entire plan. [redacted]

Industrial modernization is seen as contributing to China's economic and political status in the world arena as well as improving living conditions within the country. Chinese leaders have increasingly emphasized development of light industry, to include energy resources, as a principal means of capital accumulation. The products of light industry are to be geared to both domestic and foreign consumption. Exploitation of China's energy resources is critical to the acquisition of foreign exchange and to the support of heavy industry. Modernization of China's heavy industry has been made more of a long-term priority, but it is still vital to financing of the modernization program and to improving the military industrial base. [redacted]

The need for military modernization has been stressed by the Chinese in both their words and actions (for example, solicitation of foreign military technology). While an enhanced national defense could well be the priority motivating force in China's modernization, Chinese leaders have provided little insight as to their specific plans for modernization in this sector. [redacted]

S&T modernization has been labeled by Vice Premier Deng Xiaoping as the "crux of the four modernizations." The Chinese leadership see all other areas as dependent upon S&T modernization in order to upgrade agricultural, industrial, and military capability. S&T modernization, like military modernization, is dependent upon the agricultural and industrial sector to produce capital needed to purchase necessary research and test equipment, fund research activity, and educate S&T personnel. [redacted]

B. S & T Modernization Goals

China's eight-year S&T modernization plan was announced by the Minister for S&T, Fang-Yi, at the National Science Conference held in March 1978. Although there has been a good deal of discussion of the political differences and shades of emphasis that emerged at this Conference, the statement of major goals which emerged remains the most authoritative outline of China's science and technology program for the next eight years. Four broad goals were specified:

- To approach or reach advanced world levels of the 1970s in unspecified S&T areas by 1986.
- To increase the number of professional research workers to 800,000.
- To build a number of up-to-date research centers
- To complete a nationwide system of scientific and technological research [redacted]

With regard to the first goal, the Chinese perceive themselves to be 10 to 25 years behind the advanced nations in most areas of science and technology. While they plan to reach 1970 levels of Western technology in some unspecified fields by 1986, they hope to equal or surpass the West in other areas by the turn of the century. Chinese leaders have stated that they lagged 20 to 25 years behind in high energy physics, agricultural machinery, steel plants, radar technology, and most areas of telecommunications. They believe they are only 10 to 15 years behind in the areas of computers, microelectronics, and integrated circuits. Chinese leaders are particularly disturbed, however,

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that the past 10 to 12 years have seen a widening of the technology gap between the advanced nations and the PRC. []

China recognizes that an enhanced educational system is central to the realization of each of its four broad S&T goals. The PRC has made it clear that it intends to place renewed emphasis on academic excellence in its universities and technical schools and to raise the S&T expertise of students and technical workers both by sending some abroad for study and by inviting foreign experts to teach and lecture in China. Nonetheless, the goal of 800,000 researchers will also depend upon exploitation of existing talent. Thus, extensive efforts have been made to remotivate scientists discouraged from research work by the antisience policies of the late sixties and early seventies, but many scientists remain wary of this shift in policy []

While a system of nationwide research has existed for some time, over the past two years steps have been taken toward rejuvenating it as called for by Fang-Yi. Science conferences have been held in virtually all provinces and major cities to bring together provincial S&T personnel and to spur plans to develop S&T in the provinces. Lectures on scientific subjects have been given to provincial cadre to raise their scientific awareness, and the *Guangming Daily* and the *Liberation Army Daily* have both instituted science sections to popularize science. Administrative and structural reorganizations intended to improve the science system have been made in the Chinese Academy of Sciences and in universities. Personnel in these organizations have been shuffled so as to give more authority to professional scientists as opposed to political activists. Most of the professional societies have been reactivated along with their parent organization, the Chinese Science and Technology Association, which was reestablished in 1977 after a 10-year hiatus. These societies have again begun to publish their scholarly scientific journals. []

