Case Study

SATELLITE TELECOMMUNICATIONS TECHNOLOGY TRANSFER TO CHINA

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for

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INTRODUCTION - SUMMARY

Shortcomings in communications infrastructure have been
threatening the success of China's all-out drive for economic
modernization. Fortunately, China's emergence as a space power
has provided China with an opportunity to develop space
communications as an adjunct to its faltering terrestrial
communications system. Seizing the opportunity, China has been
establishing a serviceable domestic satellite communications
system including the launching, February 1986, of an operational
Chinese communications satellite. Space communications successes
have assisted economic development, bolstered national pride,
contributed to national defense, and provided highly-visible
evidence of China's technological capability.

The fact that China's satellite communications system has
been developed with very little direct foreign technological
assistance is regarded in China as a victory for self-reliance.
The hiatus in U.S. launch services has even provided an
opportunity for China to enter the international market with its
less complex launch capabilities. Despite their progress, the
Chinese are quite ready to admit to their comparative
technological backwardness; a condition which has been reaffirmed
by delegations of U.S. space technicians visiting China. There
are important areas in carrier rocket and satellite technology in
which the Chinese need and want technology transfer to narrow the
technological gap with the developed countries and to establish an
efficient and effective satellite communications. Obtaining from
abroad the developmental technologies China needs is, furthermore,
a principal objective of the Chinese leadership's "open" policy of
economic relations with the outside world, a policy which has led
to strong and growing commercial ties with Japan and the West.

China's capability to receive and absorb technology is
especially high in satellite communications which, as a result of
Beijing's comparatively generous allocation of human and material
resources, are at a relatively advanced technological level. Yet
problems affecting technology transfer remain. There is no
overall communications development plan. Program management is
weak. Funding of the program is not consistent. There is
bureaucratic infighting over appropriate technologies which causes
delay in imports of needed technologies.

Transferred technologies, even when the transfer is
controlled, carry with them the possibility of strengthening
China's military capacity. Yet current Chinese leadership
policies, which appear likely to continue for the foreseeable
future, emphasize economic development in a peaceful international
environment. At the same time, China is drastically cutting its
military forces, reducing military expenditures, and deemphasizing
military modernization. Nonetheless, China's Pacific neighbors
remain apprehensive about Western programs for the transfer to
China of "defensive" military technologies. The transfer of satellite technologies for the peaceful use of space would appear comparatively less threatening.

There is strong competition among space powers to supply China's satellite technology import requirements. The U.S., because of its longer experience and technical capability, is best qualified to be the supplier. Furthermore, a wide range of U.S. agency programs is available to support U.S. commercial activity, either directly or indirectly. Although a sale of satellites has not materialized, U.S. companies have sold ground equipment including electronics. Given China's off-stated preference for U.S. technologies, and its space communications priority, the outlook for sale of sophisticated U.S. technologies is promising. However, U.S. suppliers face the double difficulty of U.S. export licensing restrictions plus the Free World (COCOM) licensing review. Also, U.S. competitors sometimes appear to be less restrictive in licensing technology transfer, and can frequently offer lower prices and better credits. Be that as it may, the U.S. must deal with persistent Chinese perceptions of a U.S. reluctance to transfer technology.

Since the Nixon policy breakthrough in 1972, successive U.S. administrations have built a U.S. - China relationship based on the principle that a secure, independent, developing China is essential to the peace of the Pacific. Fundamental to maintenance
of the relationship is a continuing economic exchange involving trade, investment and, of course, technology transfer. Yet the exchange requires caution on our part since the U.S. and Communist China have no guarantee of continuing common interests.

In considering policy options for technology transfer to China, the U.S. has three general options. The U.S. can: tighten up on restrictions; continue the present policy of guarded response to Chinese requests; adopt a new positive program of technology transfer. If the third option is chosen, satellite telecommunications provide an ideal medium. A combination of U.S. Government and private sector activities which establish a U.S. China partnership in the development of space communications could provide political, economic and strategic benefits which appear to outweigh the risks. The Chinese have been seeking such a relationship and, if the U.S. does not respond, China may well turn to another country. The Soviets have made overtures.
A. TECHNICAL BACKGROUND

1. Chinese Satellites and Launch Capabilities

The Chinese like to say that they were the first country to put payloads into space, having invented rockets some 700 years ago. But Chinese science languished until recent years. China began development of modern space capabilities in 1958 with experiments to develop sounding rockets, first with single stage liquid fueled rockets. Later, two stage liquid and solid fueled sounding rockets were developed.

The Soviet launch of Sputnik in 1957, and space activities of several nations, made it apparent to China that a modern nation must develop the ability to operate in space. Based on their success in the sounding rocket programs, the Chinese began a space program in 1965, leading to a family of launches and a series of spacecraft which have been successfully orbited. They have launched 18 spacecraft into orbit in the last 16 years, beginning with the SKW-1 satellite launched on April 24, 1970.

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a) SATELLITES

Chinese spacecraft satellites which have been discussed publicly fall into the following categories:

1. communications satellites
2. earth resources satellites
3. meteorological satellites
4. scientific satellites
5. navigation satellites

While this study is concerned with the first category, it is worthwhile to mention the other types as a means of giving credit to the breadth of Chinese space activities.

The first satellite SKW-1, was called in Chinese "Dong Fang Hong" ("The East is Red"). This was a small (173 kg) battery-powered broadcast satellite which was able to transmit for several weeks before its batteries ran down. The SKW-1 fell from orbit in 1983 having been launched in April, 1970.

The next satellite, SKW-2, only slightly larger (221 kg), carried a scientific payload and was able to operate using solar cells and batteries for about eight years. It fell from orbit in 1979, having been launched in March, 1971.
There was a long (four year) gap before the next launch of a Chinese satellite. Some have interpreted the gap to represent a diversion of effort to the IRBM (Intermediate Range Ballistic Missile) program, which presumably enjoyed higher priority. Be that as it may, the next satellite launched July 27, 1975, was of an entirely different character. This satellite, called ERES (Earth Resource Exploration Satellite), weighed 1750 kg and fell from orbit in seven weeks.  

But it was first in a series of seven ERES satellites which have been successfully launched so far. The ERES satellite carries two cameras, one a CCD (charge coupled device) camera which transmits pictures to the ground with resolution of about 50 meter quality from an altitude of about 500 km. This camera operates in real time and can be used to direct a second camera of higher resolution (10-15 meters) which is returned to earth for processing and exploitation.

2China's early earth observation satellites fell from orbit after short periods because, in low earth orbits, they encountered friction with associated heat and drag. Low altitudes permitted good resolution photographs with unsophisticated equipment. With better equipment aboard, higher altitudes satellites could give comparable results and the satellite would have longer life.

3Apparently, the complete satellite - not just the film capsule is returned from orbit. The Chinese statements are not too clear about whether it is perhaps only the camera and film - or even merely a film package which is returned. In any case, the return of film, etc. from space demands a sophisticated control technology. The reentry body is in orbit above the atmosphere moving at five miles per second. It must be reoriented so that, when its rocket thruster is fired, it will be slowed down by an amount which will cause it to reenter relatively close to the
The camera's wavelength characteristics are suitable for exploring earth resources. It is normally flown for one week before the film is returned to earth.\(^4\)

While this satellite is listed as an earth resources satellite, it achieves good resolution (comparable to the French satellite SPOT) when flown at a nominal 500 km altitude. But since it also flies at about half that altitude, it is quite capable of producing higher quality images of 5 - 10 meter resolution which could have significant military value. As such, the system could give excellent results in revealing military order of battle information, tracking force deployment, aircraft stationed at airfields, ships in harbors, etc. These satellites are expected to be flown for several more years.

A fourth kind of satellite developed or being developed by the Chinese is a polar orbiting meteorological satellite. This satellite has been seen by a number of visiting Americans recovery forces on the ground. Before it falls into the atmosphere, it must be reoriented so that its heat shield will protect it from burning up. China claims to be the third country to master the technology. The U.S. mastered this technology and returned its first film capsule in 1960. The Chinese had 15 years of knowing in general how we did it, so perhaps it is not surprising that they mastered the technology by 1975.

(including a study team member) as it nears completion. It is quite comparable in appearance and planned operation to the RCA Block V weather satellites operated by NOAA & USAF. It should be ready for launch in 2-3 years (1988).

A fifth kind of satellite seen in some Chinese literature is a navigation satellite. There have been no launches of Chinese navigation satellites so far. A complete list of Chinese satellites launched to date together with orbital parameters and other data is found in Table I.

The two geosynchronous satellites (experimental communications satellites), which have been launched in the last two years are discussed separately below.

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7 Confirmed in oral conversation with Jing Zhaoqian at Chinese Embassy.

b) LAUNCHERS

China has developed in the last 20 years three types of rockets suitable for placing satellites in orbit. They are called Long March rockets. In Chinese, long march is "Chang Zheng," so the rockets are known as CZ-1, CZ-2, and CZ-3.9

CZ-1 is a 3-stage rocket using liquid propellant first and second stages and a solid rocket third stage. The CZ-1 was used to launch China's first two satellites in 1970 and 1971. It is capable of putting 300 kg into low earth orbit.10 An improved version is said to be under development, which will be capable of putting 400 kg into low earth orbit. China next developed the CZ-2, a 2-stage liquid propellant rocket capable of launching 2000 kg into low earth orbit. The CZ-2 was used to launch the 1750 kg ERES satellites beginning in 1975. Compared to the CZ-1 with 82 tons lift-off weight, the CZ-2 lifts off at 191 tons (metric tons). This launcher made news recently when the Swedes agreed to launch their Mailstar satellite on it.

China now has a rocket, CZ-3, which uses the first two liquid propellant stages of CZ-2 and a cryogenic upper stage (liquid


10 Ibid
oxygen, liquid hydrogen stage). China is proud to be only the third entity to achieve a cryogenic stage (after USA and ESA).

This launcher was used to launch the two communication satellites, STW-1 and STW-2 in 1984 and 1986. CZ-3 is comparable in lift-off weight to CZ-2 (actually 202 tons) and is capable of putting 1.4 tons into geosynchronous transfer orbit. (Variously reported as 1.3 or 1.4 tons.)

Further data on China's rockets is shown in several figures (attached). Figure I shows the CZ-2C/OTM with three satellites on board. In 1981, this launch vehicle CZ-2C put in parking orbit a package consisting of three satellites and the OTM (Orbital Transfer Module). As shown in Figure II, the OTM then put the three satellites in separate orbits. Launch took place at the Jiuquan Space Center in Northern China.

Figure III shows the CZ-3 launch vehicle with a communications satellite on board. Launch took place from the new Xichang Space Center in central China. (For synchronous orbit, the further toward the equator the launch site, the larger the payload for a given rocket.) In April 1984 and February 1986, the CZ-3 launched eastward, using tracking stations in China plus three tracking stations on ships placed along the satellite trajectory. In both cases, the satellite was successfully placed in GTO (geosynchronous transfer orbit) and later boosted into geosynchronous orbit by firing an apogee motor on board the
satellite. Figure III merely shows the dimensions of the payload which can be mounted on the launcher.

The Chinese have explained a few failures of their launch rockets. The loss of the CZ-2 in 1974 (its first flight), is attributed to loss of the attitude control signal. Since then, there have been eleven successes of CZ-2.\textsuperscript{11,12} Also, the first attempt to launch into geosynchronous orbit failed when in January 1984, the cryogenic stage of the CZ-3 failed to ignite for its second burn. After the trouble was diagnosed as a problem in the fuel pump, corrective action was taken, the engine retested, and two successful launches were achieved.

The record of Chinese launch successes, their desire to be recognized as a space power, their need to generate hard currency and recent U.S. launch failures, all have combined to produce the Chinese launch marketing campaign. Announced Chinese prices have varied over a fairly large range during the last several months beginning with numbers of 1/4 to 1/2 of going rates. More recently the Chinese seem to have pegged their prices at about 85\% of going rates. This seems more reasonable if one accepts the idea that pricing too low brings into question the value of what

\textsuperscript{11}The Launch Vehicles of the Peoples Republic of China," Eleventh Communication Satellite Systems Conference, AIAA.

\textsuperscript{12}Craig Conault, Av. Week, July 8, 1985, "Austere Chinese Space Program Keyed Toward Future Buildup."
is being offered. In any case, if the offers to launch are made mainly to generate hard currency, it would seem logical to charge what the traffic will bear.

The Chinese marketing team to the U.S. in April of this year, visited a number of potential customers. They also dropped in on NASA where they described their launchers, successes and failures, prices (85% of going rate), and insurance (10% of value of payload, second launch free). The marketing team was led by China Great Wall Industry Corporation, sole agency of the Ministry of Astronautics with the authority to quote price and delivery (1988 onward). Representatives of the Ministry of Astronautics and the Commission of Science, Technology and Industry for National Defense accompanied the delegation. Similar approaches have apparently been made in a number of other countries, several of which reportedly are interested -- and with Sweden having signed up and made a deposit to confirm the launch of Mailstar in 1988.

A concern expressed by several potential users is that the Chinese may intend to use launches as a back door method of

\[13\] Seth Paine in the magazine Science and Technology, April 14, 1986.


getting access to technology they could not otherwise get. The Chinese dealt with this fear adroitly. They pointed to their plan to have the satellite delivered via B-747 or C-5A to an airport with a 3500 meter runway some 50 km from the launch site at Xichang. From there, the satellite would be trucked over a good highway or go by rail to the guarded hangar for final processing and checkout before launch. Those who heard the presentation were favorably impressed.\textsuperscript{16,17}

With the U.S. record of launch success (two successes out of the last five attempts), we are not in a good position to look too critically at the Chinese launch record. Just as NASA's refusal to continue the Atlas-Centaur production gave the market to Ariane, so the failures of STS, Titan and Delta may have put the Chinese in business.

c) FUTURE SPACE LAUNCHERS

The Chinese have announced that they have begun development of a greatly upgraded launch capability which would achieve GTO payloads up to 5000 kg (versus 1499 kg today). They plan to do this using existing building blocks plus a new upper stage. For example, a CZ-2-4L would use four strap-on liquid rocket boosters;

\textsuperscript{16}China Great Wall Industry Corporation brochure

\textsuperscript{17}Report on a Chinese briefing of Comsat officials.
these boosters would use the same fuel and engines as the first stage. This combination could put 9000 kg in LEO (low earth orbit). Similarly, the CZ3-4L with stretched tanks and four strap-on boosters could put 3000 kg in GTO (geosynchronous transfer orbit), double the CZ-3 present capability. The addition of the new cryogenic upper stage would take them to the 5000 kg capability which the U.S. is presently under contract to develop but is many years from having it as a shelf item.18

d) CHINESE GEOSYNCHRONOUS COMMUNICATIONS SATELLITES

The Chinese launched STW-119 on April 8, 1984 and soon parked the 925# (400 kg) satellite at 125° East longitude. According to their announcements, this is an experimental communication satellite which is used for a few hours per day for both telecommunications and TV broadcast. Although U.S. visitors found the lack of 24-hour service puzzling, this seems entirely explainable by the stated use of the satellite.20

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18Diagram of new launch capabilities, undated, unsigned, supplied by Chinese on recent visits.

19"STW" is Shiyian Tongxin Weixing = experimental communications satellite

Not much is known of the technical details of the satellite. It measures about 1.8 meters by diameter and 2.3 meters high. Its solar cells cover essentially 90% of its cylindrical surface. Chinese solar cells are said to be about 11-12% efficient.\textsuperscript{21} The number of traveling wave tubes inside is unknown but China is known to be able to build its own TWT's,\textsuperscript{22} albeit of less than optimal efficiency. It is assumed that two transponders are on board. The horn antenna operating at C-band covers the whole earth with its footprint, thus leading to inefficiency, but the arrangement is not very different from that of the Intelsat-III satellites built by TRW in the last 60's. Intelsat III was a 335# satellite capable of handling 1500 telephone circuits.

Mr. Jing, S & T First Secretary at the Chinese Embassy, said that STW-2 could be compared to Intelsat III, although it (STW-2) was much heavier. If really comparable, then it should have four transponders. STW-2 has a narrower beam, not focused on China alone but 4-6 db improvement in power density over STW-1.\textsuperscript{23} Jing

\textsuperscript{21}Craig Covault, Aviation Week, July 8, 1985, Austere Chinese Space Program Keyed Toward Future Buildup.

\textsuperscript{22}Statement by Martin E. Packard, Varian Associates, Palo Alto, CA. Mr. Packard was a instrumental in developing Varian's technology transfers to China.

\textsuperscript{23}Aviation Week series on Chinese space technology, July 22, 1985.
said that Chinese TWT's are very expensive, heavy and not too efficient. They would not be competitive on the open market.

The first two Chinese communications satellites were launched about 20 years after the first Comsat launch. One way of measuring "lead" is the number of years between U.S. launches and comparable Chinese launches. Another is in the technical sophistication and/or efficiency of what is done. STW-1 has a horn which sprays energy over a cone in space which is larger than the earth. This allows for illuminating the earth even if the satellite does not point accurately at the earth. STW-2 has a larger antenna which generates a beam smaller than the earth but larger than China. This tends to show that the accuracy of pointing is being improved.

Similarly, the accuracy of Chinese station keeping is expected to improve. Western standards call for keeping a satellite within \( \pm 1^\circ \) of its nominal fixed location. Mr. Jing at the Chinese Embassy said they have not tried to do this on STW-1 and STW-2. But the filings made by China for Chinasat-1, -2, and -3 with the International Frequency Registration Board for satellites to be launched in 1988 and 1989 call for that accuracy.\(^{24}\) When the Early Bird satellite was launched in 1965, it was allowed to wander over about \( 20^\circ \) to avoid deterioration of

\(^{24}\) IFAB filings by China, dated 17 Dec 1985.
station-keeping thrusters. The Chinese apparently followed the same philosophy on STW-1. Jing said that the Chinese work in composite materials is important for reducing satellite weight and for low distortion under temperature cycling.

The critical elements in designing a satellite such as STW-1 or STW-2 include:

1. traveling wave tubes (TWT's)
2. batteries
3. solar cells
4. despin electronics and mechanical joints
5. thrusters for station keeping
6. earth sensors for pointing the antenna toward earth

Other less critical factors are designing for heat balance, discharging the fuel supply without displacing the center of gravity, and incorporating the right amount of redundancy to assure long satellite life in spite of component failures.

With respect to the above list, all items on the list have been in production for decades so it is not a question of some recent technology. All of these items are described in the literature of the professional/technical societies. Most of these items could be acquired by China through purchase from the West. However, China's goal -- restated many times -- is to develop an indigenous capability to produce all the components of a satellite
communications system.\textsuperscript{25} Since they have such systems in operation, they have established the fact that they can produce. They do not claim to be cost-competitive on any of these items but they have stated their intention to be so eventually. They are apparently 15-20 years behind us in satellite technology.

They recognize their limitations, and do not expect to come anywhere near to American capability in satellite communications in this century. In discussions with Mr. J'ing, we were told repeatedly that China does not expect to be a competitor to the U.S. in this field. Rather, they see themselves as partners with us, concentrating or supplying the low-tech equipment and launches.

Areas where the U.S. has had trouble in satellites similar to STW-1 and -2 include the following:

1. station keeping thrusters of inadequate life
2. freezing of despun bearings -- lubrication problems
3. buildup of static electricity and damaging discharge
4. rapid decay of solar cell efficiency (radiation damage)
5. failure of earth pointing mechanism, causing spinup of satellite antenna

\textsuperscript{25} Visit by Chinese delegation to Comsat in 1978.
6. failure of the rocket inside the satellite (the so-called apogee motor)

All of these problems have led to degraded performance or actual loss of service at one time or another. All have been overcome as the state of the art has matured. Since China has only one such satellite with any significant life in orbit, we do not know yet whether they will experience difficulties of these types. It is reasonable to assume that Chinese technicians are familiar with all these problems and have taken steps to profit from our troubles and try to minimize the likelihood of similar problems.

While China is to be congratulated for having moved into the age of satellite communications, their demonstrated capability is still rudimentary in terms of supplying their own communications needs. To augment their meager existing capacity, China like many other third-world countries, has had the use of a leased Intelsat transponder which has been used for both telecommunications and TV broadcast. On May 9, 1986, Intelsat announced that China has purchased two transponders for domestic use, one to begin service on July 1, and the second on January 1, 1987.\(^\text{26}\) China plans to use one for distribution of an educational service from Beijing to some 50 TV broadcast sites throughout the country. By year end, the number of TV stations equipped with 6-meter TV receive only

\(^{26}\) Intelsat news release, 9 May 1986. Intelsat will supply China transponders using a so-called hemi-beam of eirp of 30 dbw power level. Intelsat has also sold transponders to Israel, Norway and Germany for a kind of direct broadcast service.
antennas is expected to reach 200. The second transponder is to broadcast a news and cultural program. Because of mountainous terrain, it is said that about 1000 antennas will be needed to reach 64% of the land area.\textsuperscript{27} Complete service would require some 30,000 antennas! Although China has announced that it is now self-sufficient in TVRO antennas, the statement apparently refers to their ability to make all the components of a TVRO earth station and \textbf{not} to the statement that they could soon make 30,000 of them.

China has announced that a nation-wide communication system is necessary to "enhance political controls, national security and economic development."\textsuperscript{28} Although China had earlier decided that its population should be reached by the more conventional means -- newspapers and radio, China has now decided that TV is the most effective method.\textsuperscript{29} Accordingly, TV production has soared in the last few years, leading to a total population of about 50 million TV receivers. The attached table illustrates the buildup of production. Although the Chinese are said to prefer higher

\textsuperscript{27}China inaugurates a Satellite Television Network. Harold Jacobson, United States Information Agency, April, 1986.

\textsuperscript{28}Quoted by a controlled source from a published Chinese document.

\textsuperscript{29}Quoted by a controlled source from a published Chinese document.
quality Japanese TV sets, it is not known how many have been imported.

(The Chinese have imported more than 250,000 computers, most of them PC's, so it is likely that at least as many TV's have found their way into the country.\textsuperscript{30})

China's television system (See attachment "Table of TV Stations and Production") begins with studios in Beijing where China Central TV broadcasts to the local area and through an earth station to the satellite (either domestic lease Intelsat or eventually a Chinese satellite). There are large earth stations at the provincial level (29 provinces counting Shanghai and Beijing as provinces) to receive the central TV signal for rebroadcast. The antennas are 10-13 meter dishes. A third tier of county low-power TV stations are fed by smaller satellite dishes of about 6 meter diameter.\textsuperscript{31} All these facilities will be called into play beginning on July 1 when the newly-purchased Intelsat transponders become available to China.

\textsuperscript{30}China study on Computers for OTA, Denis Simon, 1986.

\textsuperscript{31}"China Inaugurates a Satellite Television Network", Harold Jacobson, United States Information Agency, April, 1986.
2. **China's International Satellite Connections**

In 1972, President Nixon visited China to begin the evolution of U.S.-China relations toward those of friendly non-allied nations. In order to remain in touch with the White House, Mr. Nixon called on Comsat to establish a 2-way communications link to Beijing. This was done by means of an 11-meter transportable antenna and associated equipment. A second antenna was soon added in Shanghai by RCA. As a gesture of good will, the second antenna remained in China after Mr. Nixon's departure, providing for continuous communications from China into the Intelsat network. The present whereabouts of the antenna left in China is not known, but China has bought from the West four 30 meter Standard A earth stations, two of which handle traffic through Intelsat's Pacific Ocean Region satellites, with the other two providing service through the Indian Ocean Region satellites. Two of these antennas are in Beijing, 2 in Shanghai. China's Intelsat service includes 86 circuits to the United States and a total of 525 circuits to all countries to which China has full time connections. China is also served by an undersea cable to Japan. There are a large number of circuits connecting China to Hong Kong. This is more like a domestic than an international link with about a 3000 call capacity cable connecting Hong Kong and southern China and an 1800 call capacity coax going overland to China. Cable and Wireless, the Hong Kong organization supplying interconnection to China, has gone out on bid for a fiber optic cable which would supply 12,000
additional circuits to China. This request for proposal is in line with the expected rapid buildup of traffic to China as Hong Kong prepares itself for passing under Chinese sovereignty.

While China began receiving Intelsat service in 1972, it did not become a member of Intelsat until 1978 (its interests in Intelsat being represented in the interim by Comsat). In 1982, China also joined Inmarsat, the organization supplying satellite communications service to ships at sea.

3. Elements of A Satellite Network

Although we have discussed much of China's involvement with satellites, we have not described a complete network. A communications satellite is frequently compared to a "bent pipe", the analogy being that communications signals flow like water from an earth station up to the satellite which turns the signals around and sends them back to the ground with as little loss or distortion as possible. To avoid interference between the signals going up and those going down, the satellite translates the signals coming in on one frequency band to a different band. Typically, signals are sent up in the 6 gigahertz frequency band. These frequencies are received, amplified and translated to the 4 gigahertz band for their return trip to earth. The combination of black boxes which perform all these functions is called a
transponder, meaning it includes a receiver, a translator to change the signal from 6GHz to 4GHz, and a transmitter.

A satellite can be used to establish a link between two earth stations which may be close together on the earth or thousands of miles apart. The two earth stations must be able to "see" the satellite in order to pass signals to each other through the "bent pipe". A satellite in geosynchronous orbit can see almost half the earth -- and an earth station anywhere within its field of view can also see the satellite. While there may be cases where a satellite is used to connect only two earth stations, a more typical use is to connect dozens or hundreds of earth stations through a single satellite.

Satellite links between earth stations may be symmetrical -- that is, each earth station may send and also receive traffic to and from the satellite. Or the links may be asymmetrical with some antennas sending, others only receiving -- and some doing both, all in the same network.

Satellites are used in the U.S. to distribute cable TV programs. A single earth station may transmit 20 or more programs, passing them all to one satellite which in turn might retransmit the signals to 1000 or more cable TV systems. Recently, the number of earth stations picking up cable TV programs mushroomed as many people bought backyard antennas which
are estimated to number between one million and two million antennas.

Both NBC and PBS now use satellites to distribute their signals to their affiliated broadcast stations (about 150-200 each). Users like NBC and PBS do not need to be concerned about the so-called housekeeping chores involved with the satellites they use. Typically, they lease capacity on a satellite which belongs to someone else. The capacity of the "bent pipe" is made available to them and is kept in a given location in the sky by the owner/operator of the satellite system. All the user needs to do is aim his transmitting antenna at the satellite and line up his receiving sites to point at the same satellite. His signals must be broadcast on the right frequency at the right power level; aside from staying within these limits, the user is not concerned with controlling the satellite system.

The operator of the satellite on the other hand, is concerned with the whole system. Once the satellite is placed in the proper orbital slot, the operator, using a control console, monitors the location and health of the satellite. When the satellite drifts out of the "box" in the sky in which it is normally kept (usually a box measuring 0.10 in North-South and East-West coordinates), the operator energizes small thrusters on the satellite to impart momentum in the right direction to return the satellite to the box. The operator also monitors critical voltages, currents,
temperature, etc., and may take certain actions to restore normal operation. If one transmitter on the satellite fails, for example, the operator may deactivate the transponder with the problem and turn on a backup replacement. Or he may use the same transponder, engaging a spare transmitter tube.

The operator may or may not have been involved in putting the satellite in orbit. Some operators such as Comsat have their own launch control centers (LCC). Intelsat has typically used Comsat's LCC to handle the satellite until it is placed in its final location. Comsat and other satellite operators have relied on NASA for the actual launch of the satellite. (The French Company, Ariane Space, offers launch services from their site in French Guiana near the equator.) NASA's launch involves the use of a launch control center in Florida -- they have a comparable control center in Houston -- together with a world-wide network of tracking stations which keep the launcher and satellite in view essentially continuously and communication links to get orbital data back to the control center. The control center decides when certain commands are to be sent and, using the proper tracking antenna, passes the command signals to the vehicle/spacecraft at the proper time. NASA may put the satellite in final orbit or -- in the case of Comsat launches -- may pass control of the satellite to Comsat after putting it in grosynchronous transfer orbit. The transfer orbit is a highly elliptical orbit of about a 12-hour period. Comsat normally tracks the satellite for two or
three orbits, and then fires the apogee motor on the satellite at just the right time.

If everything has been done properly, the satellite ends up in a 24-hour (geosynchronous) orbit, i.e., stationary over the equator. The only remaining step is to move it slowly into position in the "box," the desired permanent operating position in space. This is done by firing the small thrusters which can be used to nudge the satellite into position and to keep it there.

To establish a tracking network for its satellites, Intelsat makes arrangements with its member states to perform tracking services. Thus, the Intelsat network will include -- in addition to its Satellite Control Center and the Comsat Launch Control Center -- perhaps a half dozen tracking stations in such countries as the USA, Australia, Japan, Italy, and the Cameroons. These are chosen as being in locations which together can see the whole arc through which the launcher/satellite will pass while achieving the proper orbit. Private companies in the US have made various arrangements to put together a network of tracking stations and control centers for launch of their own satellites.

The system which we have described is based on joint use of several tracking networks. NASA can, of course, carry out all these functions for itself since it has satellites of its own which it must control.
4. **The Chinese Network**

China needs a complete network in order to be able to operate independently from other countries. Thus China needs a launch control center which can serve as a nerve center to do the calculations involved in determining the orbit. Orbital mechanics is a well-understood science and the actual determination of the orbit is done over a period of a few hours. Therefore, the LCC, by itself, does not have very demanding computer requirements.

For Comsat's first launch, for example, Comsat did not even own a computer. The person in charge of the launch at that time (1965) said he would have been very happy to have had a PC to use. He actually rented time on a nearby computer.

China has several tracking stations which she needs to feed location information and telemetry on the workings of the launcher and satellite back to the launch control center.

Richard Smith, NASA's director of the Kennedy Space Center, was recently in China with a U.S. group which became the first outsiders to see many of the Chinese facilities. Smith visited the new Chinese launch site at Xichang in central China where the US visitors were shown a single launch pad. (Mr. Jing at the Chinese Embassy said they were prepared to build a second pad if growth in traffic warranted it.) The US tour group also saw the
so-called range control center, a local control center which would supply data to those controlling the launch.\textsuperscript{32} There they saw a large data display room with seating for 20 or more. In the room were Chinese-built computers which they were told were used for processing data related to the launch, range safety, etc. Special attempts were made to keep everything clean. Computer disc drives, for example, were in small clean rooms inside the main control room.

The group also toured a nearby booster checkout facility. They were surprised and impressed with the cleanliness of this room. Visitors are particularly interested in such facilities because many of us who have been given tours in China were impressed by the apparent lack of clean rooms. In the facility they also saw the rocket, including the liquid oxygen-liquid hydrogen stage.

At Weinan, in northwest China, visiting US scientists were shown two control centers, one used for control of spacecraft while the satellite is being brought to its proper location in space, the other for optional control of the satellite once it is in orbit. The first center is called the satellite telemetry and control center. In addition to monitoring telemetry related to injection into orbit and controlling the maneuvers of the

\textsuperscript{32}Craig Covault, Aviation Week & Space Technology, Aug. 12, 1985.
spacecraft, this center also has a coordinating role for eight other satellite tracking stations.

The range control center at Xichang apparently controls the actual launch, with Weinan taking over orbital maneuvers of the spacecraft. Once the satellite has been placed in proper orbit and positioned near its final destination, the Weinan ground station a few miles away takes over and controls the satellite. Assuming we have interpreted the roles properly, the Xichang range control center would correspond to NASA's center at the Cape, while Weinan mission control center (Satellite Telemetry and Control Center) would correspond to Houston. The Weinan ground station corresponds to the dozen or so facilities in the US which keep track of satellites in order for NASA, Comsat, RCA, Western Union, MCI, etc. to be able to position their satellites in proper orbit.

In China, it appears that facilities such as these belong to the military. China does not have a carefully defined and isolated civil space program. The launchers are built by the Ministry of Astronautics which apparently also builds missiles for the military. Similarly, the satellites are built by the Ministry of Astronautics. Mr. Jing in the Embassy says that although both military and civil programs are handled by the MOA, there are different divisions within the ministry for each.
5. **Comparison of Chinese and American space technology**

Without access to classified material, it is difficult to compare US and Chinese technology. Inferences must be drawn on the basis of partial evidence. Evidently the Chinese have decided that they cannot be taken seriously in the world market for launches unless they begin to treat potential customers as friends and open up their hitherto closed society. Permitting Richard Smith of NASA's Kennedy Space Center to tour their launch facilities and see their launchers was a major step in this regard.

The technology of the launchers, the launch facilities themselves, the scope of activities being carried out with four or five different types of satellites indicate that the Chinese are becoming a space power in their own right. The successes they have achieved speak for themselves. Their satellites do what they were intended to do. We know that they intend to move on beyond their present level of communications satellite technology because they are negotiating -- although sporadically -- for the purchase of advanced satellites from the West. Part of their strategy is to maximize technology transfer in the process of buying whatever they eventually decide to buy.

There is a debate going on, according to the Chinese Embassy's Mr. Jing, between those officials who say China doesn't
really need to buy satellites from the West and those who say they do need to buy from outside. People from MOA and MEI (Ministry of Electronic Industry) believe that, given the resources, China can build its own satellites. Ranged against them, according to reports, are the user agencies -- MPT, Coal Ministry, Water Resources and Electric Power, and Railway Ministries who don't want to wait the five to ten years it will take for the native industries to produce sufficient capacity. But the fact that there can be a debate of such consequence speaks well for Chinese technology and for the self-confidence of their technical community.

There are many varying estimates of the lag of Chinese technology vis-a-vis US technology. The consensus seems to be that generally, in space technology, the lag is 15 years or so. The lag in space technology is also usually judged to be less severe than in many other areas. 33

6. The Role of Satellite Communications

China has stated their goal of achieving a modern communications system on a high priority basis. This was stated on many occasions, including the study team visit to the MPT (Ministry of Posts and Telecommunications) in February 1986.

To achieve the goal, the Chinese expect to combine the best properties of different technologies. They will move quickly on all fronts of communications technology. They expect to use fiber optics to wire the inner cities, microwave links to tie nearby cities together and satellites to establish trunk communications throughout the country. Satellites will also be used as a major component of their broadcast system as mentioned earlier in this report. As for capacity of their system, they begin with a highly underdeveloped communications infrastructure. There are about 200 people in China for every telephone. There are about ten times as many TV receivers as telephones. Since a good communications system is essential to economic development, they intend to work very hard to improve communications. The satellite system they have discussed buying from the West could supply about 30,000 trunks for long distance service. This would be a major step up in capacity.

The amount of capacity needed for TV broadcast depends upon whether they decide to satisfy local demands. The Intelsat transponders can supply two TV channels nationwide. Since many countries seem satisfied to supply only two or three channels to their people, the Embassy's Mr. Jing was asked if these two channels would be adequate. He said there was also a need to make channel capacity available to each province to originate and distribute by satellite its own TV programs. This means there is a need for 29 transponders for TV alone, if carried to completion. Jing also said that one province had placed an order for 800 TVRO
antennas in the West. These would be used to reach 800 towns in the province.

7. C-band vs K-band -- A Chinese choice

Much of the prolonged delay associated with the Chinese RFP (request for proposal) for DBS (direct broadcast satellites) has been related to Chinese indecision on the question of the relative merits of C-band and K-band.

C-band has been in use throughout the world for decades, both for microwave terrestrial links and for satellite links. Microwave telephone relay towers have been features of the international landscape since the '50s. Towers are located on high ground every 30 or so miles to establish broad-band links for telephone long distance service. They are also used for TV relay -- for example by a network (CBS, ABC, etc.) which wants to put the same program on the air from 100 or more TV stations nationwide. These relay links crisscross the country in various directions.

When commercial satellites came along, they were assigned the same frequency as the microwave links. To avoid interference, satellite earth stations were carefully located so that stray signals from microwave links could not be picked up by the earth
stations. Frequently, this meant locating earth stations in remote sites, preferably in a hilly or mountainous area with shielding provided by the surrounding hills.

Satellites and microwave links learned to live with each other, but it was the latecomers -- the satellites -- which had to adjust to the problems of mutual interference. And satellite earth stations typically could not be located near the source of their revenue. The traffic meant to go out over an earth station was hauled out of town 30-100 miles over microwave links and then sent out of a carefully shielded earth station.

Then K-band was opened up. K-band is roughly twice the frequency of C-band. K-band has several advantages and a few disadvantages as compared to C-band. First of all, it is a new technology. C-band systems, having been in service for years and years, have been through the learning curve cycles and so the techniques are well known, and prices for C-band equipment have fallen over the years. K-band, being relatively newer, does not enjoy the learning curve advantages, there is not as widespread a group of technicians who know how to repair the equipment, just as there is not widespread knowledge among engineers of how to design systems and components. All this is changing with time -- and in perhaps five or ten years, the advantages of C-band over K-band will have largely disappeared.
In our dealings at international meetings with third-world countries, these same questions surface. The advanced countries, led by the US, have said that there is no shortage of frequency available that there is new spectrum being opened up all the time. But the new spectrum requires knowledge of how to operate at K-band -- first, Ku-band, and eventually Ka-band. So the third world countries have frequently said that the advanced countries should move into the new frequency bands and leave the old tried and true ones to them.

C-band, then, has the advantage of familiarity for the engineers and technicians who know how to use it. It also has the advantage of freedom from weather effects. As we go toward higher frequencies, rain attenuation becomes more and more important. At C-band, rain is almost never a problem. At K-band, the next higher band, rain during heavy thunderstorms is definitely a factor. The total time of outage may be only ten or so hours per year, but for some types of service, this can be important. The way to alleviate the problem is to build a system with perhaps a figure of two safety margin, i.e., using twice the power (or antenna size) which is needed in clear weather. This of course adds to the cost of the system.

The advantages of K-band are that it is easier to form narrower beams at K-band and there is less congestion. There have been problems of siting C-band antennas in or near cities because of microwave link interference. Since microwave links have not
been approved at K-band, one can locate K-band earth stations anywhere including at downtown sites. This saves the cost of hauling traffic from downtown to remote sites. It also has security advantages in that the customer does not have to worry about the link between his place of business and the earth station being tapped by unfriendly people. Of course, the satellite link itself can be intercepted, but this can be dealt with by techniques such as bulk encryption.

The higher frequencies of K-band permit either the forming of narrower beams -- which permits the use of lower power transmitters -- or the use of smaller earth stations with all the advantages thereof. One advantage is cost. The smaller dish is cheaper to build and install. Another advantage is aesthetic. Many neighborhoods do not want giant antennas in every yard.

Also, because of congestion in the geosynchronous arc where these satellites must be located, we have gone to two degree spacing at C-band. This requires a better antenna on the transmitters' earth stations -- to prevent sending energy into a nearby satellite. It also requires accurate station keeping on the part of the satellite itself. Furthermore, because there is not yet similar congestion at K-band, satellites can be spaced farther apart.
There is finally the question of ITU approval. The International Telecommunications Union is a UN-agency which deals with frequency and geosynchronous "slots" issues. The ITU tries to maintain discipline in frequencies and slots so as to avoid interference between signals emanating from different countries. In spite of frequent conflicts and differences, ITU has done a remarkable job of resolving issues in order to reach agreement on what types of service will use what frequency bands, etc. ITU has said that C-band will be used for microwave links and for point-to-point satellite services. It has said that S-band and K-band will be used for direct broadcast service. Countries can of course use frequencies in ways not approved for general use if they confine the signals inside their borders. This has permitted China to contemplate the use of C-band for their own domestic DBS service, even though China has said that eventually they intend to move DBS service to K-band.

Actually, China's definition of DBS service is not quite what we in the US mean by the term. Here, we anticipate DBS service to the home and there are 75 million homes in the US. In China, it is assumed that DBS service may be supplied to individual villages and apartments. There is no way of going to the one or two hundred million homes in China, many of which exist at a subsistence level with no prospect of the amenities of modern life (including electricity) in the near future. This means that DBS in China is essentially more like satellite service to TV cable

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systems in the US, all of which are fed by satellite. These systems number in the thousands -- perhaps five to ten thousand. Feeding these systems by satellite is done at C-band in the US.

We have said that DBS will operate at K-band, but so far no one has deemed it financially profitable to offer this service. There is talk of such service in Japan and Europe but that has not happened yet, either.

The internal debate in China has apparently been resolved. The Chinese say they will go ahead with a C-band system which will be used for the foreseeable future, \textsuperscript{34} perhaps seven to ten years, or one satellite generation. This will allow them to employ their C-band skills in earth station design and construction. It leaves open whether they will decide to build their own C-band satellites or whether they will buy a more advanced design from the West. They were expected to make that decision in March 1986. But so far, no RFP has been issued which would make it known officially in what direction they will go.

An advantage accruing to C-band is that satellites have been built recently which use solid-state transmitters. This eliminates one source of uncertainty in satellite lifetime -- the

\textsuperscript{34}The C-band versus K-band debate within China is well known to suppliers and observers including the commercial and science officers at the US Embassy in Beijing who were interviewed by the study team. The decision for C-band was confirmed to the team by the Satellite Office Director of SSTC in Beijing and the First Secretary for Science at the PRC Embassy in Washington.
life of the TWT (traveling wave tube) transmitters. A typical satellite has 15-30 TWTs on board. While C-band TWTs have become fairly reliable, there is relatively less experience with K-band TWTs, and there is essentially no good experience on the use of high-powered K-band TWTs in orbit. Low-powered (10-20 watt) tubes have been used in K-band satellites for six to eight years, but DBS planners in this country have counted on using high-powered TWTs (100-200 watts) to permit the use of even smaller earth stations. Typical designs have centered on antennas of about two-foot diameter. While China does not intend to build earth stations by the millions, and hence would feel little pressure to go to such high-powered TWTs, the lack of experience in orbit with such high-powered tubes has been one more source of uncertainty in planning DBS systems. The reason one can think of using such high-powered tubes at K-band is that the orbital arc is relatively free of similar satellites and they can be spaced far enough apart so that interference between satellites is not a problem. This is not so at C-band.

To sum up in a few words:

Advantages of C-Band for Satellites

1. An old and proven technology.
2. Less rain attenuation.

Disadvantages of C-Band Satellites

1. Orbital congestion.
2. Interference problems from microwave towers/links.
3. Power limitations because of potential for interference.

4. Need larger antennas for a given size beam.

**Advantages of K-Band Satellites**

1. Allowed to radiate higher power.

2. Can use smaller (thus cheaper) earth stations.

3. No interference from microwave links (therefore can locate near downtown, on top of office buildings, etc.)

**Disadvantages of K-Band Satellites**

1. Technology not as well established (engineers/technicians not as well trained in it).

2. Components can be more expensive.

3. Rain can be a problem -- so system must be somewhat over-designed.
B. CHINA'S SPACE COMMUNICATIONS--PRESENT STATUS AND FUTURE GOALS

1. The telecommunications and telecommunications satellite priority

Chinese planning authorities have identified communications (with energy and transport) as one of the three major infrastructural weaknesses that imperil China's all-out drive for economic modernization. In the Seventh Five-Year Plan (1986-90) the Chinese leadership once again acknowledges the urgent need to develop communications if China is to approach its year 2000 target—quadrupled production in two decades.\textsuperscript{35}

Yang Taifang, Minister of Posts and Telecommunications, states that "telecommunications, a weak link in the national economy, will be shielded from a planned overall tightening of state investment in capital construction during the next five years . . . the state will invest about ten billion yuan [roughly

\textsuperscript{35}"The Seventh Five-Year Plan," \textit{Beijing Review} April 28, 1986. The introduction cites these three sectors for accelerated development. Premier Zhao Ziyang's report on the plan, \textit{Beijing Review} (hereafter "BJR") April 21, 1986, also groups the three sectors under "Basic Tasks of Development." Hiroshi Yoshida, \textit{JETRO China Newsletter} (61 (1985), cites telecommunications development as a major task in the Sixth FYP, and again in the Seventh FYP, alongside transportation and energy. He cites a Party Central Committee document setting forth policy suggestions for the Seventh FYP. He says this document identifies the three sectors as "areas known to be stubborn bottlenecks in Chinese efforts to develop the economy." U.S. Embassy, Beijing, September 1985. \textit{Telecommunications Sector Analysis}, says the Chinese leadership continues to consider this sector as one of the top three priorities in the modernization drive.
three billion dollars], almost double the state investment in this field in the Sixth Five-Year Plan . . . planned investment will include setting up a domestic telecommunications satellite system . . . .

Emphasizing the need to use China's space program for direct support of economic development, the Chinese Embassy Minister Counsellor for Science and Technology says that China cannot spend too much on space, when there is so much that China must do on earth. However, since satellite communications provides benefits for the whole Chinese people, he continues, then China will continue to develop it.37

And what kind of a priority does the satellite telecommunications segment enjoy within the priority communications sector as a whole?

The State Science and Technology Commission (SSTC) and the Ministry of Posts and Telecommunications both subscribe to the three-part system of telecommunications development we have mentioned -- fiber optics for short distance communication, microwave for medium distance, and satellite communications for

37Lu Jing Ting in a study team interview at the Chinese Embassy, February 7, 1986.
long distances.\textsuperscript{38} There is no suggestion of telecommunications load balancing or the need for parallel systems. In fact, there is no Chinese plan in evidence for balanced, integrated telecommunications development, although China can ill afford the continuation of a situation in which various telecommunication modes and telecommunications systems are permitted to grow without coordination.

The National Council for U.S. China Trade reported in 1984 that Chinese communications authorities have come to realize the difficulties involved in achieving a more thoroughly integrated national telecommunications system and were expected to seek foreign assistance to improve network design and planning.\textsuperscript{39} The foreign assistance will apparently be sought from the United States, and perhaps other countries. The original draft protocol\textsuperscript{40} for the promotion of U.S.-China scientific and technological cooperation in telecommunications, was specific as to this point. Under the protocol, a U.S. Government/business group would perform an economic and management analysis of China's telecommunications needs, and study the need for development of a long-range Chinese national telecommunications plan based on

\textsuperscript{38}Interviews, Wu Jiakiang, China Broadcast Satellite Corp. (CBSC), February 19, Beijing. Yun Jin, Ministry of Posts and Telecommunications (MPT), February 20, Beijing.


\textsuperscript{40}The protocol, finally signed in May 1986, is discussed further in D. INTERNATIONAL COMPETITION 2.c. U.S. Agency Support.
China's telecommunications requirements. 41 Although Beijing says it still needs this study, it was omitted from the final protocol in favor of a more general statement of the U.S. Delegation's purpose. The omission is not surprising in view of its open acknowledgement of Beijing's communications planning difficulties.

When the U.S. group conducts the study, they will find that China's telecommunications planning is complicated by the existence of several separately controlled and administered telecommunications networks. Ministry of Posts and Telecommunications (MPT) officials ruefully admit that the separate networks of the ministries of coal, petroleum, rail, electric power and national defense, all came about as a result of the MPT's failure to provide for basic communications needs. 42

The U.S. Group will also be likely to find a good deal of enthusiasm among Chinese planners and public alike for rapid expansion of space communications. The enthusiasm will not be fully shared by the MPT whose officials are concerned that concentration on satellite capabilities will lead to down-grading of the requirement for further expansion of the existing microwave

41 Draft protocol.
42 Interview. Yun Jin, Deputy Director, Department of Science and Technology, MPT, February 20, 1986, Beijing.
system which, unlike the satellite system, is fully under MPT control.