China's overall modernization program is geared toward what appears to have become an overriding national objective: transforming China into a modern, powerful, socialist country by the end of the century. Chinese officials have constantly stressed the importance of science and technology and education in attaining this objective. []

C. Priority Areas for S&T Development

As revealed through accounts of Fang-Yi's address to the 1978 National Science Conference, the eight-year S&T modernization plan provides for research in 27 separate fields and enumerates 108 key research projects. These fall within eight areas which have been designated as priority "Pace Setting" spheres of endeavor:

Agriculture
Energy
Materials
Electronics
Lasers
Space
High Energy Physics
Genetic Engineering []

Perhaps the clearest statement of these priorities was offered in mid-1978 by Zhou Peiyuan, a top Chinese spokesman in science. According to Zhou, there were three levels of priority for the PRC:

- At the top was the "production-related sector" (including agriculture, energy, and materials) to be developed first.
- The "new" science of electronics, lasers, and space was assigned second importance.
- The "basic sector" (meaning S&T development involving basic rather than applied research) was third. It includes high energy physics and genetics.

Two fundamental constraints to S&T development, limited finances and limited quantities of trained manpower and equipment, became apparent to the PRC leadership in mid-1979. At that time the Chinese scaled down some S&T projects, emphasizing those with near-term applications. []

1. **Agriculture.** PRC leaders hope to expand agricultural output by up to 4 percent. With only about two-thirds as much arable land as the United States, China must feed a population that is more than four times as large and is increasing at a rate estimated at 1.2 percent annually. Consequently, China's most persistent challenge is to expand food production at least as fast as the population growth rate without the option of a sizable increase in cultivated area. Accordingly, applied research in plant breeding and protection has received top priority in China's agricultural

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research, and the Chinese hope that these, together with new irrigation techniques and expanded use of fertilizer, will lead to self-sufficiency in food production. [redacted]

2. **Energy.** Beijing believes that the success of its economic and industrial modernization is largely dependent on its ability to provide adequate energy to run and build its industrial machine and to earn export income from energy sales abroad. Chinese investments to date have been most significant in the energy areas of fossile fuels and electric power. Emphasis is to be placed upon improved processing and utilization techniques as well as upon technologies for hydroelectric, thermal, and waterpower generation. The Chinese have shown the greatest interest in nuclear energy, but remain in an investigative phase. [redacted]

3. **Materials.** Under this objective in their plan, the Chinese lumped a wide number of S&T efforts ranging from the improvement of steel and other metallurgical processes, through the upgrading of the metals mining industry, and including the development of better capabilities in the newer materials technologies such as reinforced plasties and metal-plastic composites. Like the energy field, the improvement of China's metallurgical technology, including that of nonferrous metals, is of major importance to its economic modernization. China has considerable raw materials (for example, tungsten, copper, and so forth), but lacks the technology to extract, transport, and process them adequately, and therefore is left dependent upon foreign sources. [redacted]

4. **Electronics.** China has designed and now produces in limited quantities a wide range of communication, industrial electronic, and computer equipment using modern digital circuitry, solid-state components, and medium-scale integration of components. Such equipment, however, is inadequate in such important areas as high capacity communication systems, geophysical prospecting, precision instrumentation and test equipment, and high-speed, high-capacity computers for handling and analyzing large amounts of data. The Chinese view electronics as so critical to modernization that they have established three-year goals within this area. Special attention has been given to the solution of scientific and technical problems in the industrial production of large scale integrated circuits. [redacted]

5. **Lasers.** The Chinese have expressed great interest in laser development, and have conducted laser RDI&I for civil and military uses. In conventional, non-strategic applications of lasers (for example, surgery, surveying, and welding), the Chinese believe they are rapidly approaching a par with the West and Japan. [redacted]