Despite the lack of any official prioritizing as among telecommunications systems, satellite communications are likely to have a strong claim on use of limited communications development funds. For one thing, satellite communications are on the cutting edge of new telecommunications technologies. Highly visible successful satellite launches are evidence of China's technological progress which can be displayed before China and the world. A satellite launch, even an experimental launch, boosts national esteem and adds domestic constituents for priority development of this mode of telecommunications. It is furthermore, palpable evidence of achievement in the third (science and technology) of the "four modernizations" which underlie China's drive for development. It is evidence to which the current Chinese leadership can gratefully point with pride.

After the launching of China's first communications satellite, ST-1, in 1984, the Beijing Review trumpeted: "Everybody where the Chinese people are reported overjoyed with the successful launching...It will greatly inspire people throughout

\[43\text{Ibid.}\]
the country to strive for new victories in socialist construction. 44

Another reason for an unofficial satellite communications development priority is the central role satellite transmission plays in the rapid development of China's national television. Not surprisingly, three-fourths of the Intelsat satellite capacity leased by China is devoted to television. 45

Bad as China's telephone system is, and it is very bad, the Chinese public undoubtedly gains much more psychic satisfaction from good satellite TV reception than it could gain from improved telephone service via microwave or fiber optics. This is especially true of that large part of the Chinese public which never had, in the past, either TV or telephone, but now has access to TV and would find it difficult to live without it.

The propaganda possibilities of the countrywide spread of satellite TV is not lost on a government which needs to retain control over popular attitudes. In Part A we noted official acknowledgement of nation-wide communications as necessary to

44BJR, May 7, 1984. The Chinese press gave wide coverage to the visit to China in June 1985 of U.S. (Shanghai-born) astronaut Taylor Wang, shortly after his participation in the Challenger-17 mission. In China, astronaut Wang declared: "Chinese scientists have worked hard...and have now constructed the whole comprehensive system for space scientific research and development on their own. It is amazing." China Daily 7/10/85.

45Intelsat statistic.
enhance political controls and national security. Judicious use of TV programming will help the government condition the impact of the outside world on the Chinese public. Americans are aware of the public opinion forming influence of skillfully-edited TV programming. 46

Satellite television in China is not only a powerful tool of entertainment and controlled information, for many Chinese officials its paramount importance is its contribution to public education. 47 Speaking to an international television symposium in Montreux in 1985, the President of the China Broadcasting Satellite Corporation pointed out that the foundation of the success of the "four modernizations lies in the popularization of education and in the raising of the scientific and cultural level of the whole nation." He noted that in 1984 alone there were over a million (mostly higher education) students in the Central Radio and TV University, and that in 1987 the higher education students reached by this medium would more than double those in the regular universities. He also noted that 2.4 million "unqualified" teachers had been reached by TV, and declared that "to cover China's vast territory of 9.6 million square kilometers (70% _______

46 At the same time, the spread of TV can put government control at risk, by opening backward and previously closed-off sections of China to a variety of impressions of the outside world.

47 One of the two transponders China has contracted to buy from Intelsat will be devoted exclusively to educational broadcasting.

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mountainous) with high quality TV and radio programs, the introduction of satellite is the only solution." The CBSC president went on to say that "to use satellite for the realization of national radio and TV coverage for education and recreation will have invaluable social, cultural and economic effect in China." Arriving at a similar conclusion, the World Bank has loaned $50 million to the China Television University project.

2. **China's satellite communications goals**

Although China has, as yet, no comprehensive communications development plan, it seems clear from the foregoing that satellite communications development will play a pivotal role in the evolution of China's communications system. A generally accepted goal for the system is a comprehensive, good quality, national


50 Minister of Defense, Zhang Aiping, has observed that China's satellite system is an instrument of neighborliness because "it will provide coverage, not only for all of China, but also for some friendly neighboring countries and regions. This will establish the groundwork for establishing satellite communications linkups between China and these countries and regions. Beijing Review, April 8, 1986.
radio and TV network by the year 2000. In subscribing to this goal, CBSC President Xu, at the Montreux conferences conceded that China has a long way to go because, by 1984, the TV network only covered an area inhabited by 64.7% of China's population, and the technical quality of relay broadcasts was often poor.

China's communications satellite development goals relate directly to development of China's space program of which it is a part. China's space officials maintain that China has now emerged from a prolonged initial experimental period to a new period of space technology applications. As indicated in the preceding technical background, China is proceeding with development of carrier rockets which will provide increased satellite lift. By 1990 China expects to have a carrier which will lift a synchronous satellite weighing up to two metric tons. The power of this next generation of rockets would thus be equivalent to the Saturn

51 U.S. Embassy 1985 "Telecommunication Sector Analysis."

52 Xu Zhongming, "Planned Broadcasting Satellite System in China," International Television Symposium, Montreux, June, 1985. The Chinese debate over the merits of C-band versus K-band must have been going on at that time, so it is worth noting that in this speech Xu goes on to compare the technical qualities of C-band versus K-band and concludes that K-band is more suitable for China. The study team was told, on good authority, that C-band had been found more suitable after all. Comrade Xu has since been removed as CBSC president.


54 Ibid.
I class used by the U.S. twenty years ago.\textsuperscript{55} Looking even farther ahead, China's space officials have stated that the next objective is the launching of reusable vehicles and a space station.\textsuperscript{56} The developing communications satellite program will be carried forward as part of the broad expansion of the space program.

Many related parts of the program are reportedly moving ahead. Satellite development and test centers are adding substantial new facilities to upgrade Chinese capability in design of operational space systems and in the preflight checkout of spacecraft. A large new solar simulation laboratory in Beijing will help improve altitude control, a Chinese weakness. At Weinan, the mission control center is undergoing a complete renovation, together with the installation of a new computer center which will bring the facility in line with the technology of the 1980s.\textsuperscript{57}

The next communications satellite designed and built in China, China's third, is to be ready in 1987. U.S. technicians, who have visited the Chinese facility building the satellite, describe it as an improved version with a split beam antenna and complete microwave capability.

\textsuperscript{55}Craig Couvalt, AWST, July 22, 1985.

\textsuperscript{56}AWST, July 8, 1985.

\textsuperscript{57}"Test Centers Near Beijing Expanding," AWST, 7/15/85.
At this point, it would be guess work to suggest the inter-relationship, within China's future network, of imported satellites to Chinese satellites, and to satellite capacity rented or purchased from Intelsat. As we indicated above, the Chinese Embassy's first Secretary, Jing Zhaopian, maintains that, as more satellite capacity becomes available, the individual provinces and Beijing and Shanghai will each want to program their own satellite transponders. So the network will be both extensive and intensive. Chinese officials continue to say they intend to import some advanced satellites together with the technology to build them. Besides the satellites themselves, there are many other kinds of communications satellite technology which China will need to import as the network grows.

3. **China's need for satellite communications technology transfer**

The United States has been fortunate in having five delegations of highly-qualified individuals visit China's space installations and production facilities in recent years. Findings of these delegations have been reported.

The delegations, widely separated in time, were: 1979 - American Institute of Aeronautics and Astronautics (AIAA), NASA; 1985 - AIAA, NASA, People to People. Although the Americans were

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58 Study Team interview, May 12, 1986.
not able to see a number of things they wanted to see, they did come away duly impressed with China's technological advances. They also acquired some ideas as to China's need for technology imports to support an up-to-date program of carrier rocket and satellite development.

In a 1980 China Space Report, an early AIAA technical assessment, expressing admiration for what the Chinese were doing on their own, said: "In many cases our preconceived notions proved misleading. We were, in fact, surprised at the advanced state of development in several technological areas based on work conducted in China in the last two or three years. In areas such as in the development of microwave solid state devices and techniques, the research appeared to be advancing at a pace with that in the U.S. Certainly any sweeping observation that China's aerospace technology is 'n' years behind the U.S. must be made with care. In truth 'n' is anything from zero to ten or fifteen years. It might even be negative in a few areas."

The 1980 AIAA impression was updated in 1985 by Craig Couvatt, Aviation Week and Space Technology's senior space editor, who returned from a People to People delegation to write: "Using rudimentary techniques and with almost no outside help, the Chinese have demonstrated all the capabilities necessary to

conduct a space effort important to national prestige, defense and their economy.\textsuperscript{60}

The U.S. delegations found, however, that China's basic "self-reliant" development, which owes much to ingesting technologies available in free world technical data, left a number of areas where materials and systems needed upgrading.

The Chinese told the members of the 1985 People to People delegations they need help\textsuperscript{61} with:

- injectors
- acoustic resonators
- satellite tape recorders
- gyro systems
- digital computers

The delegation members described weakness in the following:

- high temperature metal coating to prevent oxidation
- rocket propulsion technology
- low noise amplifiers

\textsuperscript{60}Craig Couvalt, "Contrasts Across China," AWST, July-August, 1984.

\textsuperscript{61}Derived from series on the People to People delegation appearing in \textit{AWST}, July-August, 1985.
Problems observed in technical approach included:

- insufficient redundancy
- no routine use of dual seals in rocket motors\textsuperscript{62}
- insufficient testing to insure engine combustion stability
- use of statistical analysis to form the basis of operating principles
- poor arrangement of production facilities

In addition, the following\textsuperscript{63} were included in a Chinese shopping list for a Beijing trade show planned for early 1986:

- space positioning equipment
- tracking radar, telescopes and laser rangefinders
- cadcam equipment
- electronic network analysis equipment
- oscilloscopes, electric current meters & recorders
- x-ray stress analyzers
- laser interferometers
- ultrasonic detectors

These lists, based on limited contact and observation, are only an outward indication of the type of transfers required to update a technology which is, on the whole, ten to fifteen years

\textsuperscript{62} The observation about seals was made by a U.S. group before the Challenger disaster.

behind that of the advanced nations.\textsuperscript{64} Although he found "isolated pockets" of up-to-date technology, NASA's Chief Engineer, Dr. Milton Silvera agreed that the Chinese program as a whole was quite backward. Recounting his 1985 visit, he said that "the few payloads we saw were so basic and crude that it was difficult to establish they were flight hardware.\textsuperscript{65} The American observer groups were agreed that China's modernization needs extend beyond payload to the whole gamut of launch, tracking and control.

Backward as it is, China could, in fact, go on gradually building a satellite communications system using heavy, relatively inefficient and short-lived satellites. Through fee world technology stored in accessible data banks and open technical literature, or by covert sourcing through the Hong Kong back door,\textsuperscript{66} China could continue to make limited technological advances in the future, in the same way that it has in the past. Yet second-hand technology transfers would only tend to perpetuate technological lag. Without transfers of state-of-the-art

\textsuperscript{64} The U.S. observers found Chinese laboratory equipment to be generally 25-30 years behind.

\textsuperscript{65} 1985 report on People to People Mission to China.

\textsuperscript{66} See Bradley Hahn, "China in Space," BJR July-August, 1981, for comments on China's technology sourcing. Another source were the overseas Chinese technicians who returned to China to use their foreign training in the space program. Their expertise is not now so fresh as to be important to further program development. Chinese students currently in the U.S., and presumably in other countries, do not have wide technology access.
technology from developed countries, China would not be making the technological leaps she needs to make if she is to narrow the technological gap which keeps China behind the advanced countries. But China has already made a large resource investment to produce a satellite acclaimed as proof that China has the capability to move into advanced technologies. And China is offering to provide competitive space services on the international market. So it seems unlikely that China would avoid the import of modernizing satellite technology, and settle instead for continuance of technical inferiority in space communications.

Dr. Silvera's 1985 report substantiates this view when it concludes that China's space industry, no longer in its infancy, has to look outside for technology that will help it maintain its momentum. "Having reached the conclusion that they cannot advance much further by themselves, they are eager to learn from those nations that have well-developed space programs... The Chinese are extremely anxious to initiate a technology transfer with the U.S."

The central focus for China's near-term communications satellite technology transfer has been, and still is, the proposed acquisition of several imported satellites valued up to $200 million. China's apparent need for the satellites, and China's search for the appropriate supplier, goes back to the late 1970s.
In 1980, the purchase decision was postponed for the first time.\textsuperscript{67} By 1984, Chinese authorities had apparently decided on a high-tech, Ku-band direct broadcast satellite. Comsat was employed as a technical consultant and an RFP issued.\textsuperscript{68} After proposals had already been received, the Chinese authorities apparently began to question their own decision on the appropriateness of the Ku-band satellite. The RFP was suspended.\textsuperscript{69}

For a time after the RFP was suspended, the Chinese discussed with the U.S. Trade and Development Program the possibility of a $200,000 feasibility study on the use of satellites in China.\textsuperscript{70} As indicated below, however, the study team was informed in Beijing that since the Chinese have made up their collective minds for C-band, and since a new RFP is to be issued soon, there would be no need for the TDP study.

The controversy stirred up by China's prolonged indecision on satellite imports is important because it goes to the very heart of issues such as China's capability to select appropriate

\textsuperscript{67}Karen Berney, "Communications Satellite Program -- An Aborted Launch", CBR, March-April, 1981.


\textsuperscript{69}AFP from Hong Kong in \textit{Asian Wall Street Journal}, July 15, 1985.

\textsuperscript{70}OTA interview with RCA, November 7, 1985,
technologies, and China's relations with foreign technology suppliers—issues which will be discussed in more detail in the following sections of the study.

5. China as a Competitor

a) Selling launch services

China's entry into the world market for space products was covered by an announcement in the China Daily on June 13, 1985, many months before the Challenger disaster. The sweeping offering of the Ministry of Astronautics covered design and manufacture of satellites and carrier rockets, launching of satellites with Chinese carrier rockets, establishing of joint space engineering companies and construction of ground stations.

The Chinese sales campaign was stepped up by Astronautics Minister Li Yue in October, 1985, after the seventh successful launch of an experimental satellite on the Long March 2. Describing China's technologies as "mature", the minister offered launching services and launch insurance at "preferential prices" together with initial stage backup service, including orbital control. Putting the best possible face on the commercial proposition, Minister Li said China's action "will give impetus to

71 China Daily, June 13, 1985

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international economic cooperation and international cooperation in the field of aerospace technology, and duly contribute to upholding world peace and to benefiting mankind.\textsuperscript{72}

A subsequent PRC announcement explained that China's ability to offer low-price services was not the result of government subsidies. Cut rates were possible it was said, because of the "low cost of materials and manpower in China."\textsuperscript{73} Launch insurance coverage provided by the China People's Insurance Company at 22\% of the launching cost is also cheap as against the 38\% offered by United States insurance companies.\textsuperscript{74}

Initially, the Chinese entry into the market drew cautious comment. A NASA official who learned about the Chinese intentions during a visit to China in early 1985, declared: "They have a way to go to be able to truly launch commercial satellites. But, in a couple of years, I assume it will be possible."\textsuperscript{75} After the Chinese announcement, the Far Eastern Economic Review found that: "Observers describe China as having a modest capacity which would

\textsuperscript{72} China's News Service in Chinese, October 26, 1985 (HK260920)

\textsuperscript{73} Discover, New York, 1985

\textsuperscript{74} Wall Street Journal, May 15, 1985

\textsuperscript{75} John Conway, MIS Week, NY, March 31, 1985

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at present limit payloads mainly to launching scientific or remote sensing satellites." Aviation Week suggested that there would be: "Minimal interest in the development of geosynchronous payloads small enough for Chinese launch capability. There is a more solid market for carrier low-orbit commercial payloads".77

On February 7, 1986, the Chinese were able to announce that they had their first potential customer. The Swedish postal service had made a launch reservation on the LM-3 for a small satellite to carry their Mailstar electronic mail system. The launch could take place two and one-half years after final agreement.78

Subsequent to the January 28 Challenger disaster, the China Great Wall Industry Corporation (sales agent for space equipment and services) on their April visit to the U.S., explained that they did not wish to exploit the U.S. accident, and did not plan to become significant competitors. China was, they explained further, simply interested in providing alternative facilities in the light of reduced U.S. launch capacity.

76 Far Eastern Economic Review, January 1986, page 56

77 AWST, May 5, 1986.

78 Ibid.
The Great Wall group called on, among others, Comsat, Western Union and American Satellite Corporation. The others included Teresat Inc. in Houston. In May, the U.S. press picked up on a Chinese announcement of the signing of a letter of intent with the Teresat group for the launching of two "rescued" communications satellites which a 1984 shuttle mission pulled out of failed orbits in space. The letter of intent was later followed by a launch reservation for Autumn 1987.

The official Chinese announcement of the Teresat business possibility was a little premature and doubtless impelled by their desire to establish credibility. Teresat is in the process of obtaining financing for the purchase of the satellites from Lloyd's of London. Meanwhile, the American company is talking to possible customers about possible services. The Chinese will only handle launch insurance, so the rest of the insurance package must be arranged. If and when Teresat buys the satellites (there are other U.S. companies interested in them), their export to China will still have to be approved by the U.S. Government.

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79 AWST, May 5, 1986

80 AWST, 6/25/86

81 The Office of Munitions Control will not prejudge applications, but they informed the study team that the application could be handled in routine fashion.
Teresat's previous business experience relates principally to the international televising of heavyweight boxing fights.\textsuperscript{82}

Discussing China's long range marketing program, the Chinese Embassy's First secretary for Science and Technology foresees a growing number of possibilities, including custom production for customers abroad. He says: "The first step is to provide launch services to foreign countries... The second step is to provide telemetry and tracking services.... The third step is to design and produce spacecraft for foreign countries."\textsuperscript{83}

To lend substance to its marketing activities, China found it necessary to go public with hitherto unpublished details of rocket capabilities and launch failures. As early as April, 1985, Chinese officials attending an Italian space symposium brought along documents containing details of the Long March family of launch vehicles. According to European industry officials, this provided the first detailed look at Chinese launch capability.\textsuperscript{84} Then, in October 1985, at an International Astronautical Federation Conference in Stockholm, the Chinese provided

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\textsuperscript{82}Wall Street Journal, May 15, 1986

\textsuperscript{83}Jing Zhaoqian, "China's Developing Space Program", Signal, February, 1986

\textsuperscript{84}"China's Offering Space Launch Services", AWST, April 8, 1985
information on their investigation and analysis of two principal launch failures. The Chinese description of their failure analysis and design fixes served to enhance China's technological credibility.

As the Chinese see it, it was "sheer coincidence" that China came onto the satellite launch market with a rugged, unsophisticated, and apparently reliable booster at a time when more complex systems have been grounded, and there was a growing backlog of payloads looking for launch. Although China does not itself have a long and convincing history of successful launches, the hardware and technology that China employs is similar to those of an earlier technical generation that does have such a history. It is reported (Washington Post, July 14, 1986), for instance, that the U.S. Air Force has reclaimed, and will launch, a communications satellite from the 60's that has been hanging in the Air & Space museum for 15 years. For a launch vehicle, Air Force technicians will reach back into the inventory and refurbish a reliable Scout rocket of the same vintage as the satellite. (The Scout will be reconditioned with flight-qualified second hand


\[86\] "Sheer coincidence" are the words used by Wu Keli, Deputy General Manager and Senior Engineer of Great Wall Industries Corp. (the space marketing agency) in refutation of "Western press accusations" that China was taking advantage of U.S. and French failures. The Chinese are very sensitive on this point. (Beijing Review, June 16, 1968)
parts and total savings are estimated at $10 million). Air Force reliance on 20-year-old technology makes China's suggested space communications partnership with the U.S. seem less like an association of technical unequals. It does not mean, however, that China can stay in the market by continuing to rely on older technologies.

Commercialization of Chinese launch services gives China a chance to capitalize on a hard-won technology. And space is big business. The European launch vehicle, Ariane, earned $20 million for its owners on a turnover of $203 million in 1985. Earnings are expected to double in 1986. There are 30 launch contracts in hand for Ariane through 1988 with a value of $1.23 billion.\(^{87}\) The crowded Ariane launch schedule calls for seven to eight launches a year. The Chinese maintain that they can handle up to 12 launches a year.\(^{88}\) But if they could achieve this rate, and had reason for it, they would probably have to redirect production facilities now devoted to producing rockets for the Chinese military.

Beijing gives every indication of wanting to get into the market in a big way. The Vice Minister of Astronautics, Sun Jaidong, was being somewhat disingenuous when, in describing

\(^{87}\)Aviation and Space, Smithsonian, June-July 1986

\(^{88}\)"Long march into space," Far Eastern Economic Review, 6/19/86
China's willingness to help out in the launch shortage crisis, he says: "I'm sure the U.S. Government will give us full support since we are working for the benefit of all mankind." Getting down to business, he said: "For customers who are concerned about the risk (of their technology being copied during a Chinese launch), they can bring in their own people and supervise closely the entire launching. We can even build special warehouses for their satellites (to insure total secrecy)." China, the vice minister, added, will also go abroad to launch.\textsuperscript{89}

Acknowledging that China's current restriction to only light lifts eliminates a large part of the potential payload market, the Chinese told NASA in April, 1986, that they had begun definition of a Saturn-class heavy booster. The new booster, probably an improved CZ-3, would be capable of lifting up to 5000 kg into transfer orbit. It would be ready in the early 1990's.\textsuperscript{90}

The addition of commercialization has strengthened China's commitment to continue technological development of the space program. It has increased the need for technology transfer to keep China in the market. In forcing China's space program out into the open, it has fulfilled a precondition for successful technology transfer. By making China more eligible, it has opened

\textsuperscript{89Ibid.}

\textsuperscript{90NASA memcon 4/15/86}
new possibilities for partnership with technologically advanced foreigners.

b) Technology transfers to a potential Chinese competitor.

China's leap forward in space communications provide another dimension to the standard question about the U.S. assisting the technical development of yet another potential Asian competitor. U.S. suppliers and Chinese officials gave the study team the same general reaction to the suggestion of Chinese competition. It was, in effect, that China is so far behind technology that technology transfer, in technologically advanced areas like satellite communications, presents no foreseeable competitive threat to the market position of the advanced nations. An imported technology, as against an indigenous technology, takes much longer to master. By the time the imported technology has been adapted to Chinese conditions, the foreign supplier has moved on to other more advanced technologies.

The above argument has advocates among interviewees in principal U.S. companies concerned including Ford Aerospace, Rockwell International, General Electric and RCA. There were no dissenters. A relaxed attitude concerning possible Chinese competition in the space communications area also prevailed in
interviews with U.S. Government agencies including DOD, State, Commerce, NASA and NSC. No one, for instance, contended that cheap Chinese labor might be used to China's competitive advantage in this high tech area. Some felt that problems of economic organization, and bureaucratic encumbrances, as much as technical backwardness, would retard Chinese development and blunt the threat of Chinese competition.

As the Chinese Embassy in Washington, the study team was told by Lu Jing Tin, the Minister Counsellor for Science and Technology: "Don't worry about us. We will never catch up with you. The U.S. and China should be partners in the development of space communications."

Downgrading the possibility of Chinese competition, Richard Abington, the President of G.E. China Company, Ltd., suggested the need for U.S.-Chinese cooperation. In a Hong Kong interview with the study team he said: "Telecommunications satellites is one area where we can work with the Chinese without having to worry about their working against us. We ought to have a program of set technology transfers to China at preset intervals."
C. FACTORS AFFECTING TECHNOLOGY SELECTION, TRANSFER AND ABSORPTION

1. China's "open" policy and technology transfer.

"Open wider to the outside world and link the development of the domestic economy better with expanded economic and technological exchange with other countries."\(^91\)

"China will expend all the foreign exchange it can make to purchase advanced technology and equipment from abroad."\(^92\)

Obviously, effective technology selection, transfer and absorption, is most likely to occur in a country which aggressively searches for appropriate technology, attempts to establish acceptable transfer terms, and works to create conditions within the economy for technology absorption. China is such a country.

The first quotation is from the introduction of the Seventh Five-Year Plan. The second quotation is from a New York speech by Vice Premier Yao Yilin, who was in the U.S. in May 1986 for a ____________

\(^91\) *Beijing Review*, April 28, 1986.

\(^92\) *China Daily*, May 21, 1986.
meeting of the U.S.-China Joint Commission on Commerce and Trade. Both quotations are illustrative of the current national policy of employing foreign (predominantly Western and Japanese) technology as an essential tool of development. It is a policy which has been embodied in a series of complex Chinese regulations on technology transfer. The policy has also been institutionalized in the establishment of the special economic development zones and open cities in which concessions are made in the hope of attracting foreign investment and technology.

Confusion, arises, however, when observers of China's drive for foreign technology encounter the constant reiteration in Chinese statements of the need for "self-reliance." Because of the largely self-generated development of China's space industry, "self-reliance" is often cited in relation to space technology.

On the occasion of the successful February launching of the second Chinese communications satellite, party and government leaders cabled congratulations to the comrades involved which said, in part: "This shows that China has fully mastered the technology of manufacturing, launching, tracking and controlling the carrier rocket; that China's satellite communications has moved from the experimental stage to the application stage; and that we have made new advances in space and electronics technologies...That the communications satellite has been put into actual use is the result of your self-reliant and painstaking
research and hard work and the energetic cooperation of the people of the whole country." The self-congratulatory statement makes no reference to borrowed technology, or to any technological backwardness.

The Dean of the Chinese Aerospace Technology Institute cites self-reliance in reviewing China's space progress during the program's first two decades. "In the past 20 years and more, relying on China's own strength we have made such great progress in the space industry because we have a superior socialist system, the vigorous cooperation of all departments in the country, and a superior corps of scientists and technicians." "

On the surface, these public citations of the virtues and rewards of technological self-reliance appear to contrast with the frank, almost apologetic, statements on technological backwardness which are invariably made to foreign technicians by Chinese officials. It contrasts also with official statements of openness to needed foreign technology like those cited above. The Chinese Embassy's science counselor was expressing a fairly common Chinese view when he said (Section B) that China "will never catch up" technologically. In Beijing, the study team was told by a director of the China Association of Science and Technology that

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China must have technology transfer in the technical area of space communications if China is to maintain a position among the world leaders in technology. Chen Rongying, official of the China Society of Astronautics, said that China had done well enough developing satellite communications on its own, but has reached the stage where technology transfer is definitely needed if China is going to continue to move ahead.

So why the apparent dichotomy between Chinese insistence on self-reliance and China's declared need for technology transfer? The answer lies in what the Chinese mean by "self-reliance." The current Chinese leadership means self-reliance in the sense of freedom from outside control, and not self-reliance in the sense of isolation, or freedom from outside influence. Within this meaning, selected, successful technology transfers permit China to develop mainly through self-reliance. Without technology transfer, there would continue to be self-reliance, but development would be questionable. China is likely to remain open to technology transfer in satellite communications because China needs technology transfer and wants it to happen.

96 The distinction is made clearly by Ross Terrill, "China in World Affairs" Foreign Affairs, January 1978.
2. Decision making for technology transfers and the satellite communications bureaucracy

a) A formidable bureaucracy.

The dynamics of the world's largest bureaucracy are such that lines of authority and the power of individuals are in constant flux. That is why there are so many China consultants, and so few of them are qualified. Within the overall bureaucratic structure, however, there are distinct ascending levels of authority through which a matter requiring decision moves upward until it reaches a level which is both qualified and willing to accept responsibility for a decision. Then, according to the principle of democratic centralism, implementation follows the same path down to the action unit.

At the top level of the governing Chinese bureaucracy is the State Council. (Attached chart). The Council approves of the economic development plans (five-year and annual plans) to which all economic decisions must relate. In order to insure that full attention is given to the requirements of science and technology modernization, the Council has established the Science and Technology Leading Group. The group brings together representatives of organizations within the bureaucracy with major program responsibilities involving S&T.
The plan itself is prepared at the next lowest level by the State Planning Commission in consultation with the State Economic Commission. The former pulls together the sector plans to form a balanced national plan. The latter has overall responsibility for plan administration. Because of their broad responsibility, these commissions stand slightly above other state commissions, which have more narrowly designated areas of responsibility.

At the next lowest level are the ministries (aeronautics to textiles) which are in charge of the product and service segments of the state economy. It is at this level, the level of the commissions, and the ministries to which they are related, that the program for China's telecommunications (and satellite telecommunications) is hammered out. This is the level at which the study is centered.

As the attached chart indicates, the space technology and satellite communications bureaucracy is formidable. The three commissions concerned (there are four other commissions) represent general civil interests (State Science & Technology Commission) and military interests (National Defense Science Technology & Industry Commission) as well as the special interest (State Education Commission) in educational television. The four ministries represented at the next level are considered the most important program agencies because all four are producers of
equipment for satellite telecommunications systems, and three of them administer segments of the system.

At the ministerial level, the Ministry of Foreign Economic Relations and Trade (MOFERT), is listed because MOFERT is at least peripherally concerned with all foreign transactions. Within MOFERT, it is the Technology Import/Export Department which approves technology import licenses. Also listed are the ministries which, as operators of separate communications networks, utilize satellite communications.

On a separate line are the institutes and societies related to satellite communications. Through their respective parent institutions, the China Academy of Sciences and the China Association of Science & Technology, the institutes and societies provide a channel for the scientists and technicians to influence policy and program development. Grouped under the bureaucratic aegis of the State Science and Technology Commission, these non-governmental "mass" organizations, with their broad membership base, are the "grass roots" of the scientific and technological community. Academic and professional judgments developed therein are given weight by the inclusion in their membership of the top bureaucrats who themselves formulate policy and programs.
b) Principal agencies.

In view of the formidable character of the bureaucracy involved in satellite technology transfer, it was difficult for the study team itself to select the most appropriate agencies to be interviewed during a short field trip to China.

The host for the study team was CONSULTEC, the China Economic and Trade Consultants Corporation, a consultant group attached to the Ministry of Foreign Economic Relations and Trade, China's lead ministry for all economic relations with foreigners. As preparation for the visit, the study team sent CONSULTEC a list of all the agencies which appeared to have some relationship to policy and implementation of technology transfer in satellite telecommunications. CONSULTEC was asked to arrange appointments for the study team with the most influential of these.

CONSULTEC assembled a group of three Chinese government officials representing three agencies which presented themselves as being principally responsible for satellite technology transfer. Since the major technology transfer issue was that of continuing Chinese interest in importing several satellites, the officials concentrated on that issue and their related responsibilities thereto. A brief examination of the principals in the satellite communications bureaucracy starts with these
three agencies. After treating the rest of the civil agencies, the military role is treated separately.

1) State Science and Technology Commission (SSTC)

Although it shares some of the commission-level responsibility with the defense technology commission, SSTC is the highest ranking organization with direct responsibility for the satellite communications technology program. Lapses in SSTC's liaison with the State Planning Commission with regard to technology planning have been a matter of concern which the government has resolved by establishing a separate Planning Bureau of Science and Technology with representatives from both agencies (See Attachment). The arrangement provides for regular direct contact, and supplements the arrangement whereby the two agencies meet on matters of more general interest in the Science and Technology Leading Group.

In a February interview in Beijing, Wu Jiaxing, Deputy Director, High Technology Department and Director of the Satellite Office said that he had undertaken responsibility for

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97 The Chinese bureaucracy is, as we have said, anything but immutable. The lineup of agencies responsible for satellite technology transfer has changed before and will again. The only thing that is certain is that MOFERT, an agency which does know the lineup, designated these three agencies as the principals as of May, 1986.

reorganization of satellite technology transfer after it had been found necessary to twice postpone satellite importation. Mr. WU made clear that SSTC was taking a leading role in implementing the policy of science and technology exchanges with other countries on satellites. (He had just returned from leading a delegation to the U.S. to press for a completion of a space science exchange agreement with NASA). He informed the study team that China had reached a decision that would permit it to move ahead with the procurement of C-band multi-purpose satellite technology from abroad. He said he was prepared to inform the U.S. officially that China would not, after all, need a feasibility study financed by the U.S. Trade and Development Program.

11) Ministry of Astronautics (MOA)

The ministry is in direct charge of civil satellite development and deployment. Under the ministry, and its subsidiary, the China Academy of Space Technology, there have been established the facilities that design, manufacture and operate the satellite system. A marketing subsidiary, the Great Wall Industry Corporation, sells China's space capabilities abroad. Chen Shouchun, Chief Engineer, Scientific Research and Production Bureau, told the study team that, within the ministry, his bureau sets the conditions for technology transfer and cooperation with foreign countries which are subsequently approved by SSTC. Mr. Chen said that, in this capacity, he had long been an advocate of
close cooperation with the U.S., an advocacy which had been greeted with only moderate success. (See "Chinese perceptions" under section D below.) Chen asked for U.S. support and encouragement for China's commercial launch efforts because China was only trying to help out where help is needed.

iii) China Broadcast Satellite Corporation (CBSC)

CBSC, a direct subsidiary of MOA, is the operator of the satellite system, and the purchaser and end user of technology acquired abroad. CBSC will prepare specifications and do the contracting for the expected satellite purchase. Wong Zhengchi, Vice President of CBSC, admitted to the team that when, in 1984, the RFP was abandoned because of internal differences over the technology to be imported, the corporation had been forced to reorganize under the supervision of the State Council. The previous corporation officers had to be relieved of their responsibilities because they had become publicly committed to procurement (K-band) which was not as suited to China's conditions as the alternative system (C-band).

iv) Ministry of Posts and Telecommunications (MPT)

MPT was left out of the group presented to the study team by CONSULTEC as the principals in the program for satellite communications technology transfer. Nevertheless, MPT, as
producer of some system components and the major end user of
satellite communications, has an important interest in the
system's technological development and would have to be consulted
in this regard. MPT can be expected to resist MOA pressures for
satellite communications development at the expense of development
of the existing terrestrial system which MPT administers. MPT's
relationship to MOA resembles that of U.S. satellite users to U.S.
satellite operators. When China signed a 1984 agreement for the
lease of INTELSAT circuits, it was MPT as lessee who signed. MOA
was unrepresented in the group, headed by PTT, which came to the
U.S. to sign the telecommunications protocol.

v) **Ministry of Electronics Industry (MEI)**

MEI was also left out of the group of principals yet, as
administrator of China's developing electronics industry, MEI
controls production facilities which supply essential
communications subsystems for the satellite program. MEI also
produces satellite "dishes" which China includes in the space
products it would hope to be able to market abroad. MEI would be
consulted in satellite technology transfer decisions.
c) Other Involved Agencies

1) Ministry of Foreign Economic Relations and Trade
(MOFERT)

The ministry's position as ministerial coordinator in matters relating to foreign economic relations and trade assures its involvement in the decision-making process for satellite technology transfer. The ministry's Technology Import and Export Department reviews and puts its chop on proposals for technology imports. MOFERT also influences technology import decisions through its participation in the Leading Group on Science and Technology.

ii) User Agencies

Aside from the Ministry of Radio and TV, the ministries listed below MOFERT on the attached organization chart are the ministries which maintain communication networks separate from MPT and use them to communicate between installations under their control. As users, they influence development of the government's satellite technology transfer program. Inasmuch as their communications networks have evaded central control through MPT, it is presumed that they will seek to establish satellite television services outside of these provided by MPT. The petroleum and electric power ministries are reported to be
planning satellite ground stations which would use circuits leased from Intelsat, or available from CBSC satellites.

iii) China Association of Science and Technology (CAST)

CAST includes representation of the whole of China's S&T community, both within and outside of the government, and inevitably influences S&T policy and government actions. CAST's membership counts all of China's 138 professional societies, including its 46 engineering societies. The association is pursuing an active role in opening up channels for exchange of S&T information, both within China and abroad. CAST also prides itself on its success in leading China into association with world S&T organizations, as part of China's opening to the outside world. Cast's schedule of conferences, technical seminars and exhibitions makes CAST a principal avenue for technology transfer to China. In addition to acting as the organizational center for technical meetings between U.S. and Chinese telecommunications groups, CAST is organizing a China Committee for International Space. The Society of Astronautics, a CAST member, will be principal organizer of in this committee.100

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100 An interview with Wu Ganmei, Director, International Conference Center for Science and Technology, CAST,
d) The decision-making process

What about the process of decision-making on satellite communications technology transfer? What factors enter in? What factors, usually important, are of lesser concern in this case?

Although differences over the precise technology to be sought are bound to arise, and differences over technological appropriateness can be deep and divisive, decisions on technology transfer in satellite communications technology are relatively less complicated than they would be for other technologies. Because satellite communications are of a uniformly high technology with a relatively narrow application, the selection process is less troubled by considerations which frequently trouble the process with, say, energy technologies. Technology transfer decisions are easier in satellite communications because:

1) Tension which exists between decentralization and centralized management and production in other technologies is reduced. Satellite communications system elements are produced and managed under central supervision. Jurisdictions not under central control may import some ground station equipment, but the bulk of technology transfer relates to production and management controlled from the center. There is no local, small-scale production to be harmonized; no
technological balance to be established between industry leaders and laggards; and no threat of widespread unemployment as the result of the introduction of new technologies.

ii) Demand for satellite communications is constant and growing. There is no question of overproduction, consumer preference, or the influence of market forces.

iii) The capacity for strong, self-reliant space communications growth has already been demonstrated. There is nothing to be proved, and foreign technology can be accepted without endangering the principle of self-reliance.

iv) Importation is in a narrow technology area which is easily monitored and controlled, so overlapping technical imports by different agencies are not the problem they are in other technologies.

v) Argument over apportioning of program effort between basic and applied science does not apply. In this high tech area, advances in space science find immediate application in space hardware and systems.
vi) There is no stubborn defense of an ingrained, traditional technology by an attached bureaucracy which questions the need for high-tech imports. While defense of the maintenance of a balance with other communications technologies is anticipated, the absolute necessity to supplement terrestrial communications with satellite communications is accepted by all relevant Chinese authorities.

3. The military role

Not unexpectedly, the Chinese military have been deeply involved in China's space program from the beginning. The satellite communications portion, however, has been primarily a civil program; developed and maintained principally for civil purposes. While China's communications satellite program cannot be divorced from Chinese military production, use and benefit, an effort has been made to separate it from the military, just as the communications satellite program is separated from the military in the U.S. through NASA and COMSAT, and internationally through INTELSAT.

Maintenance of separation is not easy. The complex of civilian agencies involved in China's communications satellite program has been described in some detail in the foregoing section. Very little is known, however, about the military
agencies involved. Inevitably, the same rockets which China uses
to launch its communications satellites have military versions
with military payloads. Production of all rockets is the
responsibility of the civil aeronautics ministry, but U.S.
observers have found that production is partially in military
facilities. Part of satellite production may also be in military
facilities but, since the satellites are not primarily of military
interest, presumably a lesser portion than is the case with the
rockets.\textsuperscript{101} Rocket launches, and launch facilities, have been
under military control, but use of the new open\textsuperscript{102} launch site in
Sichuan province gives China a central-south civil launch site,
and leaves the northern launch pad for strategic purposes. The
Weinan central satellite ground control facility was seen by U.S.
visiting groups to be in military hands. Handling of
communications satellite transmission, reception and distribution,
is a civil activity.

Military influence in development of the communications
satellite program is exercised through the National Defense
Commission for Science Technology and Industry (see attached

\textsuperscript{101} U.S. observer groups have seen parts of civil production
facilities for both rockets and satellites. They have been told
that other facilities are under military control.

\textsuperscript{102} After the February satellite launch, Premier Zhao paid
tribute to "technical experts as well as commanders and fighters"
for making "more and greater contributions to modernizing national
defense and to our modernization program as a whole. (FBIS,
Beijing, February 3, 1986). A Chinese correspondent noted the
presence of the Defense Minister "personally directing launch
operations" (Ibid 2/2/86).

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a organizational chart). As its title indicates, the commission is the central point in the bureaucracy for control of military production facilities in China's space industry. The commission also exercises administrative control over launch sites, and several tracking vessels operating in the South China Sea. The official announcement of the successful February launch of an operational communications satellite was made through the commission. Military views on satellite communications technology transfer would be presented by the commission through the Leading Group on Science and Technology under the State Council.

To what extent would technology transfer for China's satellite telecommunications assist the People's Republic of China military development? In weapons production? In military communications? In military use of civilian communications?

Clearly, any transferred technology which contributes to the production, launch, operation and control of space vehicles is going to assist China's space weapons production, but the contribution may be of no special significance. The coordinating committee of free-world countries for export licensing to communist countries (COCOM) exists to prevent export of technologies with special military use and strategic implications. Presumably, licenses for export to China of technologies which fall into the military-strategic category would be rejected.
through COCOM screening, if not previously rejected by COCOM member nations at a national control level.

The Chinese military could certainly use improved communications.\textsuperscript{103} Conceivably, Chinese production and application of low-altitude reconnaissance satellites (discussed in the technical section of the report) would be benefited by technology transferred for other types of communications satellites.

Furthermore, communications satellite technology which leads to general improvement in China's overall communications system, would assist military subscribers along with the general public. At the Chinese embassy in Washington and the state science commission in Beijing,\textsuperscript{104} the study team was told that the Chinese military were not much interested in satellite communications because everybody could read the satellite traffic. Signals could be coded, of course, but the Chinese officials were right in that military use of the national communications system would not be a big factor. In the U.S., for instance, the military uses only about 5 percent of international leased satellite circuits, and

\textsuperscript{103}Dr. Ramon Meyers, Hoover Institute, in the American Legion Magazine, July, 1985. Dr. Meyers says that, when the People's Liberation Army was "clobbered" while teaching the Vietnamese a "lesson," the main problem was a lack of reliable battlefield communications.

\textsuperscript{104}Interviews with Jing Zhaopian, S&T First Secretary of the Chinese embassy, and Wu Jiaxiang, Director of the Satellite Office, State Science and Technology Commission.
less than that percent of domestic circuits. In war time, however, the military would have priority use of national communications.

In the long run, and in common with most other advanced technologies, communications satellite technology transfer, even a controlled technology transfer, is going to result in some strengthening of China's military capability. It is really a question of emphasis. To what extent does China intend to use acquired technology to build up the military?

For a dozen years, China has spelled out its modernization goals in four categories; the "four modernizations" -- industry, agriculture, science and + technology, and national defense (usually in that order). But that includes about everything. Can China's modernization really be pushed forward simultaneously across such a broad front?

For an authoritative Chinese answer, we have a June speech by party General Secretary Hu Yaobang. Addressing the British Royal Institute of International Affairs in London105 on the subject "Where is China headed?", Comrade Hu launched into the question of the relationship between expansion of military strength and economic development. Since expansion of both would lay claim to huge investment from China's limited resources, Hu says the two

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105Hu's speech is quoted in the Beijing Review, June 23, 1986.
are "mutually exclusive." "To tell you frankly," Hu says, "China lacks funds in launching the modernization drive and it is not possible today, nor will it be in the next several decades, for China to spend heavily on expanding its military forces."

Lest his remarks be misconstrued by China's potential enemies, the general secretary adds: Of course it is also necessary for us to import some advanced military technology with the sole purpose of strengthening our defense capabilities. But we are not going to squander our limited amount of foreign exchange on heavy purchase of military hardware." China, Comrade Hu explains, is going to follow "an independent foreign policy of peace" because China needs "decades, or even a century, of peaceful economic development." 106

In his statement, Hu cites the June, 1985, decision to cut the size of the armed forces by one million, or one-fourth. He also refers to recent reductions in the proportion of defense expenditures within the national budget. In the seventh five year plan (1976-1980) the rate of defense spending declines to 9.1 percent from 13.1 percent in the previous plan. 107

106 Hu's remarks show how far China's leaders have come from the siege mentality of Chairman Mao, who spoke of the inevitability of conflict, and popularized the slogan - "Dig tunnels deep, store grain everywhere!"

107 Armament factories under the Ministry of Ordnance in 1985 were devoting an estimated 31 percent of their capacity to production of civilian goods. The number is to at least double during the current five-year plan. Meanwhile production units
The limited Chinese interest in military modernization became apparent to Roger Sullivan, president of the National Council for U.S.-China Trade, who accompanied a U.S. military sales delegation to China in November, 1985. Writing in the March 1986 issue of the China Business Review, Sullivan said: "The Chinese seem to believe they are now in a period of relative invulnerability to the Soviet threat during which they can afford, with little risk, to follow the approach long favored by Deng Xiaoping: subordinating military development to economic development and reforming the structure of the PLA before attempting to modernize it." In other words, progress on fulfilling the fourth modernization - national defense - is to yield to the other three - agriculture, industry, and science and technology. And, according to Secretary General Hu, we are talking about a process which will spread over the next several decades.

Despite the present outward appearance of a China devoted to economic progress in a peaceful environment, China's developing Pacific rim neighbors remain apprehensive about a potentially aggressive China. They have expressed to a study team member their concern at the proposals, by the U.S. and other Western nations, to transfer to China weapons technology of a "limited, defensive nature." On the other hand, they could be expected to

that produce mainly civilian goods will be gradually turned over to provincial governments and/or civilian ministries. (China Market Intelligence, National Council, August, 1986)
favor Western programs for transfer of satellite communications technology (which assists China's opening to the outside world.)

Satellite communications has acquired a standing as an important instrument in the evolution of an intercommunicating world, and in the development of the peaceful uses of space. It is this international acceptability that has brought to satellite communications the support of the programs of the UN, the International Telecommunications Union, the World Bank and INTELSAT. The non-aggressive character of satellite communications technologies can also assist in their being approved for export licensing by the guardians of strategic Western Technology.

4. Capacity to absorb technology

Lack of technical sophistication creates difficulties in absorbing technology in developing countries, and China must be included. The relatively advanced technical development of Chian's satellite communications program enjoys a partial immunity from these difficulties; a circumstance which makes the program a good candidate for technology transfer.

China is trying to come to grips with problems relating to integration of technology in the development process. Science and technology is the third of China's targeted four modernization. In a major overhaul of China's science and technology system, the
leadership has concentrated on the problems of compartmentalization and the separation of science and technology from production. A lead article in the June 16 1986, *Beijing Review* entitled "Revamping Science and Technology System," outlines the task: "Promote the integration of scientific research with production and bring the role of researchers and technicians into full play."

Application of science and technology to production has not been so much of a problem in satellite communications. U.S. observers have even found research institutes undertaking major production functions. Compartmentalization, however, has been a problem; one which observers assign to technology management. Inexperienced management, shortage of technicians, and lack of infrastructure are the three problem areas with potential to threaten progress on satellite communications. Although none of these have prevented China's program from becoming an outstanding high-tech success, they could, individually or collectively, limit the effective application of transferred technology in further development of the program.

a) Technical personnel

We have been unable to uncover evidence of the total number of technicians assigned to China's satellite program, but obviously there have been enough technicians to keep the program
moving. Clearly, it has been considered a crash program calling for an extraordinary national effort. A Chinese publication says that: "According to statistics, tens of thousands of people took part in the research and manufacture of the satellite. Several hundred factories and departments in more than ten ministries and commissions, and over twenty provinces, municipalities and autonomous regions shouldered tasks in research, experimentation and production. The scale of co-operation was unprecedented in China's history." ¹⁰⁸

Major credit for the program's success is given to the older technicians who antedated the revolution. The Dean of the China Aerospace Technology Institute tells us ¹⁰⁹ that: "In the space industry corps there is a group of old specialists who have made important contributions to China's space industry. They have wholeheartedly, conscientiously and indomitably put in an enormous amount of hard work...There are also the middle-aged specialists, who were trained by the New China, who have done world class work."


¹⁰⁹Sun Jaidong, JPRS, CST-85-004, 5 Feb 85.