6. **Space.** Although the published version of Fang Yi's report made no mention of the military significance of space science, it is clear that the Chinese view space technology as vital to their national defense as well as to the development of their natural resource potential. The Chinese have focused their space technology priorities mostly on two fields during the past year: acquiring geostationary communication satellites and improving their ability to use remote sensing data obtained from satellites. As part of their S&T modernization program the Chinese announced plans for a manned space program by 1986. [redacted]

7. **High Energy Physics.** In their science plan, the Chinese stated an intention to build a world-level program in high-energy physics (HEP), including construction of a 50-billion-electron-volt proton accelerator as a first step. PRC leaders see the development of HEP capability as symbolic of their commitment to take a serious role in helping with basic scientific research in the world, but this is one of the programs in which they indicate reduced emphasis. [redacted]

8. **Genetic Engineering.** The Chinese intention with genetic engineering, like high-energy physics, is to begin studies in a new prestigious area so that they can claim to be in a vanguard of science. China has indicated that efforts in this field, at least in their initial stages, will concentrate on areas related to agriculture (animal husbandry, crop improvements, pesticides, insect control). Also, the Chinese have mentioned the possibility of improving drugs and combating genetic diseases through medical research in this area. [redacted]

Issues

China's modernization goals are clearly ambitious, and her leaders have recognized that achievement of these goals will require significant changes in some

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longstanding policies, both domestic and international. These two factors create several key issues, the handling of which will largely determine the extent to which China's modernization goals are realized. These key issues deal generally with:

- Political consensus
- Technological acquisition
- Education and training
- Organizational management and administration.

A. Political Consensus

The success of the S&T program is inextricably linked to domestic politics and foreign policy debates. At present, a solid consensus exists among the PRC leadership on the need to modernize. It must be recognized, however, that leadership succession struggles or improved or worsened relations with one of the "superpowers" possibly could upset this consensus. In the middle 1970s, for instance, the radical-moderate struggle for power dampened efforts to begin and later to resurrect the four modernizations. While the radical-moderate struggles ended with the purging of the Gang of Four, differences of approach among the moderates still exist. With regard to this issue of political consensus, a number of questions remain:

1. Can the leadership mold and/or continue to maintain a consensus in both political and scientific circles sufficient to achieve modernization?
2. Will disagreements over pace and means become profound enough to disrupt plans significantly?
3. How would the death of a key leader such as Deng affect consensus? What is the depth of commitment to modernity?

B. Technology Transfer

Chinese leaders perceive their modernization program, and particularly S&T modernization, to be highly dependent upon the acquisition of foreign technology and expertise. They are concerned with a wide range of technology-related issues: military, industrial, scientific research equipment and materials, manufacturing plants, literature, education and training, and management know-how. This is evidenced by dramatic increases in volumes of purchases, in new orders for goods, and in stated interest in acquiring new technol-

ogy. China's extensive negotiations for acquisition of foreign technology raise serious questions concerning its ability to finance such acquisitions. The Chinese clearly perceive the means for the acquisition of foreign technology to be largely dependent upon the development of an export-led economy and the adoption of modern financial and business practices.

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STIC believes the following questions are central to the technology transfer issue:

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1. Can China assimilate the technology it acquires?

2. How far will countries go in providing China with technology?

- Might the current willingness to sell abate?
- What pressures might the USSR apply to trading partners and what will the effect be?

3. Can China afford to purchase the technology and expertise it needs?

- Can sufficient capital be generated through industrial and agriculture goods?
- Will credit ratings remain good through the mid-1980s?
- Will capital developed through exports, loans, and foreign investment be sufficient?
- Can new economic management tools such as budgeting systems, modern banking practices, and methods for capital formation be adopted that will be as effective as those of the technologically developed Western countries?

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C. Education and Training

Chinese leaders recognize that success in S&T modernization will depend upon a far greater capability to assimilate foreign technology and to spawn technological innovation than currently exists within the PRC. Serious shortages of research personnel and educators have been recognized, and China has undertaken new initiatives to upgrade the size, capability, and productivity of its indigenous S&T work force through:

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- Wider educational opportunities, both domestically and abroad,
- Better use of S&T professionals, with five-sixths of their time to be devoted to professional (vice political) work.
- Greater incentives.