¹¹⁰In "The Chinese Space Program," P.S. Clark, Journal of the British Interplanetary Society, Vol. 37, 1984, we are told that the most important persons in development of satellite carrier rockets were two Chinese pre-revolutionary graduates of the California Institute of Technology. Clark says the Chinese could begin a space program by combining knowledge of the Soviet and American Space Programs acquired by veteran Chinese technicians.
Likewise, the Minister of Defense, Zhang Aiping, attributes satellite program success "first of all to China's strong contingent of space scientists and technicians including a number of veteran experts." Next to be credited are the "middle-aged specialists and technicians" trained since the founding of the People's Republic. "They have done world class work in developing China's space science and technology." 111

U.S. technical delegations to China have been uniformly impressed with the quality of the technicians assigned to the Chinese space program. If anything, they have found installations they visited to be overstaffed. They were surprised at the degree of accomplishment by dedicated technicians in facilities that are "old, dark, and rudimentary." 112 They were surprised too, that China's space, and space communications development had continued to take shape during the dark period of the Cultural Revolution (the late '60s and early '70s), a period when the JCCT itself was disbanded. 113

It was the Cultural Revolution which crippled technical training for nearly a decade. In the Late 70s, when China

111 Sun Jiadong, JPRS, CST-85-004, 5 Feb 85.

112 BJR, April 30, 1984.

113 People to People delegation report and series in AWST, especially Couvalt article AWST, 8/12/85.
emerged, there were not nearly enough trained technicians to support the new leadership's program of forced draft economic expansion. Although the space and satellite programs have so far been adequately supplied from the limited pool of qualified technicians, the programs will have to retain their priority among priorities if they are to continue to be spared the consequences of the shortage. Fortunately, the technology transfer in itself is unlikely to contribute to the problem because the Chinese will insist on technical training as an integral part of the technology package.

b) Management

In summarizing the experience of the successful 1984 communications satellite launch, the Chinese Defense Minister finds that a good deal of credit must be given to" socialist management." It is, he says, proof of the "effective Chinese system guiding scientific research. This includes establishment of a chief designer, a command system, and the combination of unified leadership and division of labor with individual responsibility." This system, he states proudly, was "invented by veteran revolutionaries."\(^{114}\)

The Defense Minister's assurance of the effectiveness of socialist management technology, even in the successful space program, is generally not shared by foreign observers. A 1984 article on the space program in the China Business Review finds that "limited coordination in the areas of project control, scheduling, quality assurance, and modeling reliability continues to slow progress. The lack of integrated management, rather than lack of funds, appears for the moment at least, to be the Achilles heel of China's space program."\(^{115}\)

In a more recent look at the situation, Craig Covault, Space Editor of Aviation Week and Space Technology wrote in July 1985, that he had found in China a real problem of basic management skills. There is, he said, "no strong sense of space program leadership. It is a too compartmentalized to allow exchange of information necessary for development of high technology on a broad scale. Facilities working on the same program are not well coordinated."\(^{116}\) Other observers suggest that the Chinese lack experience in such areas of technology management as sorting out critical elements and making critical decisions relating to research and development.

\(^{115}\)Zhang Aliping, BJR, April 30, 1985

\(^{116}\)Bradley Hahn, "China in Space," BJR, July-August, 1984
Some knowledgeable Chinese are painfully aware of the lack of management skills. He Yan, Deputy Director of the Weinan Control Center, told the 1985 U.S. expert delegation that space program management coordination is an area in which China requires help. Furthermore, the Defense Minister's above-cited complacency concerning socialist management capability is also not shared by that other old soldier, Deng Xiaoping. This spring, the paramount leader told an Australian delegation that the two things China needs most to import are technology and management.117

Foreign assistance for Chinese management is the basis for the progressive establishment of management institutes by China's principal Western trading partners and Japan following the U.S. Government initiative in founding the Dalian Management Institute in 1980. Furthermore, the recently signed U.S.-China Telecommunications Protocol allows for U.S. assistance in telecommunications management.

Effective transfer of advanced space communications technology to China may require the inclusion of management skills in the technology package. Aside from wrapping management skills into a joint venture, however, this is going to be difficult to arrange.

117AWST, July 8, 1985.
c) Infrastructure

Does China have the industrial infrastructure to support an advanced space and space communications program, and how does this affect technology transfer? The short form answer is that China does not, and it complicates technology transfer.

At least one observer says China does have the infrastructure. Bradley Hahn, in his 1984 China Business Review article finds that: "Unlike its other industrial sectors, China's space industry enjoys the latest in modern technology, the support of a comprehensive industrial complex, and a highly trained contingent of scientific and technical personnel."\textsuperscript{118}

A 1985 Beijing Review\textsuperscript{119} article describes the process whereby diverse industrial capability was brought to bear on construction of a test facility. In 1976, when China was emerging from the shadow of the Cultural Revolution, the environmental engineering and test center faced difficulties in building a thermal vacuum tank to simulate outer space conditions. Support was mobilized from all parts of the country. A special office was established, and personnel were selected from thirty factories and

\textsuperscript{118}Hahn is director of the Titusville, Florida, consulting firm, Hahn Associates International. CBR, July-Aug. 1984.

\textsuperscript{119}AWST, July 8, 1985.
scientific research institutes to work on the project. The test tank that resulted is said to be the largest in Asia.

While this kind of task orientation of available industrial capability helps to explain China's remarkable progress in its space programs, it points up the lack of the dedicated industrial infrastructure which China needs to support a sustained, large-scale space program, and to effectively absorb a technology transfer thereto. Ford Aerospace, RCA and Varian, all of whom have spent some time and considerable money tracking opportunity in China's space program, have all remarked on the lack of supporting industrial structure. They point to the lack of a certified supplier base for materials, parts, supplies and subsystems.

The Japanese (Jetro Newsletter 61, 1985) agree, saying that Chinese plans to reduce investment in telecommunications technology imports by relying on indigenous technology and equipment is infeasible. Conceding that Chinese basic research is well-advanced, the article insists that the country lacks the production technology to manufacture the precision equipment it needs for its telecommunications development.

\[120\] It is not known what other priority projects were started of resources in order to feed this satellite program emergency.

\[121\] BJR, May 7, 1984.
China's infrastructural shortcomings can be rectified as the base of industrial support is built up over time. Meanwhile, as one U.S. supplier of technology observes, when U.S. designs with U.S. tolerances are introduced into the less sophisticated Chinese technical environment, it takes a long time before the transferred technology can be successfully adapted. Chinese development is slowed in the process.

5. **Searching for the appropriate technology**

Before China's vigorous pursuit of its open policy of trade and economic relations with the industrialized democracies, it was not unusual for a supplier in a distant country to get a serious enquiry from a Chinese organization he had never heard of, and for a product he had never thought of marketing in China. The Chinese had learned of the product by sifting through catalogues of technical literature. After the Cultural Revolution, as China stepped-up its development, the Chinese search for appropriate technology moved into open commercial channels. Now, before final selection of important technologies, there is an extended, methodical investigation which includes multiple visits by delegations of Chinese technical experts to the production facilities of competing foreign suppliers where direct observation can be made of the technological capability being considered.

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122 Martin Packard, Varian.
Despite recent improvement in direct commercial contact under the open policy, the Chinese selection process is still somewhat handicapped by China's long-standing, prior ignorance of world technology markets. Furthermore, some Chinese producers develop an exaggerated view of their own absorptive capabilities, a view which leads to importation of high technology without the know-how to put it in service. Since China's technology needs are so broad, and there are a large number of foreign suppliers who have technologies that could possibly be used, the Chinese can be expected to engage in long, labored, and intensive technology quests which may end up with inappropriate technology, or the funds will run out, or the priority will change.

During the process of technology selection, an unhelpful dialogue frequently develops between the Chinese buyer and foreign suppliers. The Chinese say: "Tell us what you have that you can export and we might need." The foreign supplier replies: "First, tell us what you need, and we will see if we have it and can supply it." Normally, it requires the use of considerable commercial skills, money, patience, and goodwill, before the supplier eventually discovers what the Chinese need so that he can

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The National Council, in its pioneering 1979 work, Selling Technology to China, cites a number of examples (p. 96-97) of Chinese purchases of licensed technology which could not be converted into production. The practice has continued. A more recent example (cited to the study team) is that of a license purchased from Varian for production of aerospace equipment. The Chinese were unable to put the license to use and have continued ordering Varian's kits for the same equipment.
relate it to his production capabilities. Chinese unfamiliarity with technical markets has become an even larger problem with the growing decentralization of trade and the shift of much of the technology import responsibility out of the direct control of more experienced state trading agencies.

Then there is this other problem which results from the identification of two appropriate foreign technologies for a particular need and the attempt to determine which is most appropriate for China. That is the problem that arose when it was discovered that there are two importable telecommunications satellite system technologies, and both are appropriate in that either can propel China's space communications forward in a desirable direction. China's lack of an overall telecommunications development strategy compounds the difficulty of selecting the technology with the best fit. The long-standing controversy is so important for both the satellite communications technology suppliers and the potential Chinese users, that it deserves separate treatment.

6. Selecting A Satellite

With the issuance of a new, revised request for proposals (RFP) China's multi-year effort to select an imported communications satellite system may be nearing an end. The long process has been one of the more notorious examples of delay in import
decision making in the recent history of China's trade with the industrialized democracies.\textsuperscript{124}

We cited a number of normally complicating factors which do not apply to satellite communications technology transfer decisions because of the special circumstances of the satellite program. The fact that the cited factors do not apply removes a good deal of the complexity that could attach to Chinese decision making on satellite imports. Inevitably, however, there remain several fundamental factors, such as price and foreign exchange availabilities, as well as technical preferences, which can be compelling factors, and which apply in this case.

We do not know what made China decide to build and buy satellites, rather than depend on leased satellite services, as many other developing countries do. Leasing would have been easier, cheaper and quicker. Indeed, as we have observed, China was forced to lease some circuits from INTELSAT in order to get the satellite communications program moving. There was some domestic opinion which favored building a system based on leasing. A 1984 article on "China's Domestic Satellite Communications" in the Chinese official publication, \textit{Telecommunications Technology}, says: "Organizing a domestic satellite communications network by

\textsuperscript{124}Both the Chinese embassy in Washington, and the officials interviewed in Beijing, were willing to suggest a time for a new RFP. Both sources suggested spring 1986, but there was no evidence of the RFP by the beginning of summer.
satellite leasing can effectively change the inadequacy of our communications system to meet the needs of economic growth. The investment is small and progress fast.\textsuperscript{125}

The "buy and make" instead of "rent" decision may have been the practical consequence of the development of carrier rockets. The decision was also probably influenced by the long range view that a substantial number of communications satellites would be needed in China, and it would be better to start learning the technology at the outset. By 1979, at least, a decision had been taken to speed the process and take a quantum step in acquiring capacity by importing advanced satellites, and, along with them, as much technology as the foreigners would release and China could absorb.

In 1979 the Chinese Academy of Sciences raised the hopes of U.S. suppliers by stating, in an agreement with NASA, that China intended to purchase a U.S. broadcast satellite system "under suitable conditions." In 1980, the large-scale Chinese "economic readjustment" established conditions which the Chinese deemed unsuitable, and the project was shelved.\textsuperscript{126} In 1984, the project was revived and a request for proposals issued. In 1985, the

\textsuperscript{125} FBIS, 3/16/84.

\textsuperscript{126} The best description of this early bid situation is in Karen Berney, "An Aborted Launch," CBR March-April 1981.
project was again "postponed," this time after proposals had already been received.127

So why this Chinese paralysis when it comes to selecting a satellite technology the country badly needs?

Is it a foreign exchange problem? Foreign exchange is always a part of the problem because China has so much to buy and so little to buy it with. The "we are a poor country" argument is put forth by the Chinese as a bargaining element in every important technology purchase. It has a certain validity in this case, as in the others. The Chief Engineer of the Ministry of Astronautics told the study team that, if China were a rich country like the United States, China could afford to buy both (C-Band and K-Band) satellite systems. But, he continued, since China can only afford to buy one system, it is necessary to be absolutely sure it is the right one.128 It would not do to argue the point with the Chief Engineer. Nevertheless, the fact remains that the necessary funds had been budgeted, and a system appropriate for China already selected at the time the RFP was issued in 1984. Then doubts began to arise among decision makers concerning the clear superiority of the Ku-band (specified in the RFP) over C-band as the needed addition to China's existing communications system. The doubts were reinforced by technical

128Chen Shouchen, February 25 interview.
advice from "China's friends" in the U.S. The subsequent "suspension" of the RFP was not, apparently, so much a problem of sudden poverty as it was the result of a deep-rooted technical disagreement.

There was plenty of room for a difference to develop over the appropriateness of the technical qualities of the two different systems. The technical section describes the technical qualities of both. For the Chinese it seemingly boiled down to a question of whether China should import the newer, higher frequency technology (Ku-band), and with it the technology that would permit China, at some later stage, to become a producer at this more-advanced level. Or should China import a less advanced technology (C-band), but one which is more thoroughly tested, is part of China's experience, and would adapt more readily to China's existing system. At least one supplier (GE) detected bureaucratic infighting over the question during the earliest period of consideration in 1979.  

129 The reference to "friends" was made by SSTC Satellite Office Director, Wu Jiaxiang.

130 Karen Berney, "An Aborted Launch," CBR, March–April 1981. It appears that infighting over technology selection was joined with the bureaucratic struggle for control over the satellite circuits. Although the struggle for control undoubtedly continues behind the scenes, the important thing for the foreigner to know is who has come out on top, and thus who has to be dealt with. Our answer is above in "Principal Agencies."

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Advocates of Ku-band could argue that more power in space permits the rapid spread of economically-produced small receivers on the ground. C-band advocates, on the other hand, could argue that even though C-band requires bigger and more expensive receivers on the ground, they are receivers that China already produces. In any case, the victory of the C-band advocates is a victory for pragmatism and a mature technology with which the Chinese are more familiar and more comfortable. It is a technology which may well provide improved satellite communications in a shorter time. The choice is evidence that the Chinese do not always want the latest and highest technology. They want a market-accepted technology.

Abrupt "postponement" of the 1984 RFP, caused China to lose face before the international supplier community with some resultant bureaucratic readjustment. The RFP was issued through the China Broadcast Satellite Corporation and put the CBSC out on a limb\(^{131}\) for a Ku-band direct broadcast satellite. With European and American proposals already in hand, the internal differences over the proper technology that led to the RFP "suspension" was a public blow to CBSC prestige. Since the CBSC officers could hardly make a public retraction of their Ku-band advocacy, a new request for foreign proposals would require a new CBSC. That we have. But, before the foreign supplier goes to considerable

trouble and expense to prepare another elaborate proposal in response to the expected RFP, how is he going to know that the new RFP is a fully approved RFP which is guaranteed against postponement? He isn't. That, unfortunately, is just one of the hazards of doing business in China. It is entirely likely, however, that the eight-year battle over technologies has finally produced a clear winner, the C-band, and this time the CBSC will really mean it when it asks for proposals.

7. Transfer Modes

If the Chinese have indeed chosen the satellite system they will import, the matter now turns to how, and how much, technology transfer will be attached to the purchase. It will be one of China's most significant modernizing transfers, and it will go a long way to covering the inadequacies of a communications system needed to support economic growth.

Ford Aerospace\textsuperscript{132} expects that the second RFP\textsuperscript{133} for satellites will reflect a Chinese insistence on transfer of technology which will enable China to become a producer of these satellites. There is a way the RFP could accommodate this, and yet still provide a commercially attractive proposition. Through

\textsuperscript{132}Bob Berry.

\textsuperscript{133}The second RFP will be the third Chinese solicitation because the first was not subject to international bidding and consequently did not take the form of an RFP.
a system supply contract, the Chinese can purchase two satellites abroad with access to the manufacturer's facilities during construction and testing. Then a third satellite could be produced in China, under license, with sufficient foreign engineering assistance to insure the quality of the finished product.

Chinese production of the third satellite would take place without the difficulties China has sometimes encountered in licensed production. The manufacturing technology for C-band satellites is well-established and assimilable. Multi-purpose C-band satellites have been produced in the U.S. for fifteen years, and in Europe for five years. A combination of buy two and make one would give the Chinese a chance to learn how to make satellites of higher quality, long life and greater efficiency. This type of gradual transfer fits the normal pattern of successful transfer used by China in other technologies such as the agreement for Chinese manufacture of Westinghouse generators.

The way the Chinese will actually go about developing the new RFP could be quite different than that just described. There is some supplier concern\textsuperscript{134} that the new RFP will reflect a Chinese intoxication with their indigenous satellite successes. That, combined with a miscalculation about Chinese technical capabilities, could lead to an RFP calling for production in China

\textsuperscript{134}Ford Aerospace.
of all three satellites with minimal foreign guidance. The import would consist of essential foreign components to be put together with China-made components.

An RFP which simply calls for foreigners to come to China to teach satellite making appears possible in view of statements made to the study team by Chinese officials. The possibility is also sustained by the fact that, after using COMSAT for technical support on the first RFP, and after seeking and then rejecting TDP funding for a feasibility study to support the upcoming RFP, the Chinese have decided to handle the new RFP completely on their own.

Ford Aerospace, for one, says that, if the Chinese decide to start out making their own multi-purpose C-band under license, the company will walk away from the deal. Selling a few million dollars in assemblies, says the supplier, and then being asked to work with the Chinese on a Chinese satellite, doesn't make sense and wouldn't make money. There would be no incentive to negotiate a significant technology transfer. Other foreign suppliers might well feel the same way. An RFP which turned off foreign suppliers could mean more controversy and more delay for China's satellite program.

135 Bob Berry, Director.
6. **Non-commercial transfer modes**

Aside from transfers through straight commercial transactions (direct sale, licensing, joint ventures, engineering contracts and countertrade) significant transfers of satellite technology to China are possible in non-commercial modes. Foremost of these has been the obtaining of technology through search of the technical literature, including data bases.\(^{136}\) Given the paucity of commercial activity, much of China's "self-developed" satellite technology can be attributed to this source. The Chinese acknowledged as much to a U.S. expert delegation.\(^{137}\) They told NASA that they were particularly indebted to NASA manuals on the space program.\(^{138}\)

We have already noted that Chinese officials credit much of their satellite progress to veteran technicians, some of whom received pre-revolutionary technical training in the U.S. The study team asked a ranking telecommunications ministry official\(^{139}\) how many of the thousands of Chinese students going abroad were in

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\(^{136}\) The U.S. is just getting around to an effort to try to limit foreign access to U.S. government and commercial computer data bases which contain high-tech information. The problem is discussed in an article front-paged in the *Washington Post*, May 27, 1986.

\(^{137}\) People to people delegation report.

\(^{138}\) Interview with Peter Smith, NASA, February 12, 1986.

\(^{139}\) Interview with Yun Jin, Deputy Director, Dept. of Science & Technology, February 22, 1986.
telecommunications studies and would return to assist technical development of China's system. He was unable to give a number. He said that the system for choosing state-supported students was complex. He expressed a hope that operating ministries would obtain a larger voice in sending students abroad and reclaiming them upon their return to China.

Technical seminars by foreigners traveling to China have been, since China's "opening" in the late 70s, a method much used by China to preview available foreign technologies. Many members of the National Council, who have become established China traders, were introduced to China through technical seminar delegations. (Interested companies are asked to submit a precis of the technology they were prepared to discuss before they are approved for an official invitation.) Leading U.S. aerospace companies have conducted numerous technical seminars in China on the range of their capabilities in satellite communications. Ford Aerospace, RCA, Hughes, and GE were each required to conduct two-week technical seminars, in Beijing in connection with the postponed 1980 satellite procurement.\(^\text{140}\) It is not possible to quantify the extent of technology transfer which occurs through technical seminars, but the competitive situation, plus extensive

Q and A periods, invokes detailed explanations and has been used to advantage by technology-hungry Chinese technicians.\textsuperscript{141}

Government to government technical exchanges give the Chinese an opportunity to fill technical gaps through a negotiated pattern of graduated exchanges. Although China has telecommunications technical exchange agreements with other governments (see below), an agreement with the U.S. was only signed in May of this year.

China exhibitions with accompanying technical seminars establish a competitive situation in which U.S. aerospace companies have found it necessary to be well represented in China. At the conclusion of the most recent exhibition in May, 1986, the Chinese aviation minister said the exhibition was particularly valuable because it "opened a window on modern U.S. aerospace products."\textsuperscript{142} The significance of exhibitions for technology transfer is illustrated by the observation of a U.S. attendee that: "Many Chinese visitors interested in space had extremely specific subsystem questions, as if the answers to these questions would fulfill a specific Chinese technical information objective."\textsuperscript{143}

\textsuperscript{141}A study team member has accompanied a number of U.S. technical seminar delegations to China.

\textsuperscript{142}\textit{Editorial, "China's Technology Leap,"} \textit{AWST,} May 26, 1986.

\textsuperscript{143}Space Hardware Companies Probe Chinese Market," \textit{AWST,} May 26, 1986.
In the eyes of some foreign suppliers, extensive Chinese foot-dragging on technology import decisions is a calculated form of technology transfer. The lengthy Chinese indecision on the satellite import is cited as an example. However, we have found nothing to suggest that, as a deliberate tactic, the Chinese extend negotiations for a needed technology in order to create an opportunity to access and transfer portions of the technology. Whatever the cause for delay—financial caution, unfamiliarity with the technology, or differences over the appropriateness of the technology—delay is endemic in the Chinese system when it comes to large-scale technology import decisions. Foreign suppliers have been waiting for years for Chinese decisions on such things as: coal transport (unit trains instead of slurry pipelines, or both); nuclear power (ten imported plants or one); the Three Gorges Dam (one huge hydropower project or many smaller ones).

Even if not deliberate, there is no question but that the extended period leading up to contract provides the Chinese with an opportunity to learn more about what the foreign supplier is doing and how he is doing it. It is a period available to the Chinese to sharpen their critical faculties for the final technology selection.

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For nearly ten years now (summer, 1986), in relation to the satellite procurement, the Chinese have not only been receiving delegations of foreign aerospace companies, but what is more important, the Chinese have sent numerous Chinese technical delegations to tour the installations of potential satellite suppliers in the U.S. and Europe. As part of the standard pattern for such technical delegations, the Chinese technicians sketch and note throughout the tours and presentations. In the evening, the Chinese delegation leader assembles the group for an exchange of views on the observations of the day. At a minimum, the observations uncover both the foreign state-of-the-art and corroborative evidence to support the direction of China's own activities.\textsuperscript{145}

Obviously, the longer the pre-purchase period lasts, the longer the Chinese have to play off competing suppliers against each other while progressively enlarging the scope of the technology each is asked to transfer. At the same time, the Chinese are pressing ahead with their indigenous technological achievements. The launching of the two home-grown Chinese communications satellites, for instance, strengthens the Chinese hand, and raises the ante on the technology the foreigners will feel obligated to bid. Opinions differ as to the amount of technology the Chinese actually transferred to their own use

\textsuperscript{145}Study team members have accompanied six Chinese technical delegations on visits to U.S. companies.
during the satellite purchase delay. Officers of one involved U.S. supplier think the Chinese might have picked up enough technological information to go it alone with the first satellite.  