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Nevertheless, STIC believes a number of key questions remain. They deal with the issue of whether domestic S&T education can be upgraded quickly enough to produce scientists and engineers of sufficient caliber and in sufficient quantity to permit effective broad-based research by the mid-1980s. Specifically,

1. When can this upgrading realistically be achieved?
2. In the near term, can foreign language capabilities be developed sufficiently to achieve an unimpeded flow of S&T information?
3. Will the system be capable of preparing - linguistically and technically - large numbers of students for overseas education?
4. Can sufficient ideological commitment be instilled in Chinese overseas students to prevent detrimental Western material influence?
5. Can the body of knowledge and experience possessed by the aged, foreign-trained cadre be replaced and expanded through domestic graduate schooling and overseas education?

D. Management and Administration

Reform in the areas of organizational management and administration, and specifically in the area of technology management, is essential to China's modernization. Recent changes have been evident in industrial organization, enterprise and factory management, quality control, wage policy, and so forth. Other initiatives to upgrade management which China has either taken, or expressed an interest in, are:

- Centralization (for example, SSTC) at top levels, and decentralization at local levels.
- Consolidation (for example, research network).
- Streamlining S&T organization (for example, CAS).
- Financing local agricultural and industrial projects through bank loans rather than government allocations.
- Adoption of foreign management methods.
- Increased enterprise autonomy and a form of profit retention

In terms of the management issue, STIC believes several questions are central:

- Can a systematic approach to management and a well-trained scientific management cadre be achieved?
- Can control of programs be centralized or will military versus civil, regional versus national, party versus professional conflicts prevent it?

Assessments and Conclusion

Any use of China's S&T plan as a baseline from which to assess prospects for Chinese success in S&T modernization must be very cautious. The difficulty is in the nature of the plan itself. First, in view of US intelligence assessments of current levels in Chinese S&T, the plan appears to have been overly ambitious from its conception. The Chinese themselves have recognized the ambitious nature of the plan by seeking foreign advice on the plan, by reevaluating many of its aspects, and finally by scaling down a number of goals and endeavors. Finally, there is also evidence that the Chinese approach to national economic (and S&T) planning has been less than thorough. Prior to the ascendancy of economist Chen Yun in the spring of 1979, the process of plan formulation appeared to rely more on the desires of national decisionmakers than upon a realistic appraisal of what might be feasible. Plans such as that for S&T modernization may well undergo several adjustments as reality tempers desires. Thus, any attempt to assess prospects for S&T modernization must consider the tenuous nature of the plan, using it only as a guide to evaluation, and must look more to the reassessments which the Chinese have made and to their handling of the issues previously identified.

A. China's Reassessment of Modernization Plans

China's overall modernization plan appears to have been formulated with some understanding of the basic obstacles to the realization of goals, but not with a full appreciation of the difficulty in overcoming these obstacles. In late 1978, China initiated a major reassessment of its overall modernization program, specifically its strategy for rapid economic growth.

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Through this reassessment, the Chinese leadership apparently has come to believe that the original modernization targets were overly ambitious and in some case ill suited to present conditions. Thus, there has been a scaling down of targets in the 10-year plan announced only last year. [redacted]

The central figure in the reevaluation was long-term economics expert Chen Yun, who was reestablished as a Politburo Standing Committee member and put in charge of revamping the entire modernization program. Chen's reevaluation has led to the cancellation or postponement of expensive noncritical projects, reviews of existing capital construction outlays, and an increasing emphasis on projects crucial to the development of agriculture and light industry. Chinese plans for nuclear power plants and a particle accelerator were some of the major items that were either postponed or canceled. [redacted]

The most dramatic impact of the reassessment has been a conscious deemphasis of investment in capital-intensive, high-technology industrial projects. Simultaneously, there has been a refocusing upon the problems of agriculture and light industry, recognizing that these are the sectors that will supply the materials and money needed for faster growth, as well as soak up the extra purchasing power of the people, who have been promised higher prices for farm goods and better wages. At the second session of the Fifth National People's Congress in June 1979, China's Finance Minister portrayed a picture of economic recovery in 1977 and significant new economic advances in 1978. He noted, however, that there were shortcomings: "When our revenue multiplied at a fast tempo, we tended to see mainly the favorable conditions, and to pay too little attention to the problems and difficulties. Additional investments in capital construction were a bit too large. Importation of new technology was a bit too hasty and the steps taken were not steady enough." [redacted]

B. Working Group Assessments

1. While S&T modernization has been identified as critical to modernization in the other areas, Chinese leaders have increasingly emphasized the priority of agricultural development over all other aspects of modernization. Agriculture offers the greatest poten-

tial for near-term creation of capital (through export of raw and processed agricultural products) for purchase of foreign technology and equipment. On the other hand, agriculture also presents China's largest potential problem should scarce resources have to be diverted from investment in other areas of modernization to feed China's population of approximately 1 billion. Thus, the rate of foreign technology acquisition will be directly and indirectly affected by the rate of agricultural modernization. [redacted]

2. As might be expected, the Chinese have not been very explicit about their technology requirements for military modernization. Nevertheless, the importance of technological advances in this area is suggested by the large number of military delegations sent abroad in the past year to study or discuss the purchase of foreign military hardware. The Chinese have actively sought the acquisition of foreign systems (military and nonmilitary) from which they might garner technology which could be adapted to their own defense needs. The Chinese undoubtedly realize that they cannot achieve military modernization through the acquisition of large numbers of foreign-made weapon systems, but must upgrade their military-product scientific and industrial base in order to design, develop, and produce their own more modern systems. The 18 percent increase in the 1979 state budget may have provided for some upgrading. [redacted]

3. Within the S&T modernization plan, a number of areas, such as a high-energy physics program, are simply not as vital to Chinese security or economic modernization as are, for example, agriculture and energy. The development of a major high-energy physics research base involving construction of a large, modern, experimental accelerator, would be extremely expensive to pursue seriously even in the advanced and affluent West. It would be especially burdensome for the Chinese to develop, even with foreign assistance, on the scale envisioned in their S&T plan. In such areas, the Chinese have tended to do a lot of talking and looking at foreign equipment and programs but have made no major commitments of funds. In this, and similar areas such as genetic engineering and perhaps lasers, monetary restraints as well as uncertainty over the proper technologies to buy or develop first, will limit the scope of Chinese endeavor. In such areas, the

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Chinese probably will tend to maintain a modest program while closely monitoring Western progress for applicability to its own needs. [redacted]

know-how. There have been dramatic increases in the volume of Chinese purchases and orders for technology. [redacted]

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4. Education has consistently been one of the most controversial policy areas for China's Maoist leadership; it will, of course, be the key area for increasing the number of research workers required to modernize China's scientific and technological base and for raising levels of expertise necessary to assimilate foreign technology. Ideological and resource constraints, however, continue to be obstacles to achievement of this particular goal. Throughout the decade following the Cultural Revolution, scientific research was scorned. Many scientists were sent to the countryside. Others chose to slip into other occupations to avoid harassment. As a consequence, although welcomed, measures to rejuvenate science in China were treated warily by many scientists who hesitated to resume their scientific activity for fear of being persecuted should there again be a reversal of policy. China's technical experts are expected to remain wary. The deemphasis of politics that accompanied the first year under China's modernization program has been qualified by the more recent admonition that ideological and political work should not be weakened because of the drive for modernization but rather strengthened because of it. Similarly, the surge for acquisition of foreign technologies has been dampened by the recent reassessment of modernization goals. There is increased emphasis upon older technologies "more suitable" to China's needs, and criticism of earlier selections of foreign technologies for import. Should there be now or in the near future a reversal of policy toward the role and prestige of scientists, the disenchantment of China's scarce trained S&T personnel will be a major setback to her prospects for S&T modernization. Similarly, if China should reject foreign, advanced technologies, the pace of her S&T modernization will be greatly retarded. [redacted]