The Chinese can argue that the longer they delay a satellite technology purchase decision, the better they know what they want, and the more likely they are to get it. This, of course, begs the question of how long the Chinese can afford to put off the establishment of a communications system which will meet China’s minimum needs and will no longer threaten to stunt economic growth.

\[146\text{RCA/OTA interview.}\]
D. INTERNATIONAL COMPETITION

--The United States, with its long experience and developed technical capability, is best qualified to supply China's need for satellite communications technology imports. What is the U.S. market position versus U.S. competitors? What looks promising, and where are the problems?--

1. The Market

Although substantial sales have been made by foreign suppliers, the China market for satellite technology sales has been somewhat restricted by China's concentration in engineering and building its own rudimentary communication satellite system. Furthermore, sales in related technologies are difficult to trace because equipment, such as the 1985 U. S. sale to China of some $200 million in computers, was not exclusively for satellite communications use. The attached "Satellite communications transfers to the PRC" lists satellite technology sales of some $60 million in the two years to mid 1986.147

The market outlook for satellite technology sales is promising. China has emerged as a space power and, after an auspicious start, space and satellite communications have

147Includes a data processing center valued at $10 million to be supplied by Matra (Fr.). The PRC has specified Digital Equipment Corp. VAX computers.
potential as a growth industry in China, just as in the U.S., the USSR, Europe and Japan. As indicated in the foregoing, China recognizes telecommunications as a key development sector, and accepts satellite communications as a most important element in network development. China has invested heavily in developing a satellite capability,148 and the current (7th) Five Year Plan calls for completion of a domestic satellite system. Foreigners, especially Europeans, have agreed to cooperate in China's satellite development, and Chinese delegations are abroad looking for customers for an expanded Chinese launch program.

Despite the lag in the satellite systems sale, and the growing Chinese capability to produce related hardware, there will be many other sales opportunities. If not the satellites themselves, there will be a need for modern satellite components which China cannot duplicate. Gaps in the Chinese technological support infra-structure will have to be closed with technology transfers. The whole of the Chinese ground support system will require equipment in a number of allied fields, including computers. There are possibilities of joint ventures with foreign aerospace companies, not just in equipment, but in satellite services as well.

148According to one Chinese official, in 1984 the PRC was spending almost 1 percent of its GNP on space research and development, equivalent to several billion dollars a year. "China in Space," Bradley Hahn, China Business Review, July-August, 1984
2. **Competing countries**

a) The Europeans

For foreign competitors in the sale of communications equipment to China, the big ticket item has been, ever since 1979, the expected sale of a satellite communications system. The sale, besides its immediate value of up to $200 million, would establish a technological connection of promising future value. The French and the Germans, have pressed hard for this sale along with the U.S.

During the protracted competition for supply of the satellite, the European suppliers, particularly the Germans, have expressed increasing willingness to permit Chinese engineers to have access to their factories during production of any satellites they might buy.\(^{149}\) It is unlikely that any government would put restrictions on direct transfer of widely-used C-band technology, but Chinese access to production know-how will be a matter of supplier discretion and subject to the pressures of competition.

\(^{149}\) The Europeans have been seeking a close technological connection through cooperation agreements. Germany (MBB) has a reported agreement with China to jointly develop and manufacture equipment and components for telecommunications satellites. In 1984, MBB invited four Chinese engineers to assist in assembly of a satellite. Between 1975 and 1984 MBB received thirty Chinese delegations. *Aerospace Daily*, March 13, 1984, details the German cooperation agreement.

The UK, also, has an agreement with China for joint space projects. See *C.S. Monitor*, March 22, 1985, for details.
The Europeans will provide stiff competition for the U.S. in the expected satellite system sale. China's first foreign satellite purchase will be regarded as an important point of entry into the promising China space market. For major sales like this one, Europe has generally been able to offer friendlier financing than the U.S., but lowering of U.S. EXIM interest rates in 1986 will aid U.S. suppliers. When it comes to export licensing, the Chinese say they expect to get from Europe both faster service and a higher level of licensable technology than that which they expect from the U.S.

The Germans and the French together have attempted to impress the Chinese with their satellite technology through joint tests of the PRC ground stations using the "Symphonie" satellite. The Italians have done likewise with their "Sirius" satellite. The Europeans' continuing interest in joint space programs with China could be expected to grow in proportion to disinterest on the part of NASA or the U.S. private sector.

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150 Ford Aerospace and GE in study team interviews. Where licensing is discretionary, the Europeans are likely to have a broader view.

151 Early in 1986 the UK authorized a 300 million pound developmental credit for China at 5% for 20 years. (Financial Times, May 2, 1986)

152 As indicated in the following, because U.S. licensing is stricter and takes longer.


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Aside from satellite systems as a whole, the Europeans have been competing with the U.S. on system components. China has been considered a reasonable market for foreign supplies of C-band earth stations because, despite improving Chinese production, the foreigners can build and sell at prices which compete favorably with Chinese-produced stations, and are generally better quality.\footnote{154}

A recent Chinese announcement appears to close this market to outsiders, but a Chinese Embassy spokesman maintains that the announcement is simply an official certification that Chinese quality is now equal to that of the imports.

For the 1984 response to China's RFP, Ford Aerospace felt it wise to associate with the Europeans in a satellite 'bid to China. The company had observed that China likes to spread purchases around among foreigners for political purposes. Consequently, the U.S. company set aside its overall technical capabilities in order to participate in a consortium headed by a German company and including a French company, which submitted a joint bid. The joint bid may well have been the one most favored by the Chinese

\footnote{154As indicated in the attached list of transactions, Canada's SPAR Aerospace Ltd. has sold nearly $20 million in earth stations.}
in the now defunct RFP, but Ford is prepared to go it alone on the second RFP, whenever it is issued. 155

b) The Japanese

Japan's continuing overall predominance in China trade is the result of a trade policy designed to keep Japan on top in a market which is of vital importance to the Japanese. Fortunately for non-Japanese foreign suppliers, satellite technology is one of the areas of Chinese imports where U.S. technology, and then European technology, is still superior.

But the Japanese have a space and satellite communications program which is advancing rapidly. Given Japanese dedication, marketing skills, technical capability, and proximity to China, it is to be expected that, in a very few years, the Japanese will be a major competitor to both the U.S. and Europe in China's aerospace development. 156 Yet the Japanese have shown a singular unwillingness to transfer technology to China, and the Chinese have criticized the Japanese for hanging back. 157 Perhaps the Japanese experience with their other neighbors, South Korea and


156 "Japan Challenging Western Leadership in Space," AWST, July 14, 1986. In 1980 the Japanese won a $9.1 million contract to building the Beijing number three ground station link with INTELSAT.

Taiwan, have made the Japanese cautious about assisting the development of competing technological production. At any rate the Chinese have ranked countries by percentage of technical sales in the overall value of their China contracts. The UK and France lead with 80 percent. The U.S. is next with 72 percent. West Germany has 52 percent. Japan is listed for only 6.2 percent.\footnote{158}

U.S.-Japanese aerospace companies have recently been forming on China's doorstep. The combinations so far developed are Hughes with MITSUI, Ford Aerospace with Mitsubishi and RAC with Sony. All three Japanese companies are interested in satellite production. Sales to China might seem a reasonable prospect for these joint companies, but the Chinese have made clear on many occasions that they prefer to deal with U.S. companies directly.

3. \textit{U.S. marketing advantages}

In the distant and difficult China market, U.S. suppliers of technology are fortunate to have some things going for them that are not generally available to them in other foreign markets. For one thing, there is the oft-stated Chinese preference for U.S. technologies. For another, there is the unique array of government-to-government agreements for U.S. programs in China. Some programs directly facilitate U.S. business activities, while

\footnote{158 \textit{China Business Review}, May-June, 1985.}

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others pave the way for follow-up by familiarizing the Chinese with U.S. technologies.

a) Acknowledged U.S. technological leadership

The study team was told by every Chinese official we met that the U.S. is the world leader in space technology including, of course, satellite communications. The Chinese are keenly aware that, at least in this technical area, while other countries can offer technologies which are almost equivalent and sometimes better priced, the U.S. has the most experience, the widest variety of product, and the most highly-developed technical support infrastructure.

b) Market awareness

Because the U.S. was later in establishing relations than competing countries, U.S. firms were relatively slow getting established in China. Nevertheless, seasoned U.S. exporting companies, aware of the market potential, have been making up for lost time. They realize the importance of maintaining a presence in China, because the Chinese want to deal with "old friends" who

159 The loss of the space shuttle was never mentioned by the Chinese during our February 1986 visit. This was probably not so much out of deference to our feelings as it was Chinese recognition and acceptance of the hazards of space programs.

160 Jing Zhaopian, PRC Embassy First Secretary to the study team.
are with China for the long haul. Major U.S. aerospace companies, are now represented in Beijing. Most are there for other than satellite business, but all of the qualified companies are carefully monitoring the emerging China communication satellite situation. The fact that China's satellite telecommunications program is under central control in Beijing works to U.S. advantage. Few of the U.S. companies which are prepared to sell in China's space market have sold enough in China yet to justify a large and expensive China office, and an extensive sales effort. Even if the European competition, and certainly the Japanese competition, were willing to do so, the U.S. companies would be unwilling to travel around China chasing potential end users. Sales contact with the few key officials in Beijing, plus participation in the occasional exhibition, makes sense in terms of keeping in touch while the market develops.

c) Willingness to invest

Second only to the Hong Kong Chinese companies, U.S. companies have demonstrated a readiness to move into the marketplace and participate in cooperative arrangements and joint ventures in China. The Hong Kong businessmen are mostly in small joint ventures with 80% of the total registered investment. The U.S. has 7%, and Japan is third with 6%.\footnote{Far Eastern Economic Review, March 20, 1986.} Although space communications are not yet included among U.S.-China joint

ventures, U.S. aerospace companies like Boeing and McDonnell-Douglas are actively involved. U.S. company willingness to accept joint management responsibilities, and to share risks\textsuperscript{162} with Chinese socialist managers is a positive indication of U.S. willingness to do long-term business in China. U.S. readiness to work with Chinese managers is not so widely shared by the Japanese, who have a market position with a value several times our own. This suggests that, as long as the Japanese can sell to the China market without such a drastic step, the Japanese prefer not to dilute their management authority in joint ventures with the Chinese.

The decline in the value of the dollar reverses a trend which has been working against U.S. trade with China, particularly against competition backed by the undervalued Japanese yen. The decline in the dollar will be particularly helpful in technology trade where, the higher the technology, the higher the percentage of price attributable to the inflating costs of U.S. R&D.

d) Chinese students

It has been observed that: "Technology is not neutral, but comes in a given socio-economic-cultural-political package. It is

\textsuperscript{162}The U.S. and China have had problems in agreeing on an investment treaty but OPIC insurance is available for U.S. investment in China, and OPIC has been active in China investment promotion. A double-tax convention was ratified 96 to 1 on July 23, 1986, in the Senate. (\textit{China Daily} July 25, 1986)
linked to a given economic base. Chinese students abroad are a conduit for the transfer of technological influence to China. The U.S. has received more than one-third of all the Chinese who have been sent abroad to study the technologies of the developed countries since the opening to the outside world in the late 70s. In 1986, fifteen thousand advanced Chinese students (9,000 government sponsored) are being educated in the U.S. and learning about technologies which could be applied in China tomorrow. Although the student training is not aimed directly at obtaining U.S. commercial advantage, technology preferences are being ingrained in a way that will eventually serve the U.S.-China commercial relationship.

e) U.S. agency support

The Chinese have difficulty understanding the division between U.S. government and U.S. business in foreign activities. They have observed the close relationship between government and business which prevails with other country programs in China, particularly with the Japanese. They expect that, similarly, government and business would work together on U.S. programs in China. They seem gratified and reassured when this appears to be the case. Fortunately, because of the large number of U.S. agency programs in China, the possibility of collaborative U.S. business-

government activity may, in fact, be wider in China than in any other country.

The large number of U.S. agency programs indicates the extent of U.S. official interest in Chinese development. Even those U.S./China S&T exchange programs, which are more science than technology, provide indirect support to U.S. business through the availability of accumulated knowledge, useful in marketing, about the progress the Chinese are making in a particular development area.

The U.S. has no aid program for Communist China. Japan, and the other Western nations, do have aid programs. The lack of U.S. aidollar support makes these other U.S. agency programs all the more important for support of business. The programs provide resources capable of supporting a broader program of U.S. technology sales of satellite communications to China. To take advantage of them, businessmen must moderate their inbred antipathy to working with government, and overcome their unfamiliarity with U.S. agency program. Both are possible.

1. Trade and Development Program (TDP)

TDP, separately budgeted, but considered by Congress along with the AID program, provides financial support for project identification and feasibility studies for Chinese priority
projects which promise a value multiple in U.S. exports. China has become a major focus of the multi-million dollar TDP program. On the presumption that U.S. aerospace companies had a good chance to win a satellite export contract, TDP offered to fund a $200,000 feasibility study of satellite communications systems for China. Even though, after considerable negotiation, the study proposal was finally dropped by the Chinese, the U.S. had at least demonstrated to Chinese officials its willingness to support feasibility studies for U.S./China aerospace development. Such studies could be important as the U.S. presses ahead with space communications programs in China.

11. COMSAT

As an indication of Chinese faith in the U.S. agency's independent technical judgment, the Chinese asked the U.S. representative to INTELSAT to provide technical assistance in preparation of the 1984 request for proposals to supply a satellite system. Subsequent to the Chinese withdrawal of the RFP, COMSAT made an abortive attempt to sell China two satellites COMSAT had ordered, but which COMSAT decided not to program. 164 With its interest in satellite sales set aside (the satellites were sold elsewhere), COMSAT is in a position to offer significant

164 COMSAT was offering fully-manufactured direct broadcast Ku-band satellites, while the Chinese were interested in technology transfer through participation in the assembly of C-band satellites. COMSAT's two satellites have since been sold to a U.S. company for TV broadcasting in the U.S.
support to U.S. participation in satellite programs in China, particularly in the area of systems design. As pointed out below, COMSAT can also offer to Chinese technicians COMSAT courses in satellite management in COMSAT facilities.

iii. Science and Technology Protocol

After three years of negotiation the signing, in May 1986, of the protocol for U.S.-China cooperation in telecommunications science and technology, should be one of the most important agreements in the growing technological relationship of the two countries. Among other things, it provides a basic instrument for the promotion of U.S. private sector participation in China's telecommunications development. The U.S. agency administering the agreement is significantly the National Telecommunications and Information Administration (NTIA), a part of the Department of

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165 The protocol is the latest of 20 agreements negotiated under the 1978 umbrella agreement for S&T exchanges. The telecommunications agreement was held up at one point because of disagreement within the U.S. Government as to whether fiber optics were too sensitive a technology for exchanges with China. Fiber optics were eventually excluded, even though TDP identified several projects for U.S. participation. The Chinese have continued to develop fiber optics on their own, and in agreements with Italy and the Netherlands (Communications International, London, June 6, 1986). AT&T is also reported to be working with China on fiber optics.

166 In 1984, Congressional hearings on the protocol, Representative Al Swift (D-Wash.) promoted the protocol as providing important telecommunication trade opportunities for U.S. companies. (Bureau of National Affairs, August 15, 1984.)
Commerce. The Chinese administering agency is the Ministry of Posts and Telecommunications.

As indicated earlier in this report, in the final version of the protocol the Chinese understandably omitted references to the need for U.S. help in telecommunications management and planning which appeared in earlier versions. Nevertheless, the Chinese officials, who came to the U.S. for the signing, assured NTIA that, although no longer specified in the protocol, management and planning recommendations are welcomed. The Chinese officials suggested the recommendations be included in the China study to be conducted by the mixed U.S. Government-private sector expert delegation which is a principal feature of the protocol.

The U.S. expert delegation, divided into several sections, will include a satellite communications company, plus at least seven other U.S. telecommunications companies, and three or four government reps. They will be in China for three weeks in the fall of 1986. The U.S. experts are invited to study the status of China's civil telecommunications industry, including facilities operations and scientific and technological development.

Providing it is made up of technicians, and not marketing managers, the U.S. delegation will be in a position to gain commercially valuable insights into the state of China's telecommunications technology and her technical import
requirements. Traveling under the right auspices, it will be able to access many more important officials and much more market information than would be possible under normal circumstances. A Chinese return delegation of ranking telecommunications officials is to come to the U.S. in the first half of 1987 to examine the production and operation of American civil communications. In addition, the Chinese will be attempting to work out details of bilateral cooperation in telecommunications technology and application of communication systems. One of the listed individual technical exchanges calls for the U.S. to send an expert to lecture on satellite communications.

An extensive protocol annex is designed to ease concerns and head off disagreements about the handling of confidential information developed or exchanged under the protocol. The provisions are necessary to stimulate a frank technical exchange, and grow out of U.S. experience with previous protocols. Exchanges under the long-awaited protocol will be important to the creation of a setting for enhanced satellite communications technology transfer. But it is essential that the U.S. take early and full advantage of the opportunities presented. Competing countries will be signing similar protocols with China, if they have not already done so.167

167 Direct assistance for U.S. business is provided as well under the Department of Commerce, January, 1984, Industrial Cooperation Accord with China. Under the accord, the U.S. is to provide private sector technology to support the PRC's priority program for technical renovation of existing companies.
iv. A NASA Exchange?

The S&T exchange agreement of the greatest significance for cooperation to enhance U.S. participation in China's space and space communications program would be an agreement between the Ministry of Astronautics and NASA. Without an exchange agreement which involves the world's premier space agency, U.S. Government support for a wider U.S. role in China's space development will lack validity.

For its part, NASA has not been very interested in the proposed S&T exchange with the Chinese. In 1981, when negotiations started, China had agreed to consider purchase of several satellites and related equipment from the U.S. When this did not materialize, NASA's interest in technical exchanges slackened. Throughout the protracted negotiations, NASA has felt that the Chinese were asking for a lot and offering very little in exchange. NASA says the project is now on the "back burner" until the agency can complete the realignment necessitated by the shuttle disaster. Also necessarily on hold is the NASA project to include a Chinese payload specialist on a future shuttle flight.

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168Peter Smith, NASA's Chief, International Political Programs, has been one of the principals in the negotiations with MOA.
For their part, the Chinese have been frank in expressing their disappointment at slow progress on what they consider to be a most important exchange in a high tech area where they have demonstrated outstanding capabilities. They have implied that NASA's reluctance demonstrates official U.S. unwillingness to engage in technology transfer arrangements related to space. Dragging the problem out into the open at a space conference in Italy in 1985, Yang Jiachi, MOA Chief Engineer, addressing the conferees, said: "We are willing to cooperate with all countries in the field of space, but we place special emphasis on cooperative relations with European countries and hope to make it more substantial. In 1981 we began to explore cooperation with NASA. But it was only in 1984 that a preliminary agreement between the two sides was reached on five joint science projects."\(^{169}\) Updating the Chinese disappointment, Wu Jiaxiang, Director of the Satellite Office, SSTC, told the study team in Beijing in May, 1986, that China has done all possible to get an exchange going, and that it was up to NASA to close in on an agreement.

It appears to the study team that it might be worthwhile for NASA to at least take another look at the proposed protocol with the Ministry of Astronautics.\(^{170}\) NASA might even consider a

\(^{169}\) *AXST*, April 8, 1985.

\(^{170}\) Failure of the U.S. to respond to Chinese overtures leaves room for others who see strategic as well as commercial possibilities in space cooperation with China. As reported in the
broader exchange than the limited space science exchange now contemplated. Whatever NASA's future role, whether as a commercial or a technical agency, NASA's participation in exchanges with China would signify full U.S. Government support for U.S. involvement in China's growing space program. It would also provide an additional vantage point from which trained observers could monitor the Chinese efforts.

v. Telecommunications Training Institute

The United States Telecommunications Training Institute (USTTI)\(^{171}\) is a facility, which has been principally developed by the U.S. private sector, and is available to support training which will facilitate technology transfer from the U.S. The institute was founded as a result of the efforts of a U.S. private/public delegation to the 1982 International Telecommunications Union Conference. At the conference, the delegation discovered a compelling unmet need in developing countries for more hands-on and managerial training in telecommunications. The institute course (several months in duration) are presented in the training facilities, laboratories

\(^{171}\)U.S. press (Wall Street Journal, July 29, 1986), Gorbachev's Vladivos'ok speech, after offering concessions on "three major obstacles" China has cited in relation to improved relations, also suggested the possibility of joint space exploration and the training of Chinese cosmonauts in the U.S.S.R.

\(^{171}\)Information on USTTI from Raymond B. Crowell, Senior Director International Planning and Liaison, COMSAT.
and factories of a dozen major U.S. telecommunications companies. Pertinent courses are: Satellite Communications Management (COMSAT), SCPC Satellite Systems for Rural Communications (M/A Comm), and Satellite Systems Applications for Rural Communications (AID Rural Satellite Programs). USTTI supplies "training that will hopefully insure that people in all corners of the developing world have an opportunity to participate in the technological benefits we enjoy in the United States."172 As a practical matter, the more the developing countries advance technologically the better customers they become for advanced U.S. telecommunications technology. Training in U.S. company facilities permits identification of the needed U.S. technologies by the Chinese technician who may eventually use them.

To date, the PRC has remained generally unaware of the potential of USTTI to provide for many of their technical training needs. Jun Jun, Deputy Director of Science and Technology for the telecommunications ministry, who was interviewed by the study team in Beijing, and who led the Chinese delegation for the signing of the telecommunications protocol, did not know about USTTI. Of the 500 graduates of USTTI, only two (both within the last year) were from China. USTTI training at U.S. companies will be available to Chinese communications technicians as a follow-up to the U.S. delegation's study of the status of China's terrestrial and

172From the USTTI 1986 Annual Report.
satellite communications under the telecommunications exchange protocol.

vi. EXIM

The U.S. Export-Import Bank has previously been known in the China trade for its low profile and high interest rates. The dramatic 1986 change in the U.S. interest rate situation is leading to a change in the previous image of EXIM. Since the early 1980s, the EXIM interest rates offered to China have declined gradually from a high of over 10 percent to a new low of 7.4 percent for the second half of 1986. The new rate, lower than World Bank rates and the lowest allowed by OECD, can put EXIM back in the picture in an area where Japan and the Europeans, with large and comparatively low interest development credits, have been dominant. EXIM has let it be known that EXIM is willing to provide follow-on financing for U.S. technology suppliers taking advantage of opportunities provided by TDP-funded feasibility studies for China projects. EXIM has chalked up outstanding offers to China of $200 million to date. With the new rate, the bank expects up to $300 million in export credit requests during the third quarter of 1986. The Chinese will be pleasantly surprised at the new evidence of U.S. Government agency willingness to support technology transfer.¹⁷³ U.S. aerospace

¹⁷³Based on a report in China Market Intelligence, National Council, August, 1986.
companies which have made frequent use of EXIM credits in other parts of the developing world, can now look forward to their possible use in China.

4. Some U.S. marketing problems

a) Discouraged companies

U.S. companies competing for China's proposed purchase of satellites have spent very large sums of money, and devoted much company time, to pursue, what promised to be, both a very substantial sale, and a chance to establish a firm lodgment in a very promising market. 174 When the initial sale possibility evaporated, and then, several years later, the revised Chinese satellite purchase proposal was "postponed", these companies experienced a good deal of executive disenchantment with the China market. Lack of enthusiasm for satellite communications sales would be understandable.

The satellite postponement scenario, unfortunately, is typical of a number of other prominent China scenarios which feature the same kind of heavy investment of the foreign suppliers time and money up front followed by long delay and possible eventual disappointment, or perhaps questionable achievement.

174 Hughes was estimated to have spent $500,000 on the 1979-80 projected sale alone. GE expenditures were estimated at $300,000. See Karen Berney, CBR, March-April, 1981.
U.S. executives who see long-range potential in China cannot be sure that controlling interests in their companies are not more easily discouraged, have less patience and persistence, than their competitors in the China market.

It is alleged by an experience non-U.S. trader in Hong Kong that American companies have been spoiled by the American market. U.S. companies, he maintains, expect to return a profit within two or three quarters after the initiation of a venture in China. The critic insists that the only way to approach the China market is to be prepared for the long haul, with minimum profitability at the outset, while waiting for the market to grow. The approach suggested is not antithetical to that taken by a number of American companies involved in China. Yet American stockholders do want action, and there are many easier places to make money than China, so company management is hard put to defend long range opportunity against persistent Chinese inability to make big purchasing decisions. Fortunately, none of the firms involved in the satellite RFP are ready yet to call it quits. They are large firms with other business interests in China.

175 Traugott Goll, Jebsen and Company.
5. **Export licensing - the biggest problem**

a. U.S. national controls

To gain an impression of the relationship of U.S. controls to possible satellite communications sales, the study team held interviews with U.S. officials and U.S. firms concerning the effect of export licensing. The impression obtained is that, despite repeated, and partially successful efforts by U.S. officials to liberalize and expedite export approvals, the businessmen and even some of the bureaucrats, continue to feel that U.S. national controls put U.S. firms at a competitive disadvantage. Not surprisingly, the Pentagon, as the ultimate guardian of U.S. security interests, is held to be the principal barrier to export license approval.

A recent Pentagon ruling against equipment for networking of computers (a system potentially useful in satellite communications systems) has disappointed U.S. marketing companies in China. The companies say the Pentagon believes that tying computers together multiplies their power. In fact, the Chinese generally under-use the computers they have. The companies insist that networks are only a device that saves the time of running a messenger between individual computers. They maintain that it will only be a short
time before competing countries will sell the networking equipment to China.¹⁷⁶

The State Department's Office of Munitions Control (OMC) is involved in satellite communications technology licensing. OMC initially screens export licenses for items on the Munitions List. The list includes satellites. OMC says it gets a great deal of pressure for advance approval of U.S. exports from both Chinese potential buyers and hopeful U.S. sellers. The office is at pains to explain to the Chinese that OMC reacts only to specific export requests from U.S. companies. OMC will not give U.S. firms a prejudgment before it has received a license request, otherwise, OMC says, the U.S. firms will be selling right up to the technology ceiling, and then asking that it be lifted. A ranking OMC official concedes that technology ceilings are constantly being raised, and that a good deal of the pressure is coming about as a result of liberalized licensing by competing countries.¹⁷⁷

¹⁷⁶ The American High Tech Forum including Honeywell, AT&T and GE.

¹⁷⁷ The OMC official, Steve Komanelis, is Special Assistant for Space, so he is talking to the problem of satellite technology licensing. He is faced with the twin pressures of U.S. supplies and European suppliers. European suppliers, taking advantage of more liberal national licensing policies and the informality of COCOM controls, export to China technologies which would not be licensed for U.S. export. Providing the U.S. suppliers can provide evidence of the competitive "end run," OMC is forced to follow the leader and license the same technology for U.S. export.
The China desk in Commerce could not document cases of U.S. companies having lost a sale to foreign competition as a result of the U.S. company's inability to come up with an export license while competitors were able to do so. The desk has heard (as did the study team) U.S. companies allege that this occurs. In the desk's view, it is more likely that the Chinese would cancel an order because U.S. licensing procedures simply take too long, and certainly longer than countries competing with the U.S. The Chinese could use this as the reason for backing out of a deal, even though the real reason could be that they had run out of money or simply changed their mind.

Some U.S. firms agree that U.S. licensing delays are the biggest problem. Robert McDonald, who heads Honeywell's China Office in Hong Kong, says that, after initial submission, applications are simply "nibbled to death" with revisions and questioning.

Jeff Lee, on the Commerce China desk, suggests that a U.S. exporter might seek an initial sale to maintain competitiveness and show some success in the China market. Having proceeded with the easily-licensed segment first, he would then, further down the line, run into licensing problems with more questionable segments.

Commerce officers concede that U.S. export licensing is slow and painful because of the huge size and complexity of the U.S.
bureaucracy. Many more approval agencies have become involved in the process here than in other countries. In Japan, for instance, MITI alone handles the whole process. U.S. Government officers also admit that bureaucratic attitudes cause temporizing. Each of the U.S. Government agencies concerned conscientiously examines the many U.S. license requests against its own agency definition of national interest. While the governments of competing countries are looking for a way to make the rules bend for exports, the U.S. Government is looking for ways to prevent the exporters from bending the rules.

Some U.S. companies complain that the system of ad hoc licensing results in approval or disapproval depending on whose desk in the Pentagon the request lands. They say that subjective decisions result in two technologies at the same technological level getting two different reactions from the licensing authorities -- one approval and one disapproval.178

A U.S. company describes a type of post-purchase export control on the flight control inertial guidance system for a Boeing 767 sold to China. No spares are allowed to be kept in China. If a unit fails, it is sent back to the supplier in return for a replacement. The apparent presumption behind this procedure is that the Chinese will not ground the plan long enough to study

the system. Yet even a well-scheduled airplane spends enough time on the ground for Chinese "students" to become familiar with the system.\textsuperscript{179}

In the Chinese capital, the study team learned that the U.S. business community in Beijing was so exercised about loss of sales, as a result of over-zealous application of U.S. licensing controls, that they had organized a High Tech Forum which includes major U.S. telecommunications and aerospace companies. The team attended the first meeting in April, 1986, of this unusual voluntary association of U.S. company reps with a common cause. At the meeting, forum members were enjoined to provide the Embassy with hard evidence of loss of sales on products which were refused by the U.S., but licensed by competitors.\textsuperscript{180} The problem with the Forum's approach is that even abundant evidence would indicate, after the fact, where U.S. controls were wrong without making them right. Meanwhile, the U.S. business community in Beijing was wrestling with another licensing problem -- how to operate under a new system of end-use certificates imposed by the Chinese in an effort to comply with U.S. and COCOM export regulations.\textsuperscript{181}

\textsuperscript{179}Bob Berry, Director, Ford Aerospace.

\textsuperscript{180}Two months after the meeting, the evidence had not reached Washington. Such evidence is hard to come by, and sometimes painful to submit.

\textsuperscript{184}The system had just been disclosed at the time of the study team's visit to Beijing in February 1986. The U. S. Embassy was to seek clarification and simplification.
After obtaining hard-won approval from U.S. national licensing authorities, the would-be exporter faces another barrier, the multi-national scrutiny of his export license application by COCOM.

b) COCOM

The Coordinating Committee (COCOM) is an informal arrangement between governments which reviews applications from member countries (the industrialized democracies) for the licensing of technology for export to Communist countries. COCOM does what it was intended to do -- discourage the export to Bloc countries of technologies which could be used against Western interests. There is a body of opinion in the U.S. export community, however, which holds that COCOM overdoes what it does, and adds greatly to the difficulty of technology trade with China.

Reported here is a composite of the frequently-stated views of aggrieved U.S. businessmen and concerned bureaucrats who agree that COCOM erodes the U.S. market position in China because companies in competing countries are consistently able to use COCOM to obtain advantage over U.S. companies. A sampling of views:
Since it requires unanimity, COCOM is a horsetrading organization which is used by its participants to get around licensing restraints. The approach is: "I'll approve your license, if you approve my license."  

Whichever country is most conscientious about using referral to COCOM to resolve licensing doubts will suffer the largest commercial loss. That country is the U.S., and even U.S. officials acknowledge this.  

The new COCOM system of broadening the discretionary authority of individual countries with post-hoc reporting, is a system of recording licensing abuses which have already occurred.  

Enlarging the degree of national discretionary authority on licensing submission to COCOM, enlarges the opportunity for competitors with the U.S. because they are habitually less discrete.  

Although COCOM attempts to establish technical parameters for impermissible exports, there are numerous ambiguities which can work against U.S. commercial interest.

182 Richard Abington, GE, Hong Kong.  
183 OMC's Koumanelis.
- COCOM diverts China trade into roundabout channels. For instance, Japanese exports to Singapore of items which are impermissible for export to China can then be reexported from Singapore to China.\textsuperscript{184}

- National authorities of countries competing with the U.S. "cheat" by using less rigorous national export licensing procedures, and by not referring exports to COCOM.\textsuperscript{185}

- The U.S. refers by far the largest number of cases to COCOM so the U.S. has the most to lose by protracted COCOM consideration which can run up to a year.

- It is better to submit a "laundry list" of related license requests (as the Europeans do) than individual, ad hoc requests (as the U.S. does).\textsuperscript{186}

\textsuperscript{184}This, and the preceding three statements, were voiced at an OTA panel meeting in March, 1986.

\textsuperscript{185}Richard Kask, GE.

\textsuperscript{186}Dan Hoydysh, Office of Technology Policy and Analysis, Dept. of Commerce. Also the preceding statement.
6. Chinese perceptions of U.S. technology transfer

Chinese perceptions of the U.S. attitude toward assisting China's economic development have become a very important factor in shaping the pattern of U.S.-China relations. The study team found that the Chinese have broadly-shared, and strong views, about U.S. technology sales to China. In essence, the Chinese feel that the U.S., which has the most desirable technology, is not doing what it could and should to transfer that technology to China. Whatever its validity, the Chinese view persists, is repeated to all U.S. visitors, and clouds the U.S.-China relationship.

Aware of Chinese sensitivity on this score, in their 1985 visits to China both Vice President Bush and Commerce Secretary Malcolm Baldridge made explicit promises to speed the process of U.S. export license consideration. The significance of our self-imposed technology transfer limitations was underlined once again by the new U.S. Ambassador Winston Lord, who told the May 28, 1986 annual meeting of the National Council for U.S.-China Trade in Washington that the U.S. must continue to monitor its technology transfer policy to insure that sales of appropriate advanced technology to China are not hampered by U.S. Government restrictions.

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E. IMPACT ON THE UNITED STATES

1) China, 1986

Ten years ago, 1976 was the year everything changed for China. The Cultural Revolution came to an end. Chou Enlai died. Mao died. The "Gang of Four" had tried to take over from the dying "Great Helmsman" who had steered so erratically. They were arrested by the gang-busting, twice-purged and rehabilitated, chain-smoking, septuagenarian who set China's socialist development on a whole new course. The Deng Dynasty, China's second socialist dynasty, had begun. It was, as Deng himself acknowledged, the beginning of a "second revolution."

At the end of the first decade of the Deng Dynasty, it would appear that the paramount leader, now 81, has (fortunately for China's stability) lived long enough to set China firmly on the new course he has charted. Dengism in altering the basic nature of China's political and economic system, and reshaping its society.187

The Dengists have no hidden agenda. Their objective is clearly stated. They aim to make socialism work as the system which will modernize China. Internally, Dengism means development


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through economic reform together with decentralization, increasing use of market forces, and entrepreneurial incentives. Political reform—separating the party and the government—is next on the Deng agenda.

Externally, Dengism seeks infusions of modernizing technology through an opening to the outside world which has brought a rapid expansion of economic relations with the industrialized democracies. Thousands of Chinese students flock to the U.S. and other Western nations. China says it follows an "independent foreign policy of peace" because it will be impossible to bridge the gap of "backwardness and poverty" between China and the developed countries "without decades or even a century of peaceful economic development." And because economic development and expansion of military strength are "mutually exclusive", China is deemphasizing its military by drastically cutting its forces, reducing military budgets, and converting military to civilian production.

But China's history since the 1949 communist takeover has been one of abrupt policy changes accompanied by widespread

188 From General Secretary Hu Yaobang's address to the British Royal Institute, June 11, 1986

189 While the Maoists believed war was inevitable, the Dengists declare that "the growth of the forces for peace in the world will outpace the growth of the forces for war." (Deng to the 3rd Plenary Session of the Central Advisory Committee, October 22, 1984 in FBIS, China, January 2, 1985.)
economic and social disruption. So it is appropriate to question the stability of the Dengist leadership and its policies.

Deng is a very experienced and capable politician. He has directed a campaign of methodical "rectification" which has eliminated many of the "Gang of Four" adherents and cultural revolutionists ("left deviationists") in the party, the army, and the government. Dedicated younger Dengists have been installed in place of the deviationists. At the same time the leadership has acquired wide popular support through reform-induced improvement in the standard of living, especially in the countryside where 80 percent of the population live. A well-administered effort has been made to regain the support of intellectuals and technicians disaffected by the excesses of the Cultural Revolution.

It seems unlikely that there would be a change of leadership that could reverse the Dengist directions and lead China back towards the chaos from which it has come. In fact, opposition to Dengism appears to be centered, not on the Dengist reforms themselves, but on some of the characteristics of the reforms, and the speed with which they are being implemented. The leadership has responded to public concern about corruption spawned by the new economic freedoms, and has vigorously pursued an anti-corruption campaign. Deng has resolutely resisted the establishment of a Deng personality cult so that, after the old man goes, Dengism can survive without Deng.
And how does satellite communications fit into the picture of China in 1986? China's success in establishing a satellite communications system is outstanding evidence of the self-generated technological capability China can bring to bear on the problems of modernization. The highly-publicized occasion of the successful orbiting of China's second communications satellite was the occasion for national rejoicing and an outpouring of national pride. At the same time, the admitted limitations on China's technical capability to maintain the pace of satellite communications development is a demonstration of the importance of opening to the outside world for transfer of needed technology. Satellite communications promise to support and enhance the leadership's efforts to bring one quarter of the world population into the world community, and give China a chance, during the 21st century, "to join the ranks of the advanced nations."

2) The U.S.-China Relationship and U.S. interest

In preparation for the study, and in order to establish a framework for the examination of satellite technology transfer to China, the study team interviewed key individuals in U.S. agencies involved in the development of U.S. China policy, particularly U.S. economic policy (list attached). There was general agreement as to what U.S. policy is. There was also unanimity of opinion on
the importance of technology transfer to the maintenance and development of U.S. policy.

Since U.S. recognition of China in 1978, the China policy that has emerged has enjoyed strong bi-partisan support. The U.S. recognizes the People's Republic as a friendly, non-allied country. Our policy is to keep China secure, independent, peaceful and developing. Achievement of this goal is fundamental to the success of overall U.S. policy in Asia and the Pacific. Policy implementation is based on a convergence of interests, including shared strategic objectives and mutually advantageous economic cooperation. Perceived benefits have been such that the two sides have put aside differences over Taiwan and alleged U.S. protectionism while continuing to develop their relationship.

Strategically, the U.S. and China have a current common interest in opposing Soviet expansionism in the Pacific. In support of this convergent interest, the U.S. is assisting China's conventional military development with defensive weapons and related equipment. In return the Chinese provide the U.S. with technical windows on the Soviet Union and facilities which are beyond the purview of this report. But the military/strategic relationship is limited. While China is deemphasizing the military and following an "independent foreign policy of peace," it would not want to alarm the Russians. The U.S., furthermore,
does not want to support a military buildup on one side of the Taiwan Straits.

On the other hand, U.S. participation in China's economic development provides unlimited opportunity for strengthening the interrelationship of the two countries. Other countries, particularly the other industrialized democracies, are competing in the China market. China's near neighbor, Japan, has a trade with China almost two and one-half times our own. And Hong Kong, on China's doorstep, nearly doubles our trade level. But the U.S., as number three, has a China trade of better than $8 billion, with U.S. exports increasing at 27 percent in 1985, and with U.S. machinery and transport equipment (the principal export at nearly $2 billion) more than doubling in value between 1984 and 1985. Furthermore, as indicated in the foregoing, China has stated a preference for U.S. technology, particularly in areas of critical importance to Chinese development—energy, transportation and communications. In these areas, U.S. suppliers have a very large potential market in the expanding China economy.

Along with other modernizing technologies, China has extensive need for transfer of U.S. satellite communications technologies. At the same time, the suppliers of that technology do not fear possible Chinese competition as a result of the transfer of that technology. China's emergence as a space power, including her success in the satellite area, indicates a broad
potential technology market. To provide direct and indirect support for marketing efforts, there are a variety of U.S. agency China programs available to U.S. suppliers. Familiarity with, and respect for U.S. technology is also being established through the thousands of Chinese students sent to this country.

Unfortunately, as stated above, the Chinese appear to believe that U.S. policies inhibit the transfer of technologies. Chinese officials have publicly contrasted their inability to obtain NASA's consent to a space science exchange with the eagerness of European national space agencies to develop S&T exchanges with China.

The Chinese concept of U.S. reluctance to transfer appropriate technology is, in itself, an inhibiting factor in the development of an orderly technology trade. It also inhibits the development of our China relationship as a whole. The Chinese have wanted the U.S. to play a key role in the technology transfer on which China's modernization depends. Chinese disappointment has been invariably manifested to every high level U.S. visitor to China in the last several years. The solution to the problem of expedited technology transfer lies on the U.S. side. If the U.S. is to maximize its influence on China's evolution as a constructive force in the world community, a solution must be found.
3) **U.S. policy options for transfer of satellite telecommunications**

It is assumed that China will continue to develop in much the same manner as at present. Economic reforms will be pressed. The Dengists will remain in power. China will remain open to needed technology imports, principally from the West and from Japan. The following three policy options represent the spread of options open to the U.S.

**Policy Option One.** Tighten up on the restrictions covering technology transfer to China. Prevent U.S. export of all satellite communications technologies which could be used for production in competition with American production, or could be used, either directly or indirectly, in military applications.

**ADVANTAGES**

A. In case China were to turn against us, we would have done nothing to strengthen her military capability.

B. China could not use American technology to turn out products that compete with American products and cost U.S. jobs.

**DISADVANTAGES**

A. Any roll-back of long-standing U.S. policy to respond to Chinese requests for U.S. technology, when the technology is non-damaging to U.S. national security interests, would damage the
delicate fabric of U.S.-China relations and work against U.S. strategic and commercial interests in China.

B. Current Chinese irritation at U.S. technology export restrictions would be greatly increased while U.S. technology exports themselves would be greatly reduced to the advantage of U.S. competitors.

C. Other COCOM countries could use their discretionary authority to license exports restricted by U.S. national policy. The market would be left open to competing countries. Chinese interest in technology transfer from the USSR would also increase.

D. U.S. government programs for technical exchange with China would be considerably downgraded.

E. Pacific allies of the U.S. would be concerned because U.S. participation in Chinese economic development would be reduced along with U.S. influence on China. The concern would be magnified if, at the same time, we continued to press a program for transfer of military technology to expand Chinese military capability.

Policy Option Two. Continue our present policy of guarded response to Chinese interest in U.S. technology. Continue current attempts to simplify and expedite export licensing
procedures. Broaden the U.S.-China technical exchange to include exchanges in satellite telecommunications technology.

ADVANTAGES

A. Being responsive, within limits, to PRC requests is a non-controversial approach which accords with accepted U.S. policy towards a friendly, non-allied nation.

B. To the extent that our own national licensing controls, and our use of COCOM, parallel those of our competitors, we would have an equal marketing opportunity with them in China.

C. Chinese preference for U.S. technology, which is now being priced in more competitive exchange dollars, would permit the growth of the U.S. market share. This would be particularly true in satellite communications where the U.S. is the acknowledged technological leader.

D. Inclusion of communications satellite technology in the S&T exchange agreements would improve the prospects for U.S. technology trade in this area.
DISADVANTAGES

A. Business as usual is essentially a laissez faire policy which fails to use the available influence of a positive American technology transfer program to enhance our China relationship.

B. A cautious, gradual improvement in our export licensing approach, which gives China half a loaf, is not going to dispel Chinese suspicion that the United States, as a matter of policy, is withholding appropriate technology from China.

C. Since U.S. competitors are able to use COCOM licensing referrals to better advantage than we, leaving COCOM as is, means further erosion of the U.S. competitive position. Also, U.S. national controls have generally resisted efforts to speed processing.

D. A tardy and limited technology exchange program, utilizing NASA and NTIA, does little to put the U.S. inside China's developing space and space communications industry.

POLICY OPTION 3. As the forerunner of a new positive program of U.S. technology transfer to China, take satellite communications as a model and develop a coordinated transfer program bringing together U.S. public and private agencies with existing China programs.
ADVANTAGES

A. Satellite telecommunications technology transfers would be the first phase of a U.S.-China partnership in a joint program for development of civil use of space. This is a role for which the U.S. is best suited, although Europeans, Japanese, and of course, Russians, would also like to play it. The U.S. would be wired into the Chinese space program from top down. Presumably, we could put up with envy and chagrin in Moscow. (In his August, 1986 speech in Vladivostok, Gorbachev proposed Chinese-Russian space cooperation.)

B. China-U.S. relations would receive a powerful stimulus. The U.S. would be helping to justify the Dengist opening to the outside world by our willingness to take the initiative in a program to assist Chinese modernization in a highly visible technical area, and one in which the U.S. has acknowledged technical superiority.

C. Chinese suspicions of a restrictive U.S. technology transfer policy would be eliminated.

D. The existence of a graduated program of satellite communications technology transfer would, in itself, help to create in China conditions for a successful transfer through a
graduated program of phased technology absorption. The program would include provisions for upgrading and modernizing the Chinese satellite communications production infrastructure to support an advanced satellite communications system. For their part, the Chinese would be forced to develop an overall strategy for communications development in which satellite communications would have an allotted place.

E. A positive graduated program for technology transfer in satellite communications takes advantage of the rare convergence of views within U.S. government agencies on the value of such a program. The study team obtained converging views from the following U.S. agencies: State, Commerce, DOD, NASA, NSC, EXIM, TDP, NTIA, and COMSAT.

F. A positive program opens the possibility of utilizing a number of available U.S. agency programs in the first concerted U.S. technology transfer effort. Programs include the following:

(1) NASA space science exchange (not yet signed by the U.S.).

(11) NTIA telecommunications exchange.
(iii) Commerce-supported U.S. space company trade delegation and technical mission including study of technical transformation of Chinese space infrastructure.

(iv) Commerce' Dalian Management Institute. (Satellite communications management program.)

(v) OPIC communications investment mission.

(vi) TDP feasibility study for Chinese satellite communications management and earth segment refurbishment contracts. (Coordinate study proposal with Dept. of Commerce U.S.-China Industrial Exchange Agreement.)

(vii) EXIM precommitment to support U.S. firms responding to Chinese satellite RFP or technical sales possibilities developed through missions or exchanges.


(ix) Telecommunications Committee of the National Council, develop program proposals for pressing the U.S. commercial
advantage through coordination of U.S. commercial technology sales with U.S. agency program efforts.

(x) United States telecommunications training institute.
(Inform appropriate Chinese agencies of availability of satellite communications courses in U.S. company facilities. Embassy Commercial Section to do the informing.)

G. U.S. space companies seeking a China market position would find that U.S. agency program support had resulted in the opening of some formerly closed segments of the PRC satellite communications support infrastructure.

H. Technology licensing would be handled in a unified fashion rather than through single submissions for individual approval. A list of basic satellite communications technologies to be offered to the Chinese would be drawn up by Commerce with the advice of COMSAT and the National Council.

I. COCOM would be made to work to the U.S. advantage by U.S. submission of a unified satellite communications technology list (already cleared at U.S. national level) for blanket approval in advance of possible export to China. The U.S. would not have an exclusive on this technology export possibility. Other countries could subsequently offer the technology to China. The U.S., however, would have the jump on its competitors, and no
other country would be in a position to offer as complete an array of technologies as the U.S.

J. The Pacific allies of the U.S. would be heartened by evidence of U.S. determination to assist China's development in areas other than conventional arms. They would also welcome expansion of Chinese satellite communications which link China with the outside world and inhibit China from turning back inward.

DISADVANTAGES

A. Even though Chinese civil communication improvement is brought about by satellite communications technology transfer, Chinese military communications would be strengthened as a byproduct.

B. It is extremely difficult to weed out of satellite communications systems technology those items which, if transferred, might be of assistance to China's strategic missile program. The U.S. would thus assist the development of this program, even if indirectly.

C. There is no guarantee that, after the U.S. has developed an approved satellite communications transfer program, the Chinese will not decide to opt for satellite communications technologies offered by competing countries with price subsidies or with other
commercial enticements the U.S. cannot, or would not care to, match.