The Chinese probably view the United States as a potential mentor in S&T development as they appear to have emphasized the acquisition of technology and advice from the United States. It is significant that the 1978 announcement of China's S&T plan was followed closely by arrangements for normalization of US-PRC relations. This normalization has paved the way for expanded educational and informational exchanges and for Chinese acquisition of US computers and satellite technology. Through such exchanges, the United States could significantly influence the pace of PRC S&T modernization. Nevertheless, the United States has been only one of a number of "advanced" nations who have recently shown a willingness to provide technology to China. [redacted]

6. Since 1977, Deng has indicated that the essential importation of advanced equipment and technology would be paid for by deferred and installment payments and, most importantly, by "exporting as much as possible," particularly items that bring a high rate of exchange, such as coal and oil. At the National Science Conference, Deng indicated that there would be no substantial technological modernization in industry and defense until the agricultural sector produces surplus harvests which would free capital for foreign nonfood purchases. Hence, one major reason for the increased emphasis on agricultural modernization. [redacted]

China has undertaken, or advocated, the following actions to promote foreign trade:

- Delegation of greater authority for provincial officials to deal directly with foreign business.
- Increased allocation for foreign exchange to local production units for the purchase of foreign equipment.
- Establishment of special factories to deal in export goods.
- Establishment of corporations to deal in import/export goods.
- Financing of imported equipment and technology with "pay back by product" arrangements with foreign suppliers. [redacted]

5. The Chinese, however, continue to view their entire modernization program, particularly S&T modernization, as largely dependent upon acquisition of foreign technology and expertise. During the past two years, PRC delegations have traveled abroad, seeking a wide range of technologies: military, scientific research equipment and materials, manufacturing plants, literature, education and training, and management

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Chinese officials have been considering a number of trade and financial agreements (previously unheard of in China) which could significantly enhance China's ability to purchase foreign technology:

- Long term credits and import financing through foreign bank deposits with Bank of China.
- Barter, compensation, and coproduction deals for plant purchases.
- Component production.
- Joint ventures such as oil exploration.
- Tourism.

7. In addition to the basic problem of transforming the economic base, accompanying social reforms designed to alleviate the problems of a dualistic society will be required to sustain the total modernization program. Among the problems considered most critical are the following:

- Education: The acceptance of a revised educational system based on merit, which inherently favors urban over rural youths and those from better educated families over those from less educated lineage. The sudden change in political climate in October 1976 has produced a renascent fever for learning. The drive in education has generated the risk that tensions may build up between the educational "haves" and "have-nots," especially those millions in the countryside, who do not get as far as the entrance exams.
- Standard of Living: The acceptance of an increased gap between urban and rural living standards resulting from the priority attached to rapid industrialization.
- Foreign Contacts: Learning to cope with an increased foreign presence (though perhaps at a lower level than envisioned in 1978), both physical and intellectual, resulting from such things as the importation of complete plants with their consignment of foreign technicians and techniques, and increased tourism as a source of revenue will also provide an increased incidence of social contact with foreigners.

8. It appears that since early 1978 China's emphasis on modernization, at least in the areas of agriculture and science and technology, has remained basically unchanged. The reassessment of its modernization goals has certainly narrowed the scope of Chinese endeavors, particularly in areas of technology transfer, yet a better understanding of what is most critical and most likely to be accomplished appears to have taken place. The importance of increased educational opportunities and of a greater role for the scientist and technical expert continues to be reflected in action. Similarly, acquisition of foreign technology, although more selective than initially envisioned, continues to be recognized by the leadership as a key issue in modernization.

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