D. There would remain a possibility that, after the United States had become deeply involved in a combined U.S. government/U.S. business technology transfer program, the U.S.-China relationship would suddenly cool, and the program collapse. Differences over Taiwan, the Philippines, Korea, or a Chinese internal political turnaround, are all examples of possible chilling factors in the U.S.-China relationship.
CZ-2C/OTM MULTIPLE SATELLITES MISSION

* CZ-2C: Long March 2C Launch Vehicle.
* OTM: Orbit Transfer Module is a small upper stage used for speeding the satellite into higher orbit.
* Lift-off mass: 191,000 kg.
* Lift-off thrust: 284,000 kg.
* Overall length: 38.4 m.
* Maximum diameter: 3.35 m.
* Upper fairing diameter: 2.25 m.
  Static envelope diameter: 2.0 m.
* Lower standard attach fitting diameter: 1.6 m.
  Lower OTM maximum diameter: 1.5 m.
* Parking orbit payload capacity:
  \[ 1,700 \text{ kg}(H_p=200 \text{ km}, H_a=1,000 \text{ km}, i=63.4) \]
  \[ 1,200 \text{ kg}(H_p=200 \text{ km}, H_a=900 \text{ km}, i=98) \]
* Usable weight for satellites and their OTM:
  \[ 1,000 \text{ kg}(i=63.4, H_a=1,000 \text{ km}) \]
  \[ 750 \text{ kg}(i=98, H_a=900 \text{ km}) \]
* Separation:
  Nose cone fairing & two side doors
  Fairing: radial separation; upper satellite: axial separation; lower satellites: radial separation (frisbee deployment.)
* OTM are fired at apogee point.
Figure II

CZ-2C/OTM MULTIPLE SATELLITES MISSION.
Figure III

CZ–3 GTO MISSION.

* Three–stage. Cryogenic 3rd stage.
* Lift–off mass: 202,000 kg.
* Lift–off thrust: 284,000 kg.
* Overall length: 43.25 m.
* Maximum diameter: 3.35 m.
* Diameter of 3rd stage: 2.25 m.
* Fairing diameter: 2.60 m.
  Static envelope diameter: 2.30 m.
* GTO capacity: 1,300 kg.
  \( H_p = 200 \text{ km} \)
  \( i = 28.5 \text{ deg} \).
* Suitable for launching PAM–D class communications satellites, such as:
  HS–376 and RCA S–3000.
* Separation: axial separation.
## Reference

### TABLE I

**TV Stations and Production**

<table>
<thead>
<tr>
<th>Year</th>
<th>Television Production</th>
<th>Transmission Facilities</th>
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<td></td>
<td>Total</td>
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<td>517,000</td>
<td>--</td>
</tr>
</tbody>
</table>

In 1985, the PRC State Statistical Bureau changed its method of reporting transmission facilities. Prior to that date, it distinguished between television centers and relay stations. Centers were defined as stations with program originating authority. For 1984, the Bureau's report did not include data on radio and television stations, the number of which multiplied nearly four-fold between 1983 and 1985.
A chronology of important events

1956 Astronautics industry development begins, according to the Chinese, "out of nothing."¹

1960 USSR technicians depart, thus ending technical assistance in production of liquid fuel rockets.²

1965 Beginning of research and design of first satellite and carrier rockets.³

1968 China Academy of Space Technology formed to coordinate space program.⁴


1972 RCA Globcom erects first satellite earth station in Shanghai.⁶

1974 Long March-2 -- launch failure.⁷


Chinasat 4. November 26. 1750 kg. Reconnaissance satellite. Returned to earth December 2. China is third country to master satellite return technology. Long March 2 problem corrected and all subsequent launches with this rocket are successful.


China becomes member of Intelsat. Leases 60 half-way international telecommunications circuits.

1977
China Academy of Sciences organizes Space Science & Technology Center for space research.

1978

Begin negotiations with U.S. companies for import of direct broadcast satellite. 10

Joint tests with France and FRG on European satellite. 11

Joint tests with U.S. (RCA) on Marisat. 12

First Chinese aerospace delegation to the U.S. -- NASA invitation. 13

1979
NASA and AIAA visits to China. Cryogenic fuels development revealed. China only third country to use cryogenic third-stage rocket. 14

Deng Xiaoping visits Johnson Space Center in Houston. 15

Sino-U.S. understanding on space technology. "Under suitable conditions," China will buy U.S. DBS. 16

1980
China begins astronaut training (later abandoned). 17

Satellite purchase postponed on grounds of "economic readjustment." 18

Nippon Electric awarded contract for Beijing #3 ground station to be linked to Intelsat satellite.

1981

#9 decayed December 26.

Chinasat 10.

#10 decayed October 6, 1982.

Chinasat 11.

#11 decayed August 17, 1982.

China (CAST) begins discussions with NASA for S&T exchanges.


China-Italian joint tests with Italian Sirius satellite. 21

November 21. USG issues more liberal guidelines for licensing of technology export to China. Landsat ground station finally approved. 22

1984  **Chinasat 14.** January 29. First successful launch with Long March 3 (CZ-3). Gas generator burnout prevents proper payload positioning. First-liftoff from new spaceport in Sichuan Province.


**Chinasat 16.** September 12. Decayed September 29.

U.S. sends "presidential" aerospace trade mission to China. 23

March 7. China and Germany sign agreement for space technology cooperation including joint development and manufacture. 24

Canada's Spar Aerospace sells China ground station package valued at over Canadian $24 million. 25

August. RFP for DBS issued. 26

September 21. MOA/NASA space science exchange agreement, but implementation postponed until signing of overall "umbrella" space protocol.

1985  **Chinasat 17.** October 21. Resource survey. Recovered October 26. 27

June 13. China Daily announces that China is ready to market space products and services. 28

At Stockholm International Aeronautical Federation Congress, China describes launch failures, provides launcher details. 29

China opens new space launch complex to potential customers. 30
July 15. China postpones RFP for DBS.31

People to People, NASA, AIAA groups of US aerospace technicians visit China.32

August 1. China begins 3-months of free trial on Intelsat satellite for educational T.V.33

1986

Chinasat 1B. February 1. CZ-3 launch of "operational" commercial satellite. Geosynchronous orbit.
REFERENCES


5. Launch information from three basic sources: (a) "Experimental Satellite Firmly in Position," Beijing Review, April 30, 1984; (b) Bradley Hahn; and (c) "China Inaugurates a Satellite Television-Network." USIA Research Report, April, 1986.


11. Sun Jaidong


14. Ibid.

15. Ibid.


17. Bradley Hahn.

18. AMST April 8, 1985.


20. AMST April 8, 1985.

Madelyn Ross.
Bradley Hahn.

_Aerospace Daily_ 3/13/84.
Madelyn Ross.
Ibid.
Sun Jaifong.


Lenorovitz.

_Aerospace Daily_ 2/25/85.

_Satellite Week_ 7/29/85.

_AWST_ August 15, 1985.

CASE STUDY

Satellite Telecommunications Technology
Transfer to China
Interviews Conducted

Washington

1. Export-Import Banks
   William M. Arnold, Senior Vice President

2. Department of Defense
   Fred Ikle, Undersecretary for Policy
   Donald Hicks, Undersecretary for Research & Engineering
   Jerry Sullivan, Deputy Undersecretary for International Affairs
   Steve Bryen, Deputy Undersecretary for Technology Transfer

3. Department of State
   Dick Williams, China Desk Office
   Stephen Schlaikjer, International Economist

4. Chinese Embassy
   Lu Jing Ting, Minister Counsellor for Science and Technology
   Jing Zhaopian, First Secretary

5. Department of Commerce
   David C. Bowie, Manager, Market Support Activities, Office of Aerospace Market Development

6. NASA
   Peter Smith, Chief International Political Programs
   Kenneth Pedersen (former NASA, now teaching Georgetown)

7. Office of Munitions Control
   Steve Komanelis, Special Assist for Space

8. QSTP
   Barbara Moore, Senior Policy Analyst
   Jay Keyworth (formerly President's Science Advisor)
9. Ford Aerospace
   Bob Beach, Vice President
   Bob Berry, Director

10. COMSAT
    William Mayor, President, COMSAT General
        Dennis Curtin, Manager Aerospace Projects

11. NSC
    Gaston Sigur, Special Asst. to the President for NSC
    David Laux

12. TDP
    Dan Stein, China Programs Director

IN CHINA

1. China Economic and Trade Consultants Corp.
   Zhang Dimo, General Manager, Information and Research Dept.
   Zhou Mian, Vice President

2. State Science and Technology Commission
   Wu Jiaxiang, Director, Satellite Office, Deputy Director, Hi-Tec Dept.

3. Ministry of Astronautics
   Chen Shouchun, Chief Engineer, Scientific Research and Production Bureau.

   Wang Zhongchi, Vice President

5. Ministry of Posts and Telecommunications
   Yun Jin, Deputy Director, Dept. of Science & Technology
   Tan Xingqing, Deputy Division Chief, International Cooperation, Dept. of Science & Technology.

6. China Association for Science and Technology
   Wu Ganmei, Director, International Conference Center for Science
   and Technology.

7. Beijing Institute of Control Engineering
   Lin Jin, Engineer
4. General Electric (USA) - China Co. Ltd.
   Richard Abington, President
   Richard Kask

5. Honeywell, Inc.
   David T. Lee, General Manager, China Operations
CHINA -- SATELLITE TELECOMMUNICATIONS TECHNOLOGY TRANSFER

Chinese agencies responsible for selection, production and application of space communications technology

STATE COUNCIL

Science + Technology Leading Group

STATE PLANNING COMMISSION

Science + Technology Planning Bureau

STATE ECONOMIC COMMISSION

STATE SCIENCE AND TECHNOLOGY COMMISSION

Science + Technology Planning Bureau

STATE EDUCATION COMMISSION

Northwest Industrial College

NATIONAL DEFENSE SCIENCE, TECH. + IND. COMMISSION

Launch sites (Xichang, Shuangchengtze)
Beijing Rocket Test Center. Weinan Grd. Station

MINISTRY OF ASTRONAUTICS

Grest Wall Industry Corp.
China Broadcast Satellite Corp.
China Academy of Space Technology
Institutes, ground stations, engineering centers, test facilities, control centers.

MINISTRY OF ELECTRONICS

MINISTRY OF POSTS + TELECOM.

MIN. OF NATIONAL DEFENSE

MINISTRY OF RADIO + TV

MINISTRY OF PETROLEUM

MIN. WATER RESOURCES + ELECTRIC PWR.

MIN. OF COAL

CHINA ACADEMY OF SCIENCES

Space Science + Technology Center
Telecommunications Engineering Institute

CHINA ASSOCIATION OF SCIENCE AND TECHNOLOGY

Society of Space Research
Society of Astronautics

## Satellite communications transactions with the PRC

(A partial listing for the period May 1984 to May 1986)

<table>
<thead>
<tr>
<th>Transaction</th>
<th>PRC entity</th>
<th>Date</th>
<th>Value</th>
<th>Foreign entity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Satellite communications coproduction agreement. Memo of understanding.</td>
<td>MOA</td>
<td>1/19/84</td>
<td></td>
<td>E.B. Communications (Norway)</td>
</tr>
<tr>
<td>Sale of 26 earth stations + related equipment.</td>
<td>INSTRIMPEX</td>
<td>1/19/84</td>
<td>$16m.</td>
<td>Spar Aerospace Ltd. (Canada)</td>
</tr>
<tr>
<td>Launch reservation for two PRC satellites. 1987/88 period.</td>
<td>MOA</td>
<td>4/26/84</td>
<td></td>
<td>Arianespace (Fr.)</td>
</tr>
<tr>
<td>Satellite TV receiving equipment manufacture,</td>
<td>Anhui Elec-</td>
<td>3/84</td>
<td></td>
<td>Hans Kolbe (W. Ger.)</td>
</tr>
<tr>
<td></td>
<td>tronic Ind.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Earth station eqpt., follow-up order.</td>
<td>INSTRIMPEX</td>
<td>10/1/84</td>
<td>$3.8m.</td>
<td>Spar Aerospace Ltd. (Canada)</td>
</tr>
<tr>
<td>Technical exchange protocol. Train Chinese engineers in design, production and assembly of sat.</td>
<td>MOA</td>
<td>11/7/84</td>
<td></td>
<td>MATRA (France)</td>
</tr>
<tr>
<td>Satellite reservation. Two PRC direct broadcast sats. in 1988.</td>
<td>China Broad-</td>
<td>12/84</td>
<td>$.5m.</td>
<td>NASA</td>
</tr>
<tr>
<td>TV transmitting equipment for sat. network.</td>
<td>MOA</td>
<td>12/28/84</td>
<td></td>
<td>Spar Aerospace Ltd. (Canada)</td>
</tr>
<tr>
<td>Earth station equipment.</td>
<td>Guangxi Imp.</td>
<td>12/7/84</td>
<td>$1m.</td>
<td>Aydin Corp. (U.S.)</td>
</tr>
<tr>
<td>Tech. exchange agt. Space Sat, sat. systems + carrier rockets.</td>
<td>MOA</td>
<td>1/28/85</td>
<td></td>
<td>Ministry for Ind. + Technology (UK)</td>
</tr>
<tr>
<td>Research exchange agreement, Civil use space satellites.</td>
<td>MOA</td>
<td>3/12/85</td>
<td></td>
<td>Ministry of Research + Technology (France)</td>
</tr>
<tr>
<td>Six satellite receivers (TVRO)</td>
<td>MOA</td>
<td>3/1/85</td>
<td>$9.5m.</td>
<td>Alcatel-Thomson, S.A. (France)</td>
</tr>
</tbody>
</table>

Source: China Business Review, National Council for U.S.-China Trade. Does not include transactions held confidential by either party, or considerable value of equipment sold to China for use in production and operation of satellite communications network but not identified as such.
Note - With the terrible typists of the Old Town Business Center, it is possible to reach a point where the addition of a comma, a crossed "t", or a dotted "i" means further near-interminable delay. The add-ons below were afterthoughts of the last week or so which would have been added, but would have meant additional delays. They can be added to a final version, but would require additional time. They are presented here, because they could be significant in consideration of the subject.

B. 4 China as a competitor

Minister of Astronautics has lunch, August 18, with Congressman Nelson. The minister is then brought into the subcommittee's hearings on a commercial ELV. (Check with the subcommittee staff on the ministerial delegation and their purpose).

C. 3 Non-commercial transfer modes

Note China's cooperation with international satellite-interest agencies. China is a member of INTELSAT, INMARSAT, the International Astronautical Federation, and various associated U.N. agencies. C. has attended every major international conference on space since 1980. As far as can be determined, none of this activity has yielded traceable dividends for China's satcom program as much as it has informed outsiders on some of China's space activities.

C. 2 A formidable bureaucracy

When given the space objectives of other PRC agencies, CAST assigns its facilities to work on their projects. CAST turns out equipment for the Meteorological Bureau. (AWST 7/22/85)

C. 4 Managers

Comment that management is a Socialist problem. The difficulty of converting Socialist bureaucrats into enterprise managers. Since it is not native to their experience, they need training.

D. 2 U.S. Marketing Advantages

Hughes' alleged (by the Chinese) proposal for a joint-venture launch facility in Hawaii is denied by Hughes. Just one of the many possibilities being considered by Hughes, including Johnston Island near the equator in the Pacific. Sen. Matsunaga interested in a joint U.S.-Japanese space center in Hawaii. Launches from U.S. soil would be easier, and Hawaii is close to the equator with good launch avenues over the Pacific. (Harvey Meyerson, Sen. Matsunaga's office 224-6361. W. Post 6/16/86)

B. 2 China's satcom goals

As part of the PRC's international outreach, China and Brazil agree to cooperate in the manufacture and launch of a meteorological/remote sensing satellite. Costs will be shared. (AWST )
D. 2 U.S. sales

As indication of the market potential, Scientific Atlanta sold several million dollars worth of sat ground equipment in 1981 and remains bullish about China market development potential. (China Business Review)

Under U.S. agencies influencing the environment for U.S. business in China, include the cabinet-level commissions. The Joint Economic Commission (U.S.Treasury/FPC Ministry of Finance for macro problems) and the Joint Commission for Commerce and Trade (Dept. of Commerce/MOFERT for micro problems). China only country where we have two such commissions and thus another indication of the USG willingness to press development of economic interchange with China.

Under TTI, the Reagan quote. "Our century of experience has proven that telecommunications is a flexible resource—a resource whose abundance increases in step with the development it makes possible for all mankind. We have enthusiastically shared our experience with the world for a century, and we look forward to continuing that mutually regarding cooperation." Message to 1982 ITU Conference which gave rise to U.S. TTI.

Under U.S. licensing problems. U.S. suppliers understandably chafe under USG rigorous licensing procedures, but the government can pull itself together for categorical export licensing approval when sufficient commercial advantage is obtainable. For instance, a generally restricted and potentially rich China market for U.S. nuclear power equipment was opened when the Administration pressed an agreement with China for peaceful uses of nuclear energy. In the satellite telecommunications area, a U.S. interagency working group was able to agree on the licensing of a total technology export package which permitted the U.S. suppliers to compete on the RFP for a China satcom system. The fact of European competition spurred the U.S bureaucratic reaction. Nevertheless, it demonstrate that U.S. national approach is possible in obtaining approval for a broad area of satcom tech exports to China. Recent U.S. agreements to sell communications equipment (previously restricted for licensing) to India and Pakistan for use in non-military programs provides additional models for satcom tech transfer to China. ("U.S. to sell Pakistan restricted technology" Washington Times, 7/18/86)

Add several pertinent segments of the Telecommunications Protocol to the attachments.

E.2 U.S.-China relations.

In his May 28, 1986, speech to the Annual Meetin^ of the National Council, Ambassador Winston Lord reflected official views when he declared that China's reforms and the opening to the West are "irreversible". But it is not necessary to concede that the current Chinese leadership's policies are irreversible before agreeing that they head China in a direction which the U.S. hopes China will go. It is also possible for "China-watchers" to agree that China is more likely to continue in that direction than not, and that, by exercising its influence through economic and S&T cooperation, the U.S. can help ensure that China continues to move in that favorable direction. Whatever China's ultimate economic, political and military role in the world, and there are those who speak of a Chinese 21st century, the U.S. has a national interest in maintaining a strong and expanding relationship with China. To that end, there are things we should be doing now in response to China's plea
E.2 U.S.-China Relations

With regard to concerns of our Pacific allies about U.S. military technology transfer as against telecommunications transfer. Note that the Senate Foreign Relations Committee sent a letter to the President expressing concern over the trend in recent arms exports to the PRC. The letter asked assurance that the Administration continues to support preservation of the military balance between the PRC and Taiwan.

E.3 Option 3

Advantages

Military implications are manageable. Reasonable safeguards would minimize any direct advantage to the Chinese strategic missile program. In the agreement with the U.S. for a satcom tech trans program, the Chinese would be asked for a written undertaking not to employ the technology in military applications or to pass it to a third party without permission. The undertaking would be similar to that accepted in connection with transfer of nuclear technology to China for electric power development. The sanction on Chinese observance would be the absolute necessity for China to continue to receive U.S. technology transfer. Satcom tech trans reduces current mil. bias in U.S. tech trans.

High visibility of satcom tech trans program. Space communications has strong, favorable, international public image. It is the telecommunications of the global village. In the eyes of the U.S. and Chinese public, it would be symbolic (more than any other technology transfer) of the continuing development of the relationship between the two countries.

Assistance in opening international satellite circuits to China would underwrite China's opening to the outside world and further guarantee against China's return to xenophobic isolation. Also assists direct U.S. communication with China thereby assisting commercial contact and more circuits through which to channel U.S. influence.

No broad budgetary implications. U.S. Government contribution to joint program comes about through established and funded agency activities in China.

Catches up overall U.S. tech trans program with China. Satcom tech trans has been the area in which we have been slowest to reach agreement with the PRC. It was hoped to have a satcom tech exchange agreement ready for Reagan's trip in April 1984.

Positive program of satcom tech trans enlarges U.S. participation in PRC development by opening two avenues for broader cooperation. One is telecommunications with an opportunity for U.S. telecommunications companies to gain foothold in a priority Chinese market. The other is space, with the opportunity for U.S. aerospace companies to access a market which will grow as China emerges as a space power. From collaboration in comsats it is easy to move on to collaboration on other sats – meteorological, landsats, navsats, and scientific sats.
Commerce, supplemented by NASA, would act as the lead agency in the program of expanded satcom tech trans. A government agency must take the initiative in gathering together disparate government and private sector elements to form an organized program. Commerce is the logical lead agency because:

- Commerce is the only agency with the staff and the obligation to develop U.S. commercial interests abroad.
- A successful long-range program of tech trans must be rooted in commercial benefit and entrepreneurial participation.
- Commerce has constant and broad liaison with the affected U.S. business community and, through its commercial office in the Beijing Embassy, with the Chinese agencies to be involved.
- Commerce has three programs in China which would be used in this project. The telecommunications technical exchange under the newly-signed protocol, the Dalian management training program, and the work programs in telecommunications and aerospace under the U.S.-China industrial and technological cooperation accord are germane. The latter might provide the best program focus.
- Commerce has the China desk, industry specialists, NTIA, and technology licensing responsibilities, so that a committee in Commerce would be needed to coordinate a common approach. The Commerce committee would then take the leadership in introducing the tech trans program to an interagency group (possibly the SIG Space Working Group) to seek overall USG approval and support.

The tech trans program would offer an opportunity to reexamine the pending NASA-MOA protocol on a space science exchange. The protocol could be broadened, with the advice of aerospace company representatives, to include areas which give promise of commercial follow-up. The added exchanges under the protocol need not be limited to satellite communications. They could include any promising aspect of satellite development, including those areas (photo reconnaissance for one) in which the Chinese have shown advanced technical capability and could contribute to the exchange. A NASA agreement with the Chinese would start to repair the imbalance under which the U.S. has gone quite far in space with the Russians but has not even gotten off the ground with the Chinese.

Satellite communications is the ideal medium for a pilot program of coordinated USG/private sector tech trans because:

- China needs it, and knows that it needs it.
- Satcom enjoys a top priority and can claim available budgetary, personnel and management resources.
- China has developed its own satcom tech to the point where it can handle transfers of advanced technology.
- Satcom is a discrete, definable, and manageable set of technologies, so that both sides know what they are dealing with, and what to program.
- U.S. is preferred supplier and U.S. companies can use a cooperative program in satcom to branch out into other opportunities in telecommunications and aerospace.
- U.S. suppliers unafraid of building technological competition.
- U.S. suppliers can build market by working through network of existing U.S. agency programs.
Policy Option Three - DISADVANTAGE. China is already a competitor in the provision of satellite lift. Helping China to become a competitor in satellite technology is asking for trouble. When we help put China into space we are not only building competition, but cooperating with Communist China in a very high technology area.

China, 1986  Dengist economic policies are working so well that China's growth rates are double those of the Soviet Union. China's successful experimentation with market socialism presents a challenge to those in the Kremlin who cling to socialist economic orthodoxy at a time when Comrade Gorbachev is looking for new answers to old Soviet problems. The Soviets may eventually have to follow down the road of Chinese reforms as world Socialism moves to the right.

China 1986  China's march towards a market economy, already stimulated by the growing connection with Hong Kong and the Hong Kong Chinese, will be accelerated with the incorporation of the former colony, its laissez-faire economy intact, in 1997.

Policy Option Three - ADVANTAGE. Jerry Grey, president of the International Astronautical Federation says the U.S. is certainly sliding backwards in a number of areas relative to other countries. The commitments of the Soviet Union, Western Europe, Japan and China are cited in this connection in a report by the American Institute of Aeronautics and Astronautics. (A collaborative effort with China, besides adding to NASA's purpose, would combine the strength of the two national programs)