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SOME REMARKS ON
SCIENTIFIC ACHIEVEMENT
IN COMMUNIST CHINA

G. B. W. Young

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PREFACE

This Memorandum reviews the scientific and technological directions taken by Communist China in the past decade. It was prepared specifically for presentation at the Science Sessions of the Association for Asian Studies to be held April 2-4, 1962, in Boston, Massachusetts.

SUMMARY

China hopes to approach, in many important fields of science and technology, the most advanced levels attained in the world by 1967. This Memorandum reviews the scientific progress in contemporary China, by focusing attention on the science budget and the command decision of 1958.

Assuming the 1967 goal is to be pursued by the mature graduates of the new universities of science and technology and is to be backed or supported by a technically reconstructed industry, the review suggests that China will only have firmly established a base for such an attainment, but it can be quite an impressive base. However, by maximum concentration of effort, China can perform a limited number of scientific feats in 1967, especially those which can be performed merely with the support of a high-level state of the art in the unsophisticated technologies, and with the technical personnel trained since 1958 in the institutes of the China Academy of Science.

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I. INTRODUCTION

The Chinese Communist Party (CCP) is conducting a planned development of the national economy with the goal of building up a comprehensive industrial system and transforming the backward agricultural country into an advanced socialist industrial country in approximately three five-year plans. The principal tasks of the First Five-Year Plan,⁽¹⁾ adopted on July 30, 1955, were (1) to center the main efforts on 694 above-norm industrial construction projects, the core of these being the 156 projects, to be designed with the help of the Soviet Union, that will lay the preliminary groundwork for China's socialist industrialization; (2) to foster the growth of agricultural producers' cooperatives, whose system of ownership is partially collective, and handicraft producers' cooperatives, thus laying the preliminary groundwork for the socialist transformation of agriculture and handicrafts; and (3) to incorporate a greater part of the capitalist industry and commerce into various forms of state capitalism, laying the groundwork for the socialist transformation of private industry and commerce. The principal tasks of the Second Five-Year Plan,⁽²⁾ adopted on September 27, 1956, are (1) to continue industrial construction with heavy industry as its core, promote technical reconstruction of the national economy, and build a solid foundation for socialist industrialization; (2) to carry through socialist transformation, and consolidate and expand the system of collective ownership and the system of ownership by the whole people; (3) to increase further the production of industry, agriculture, and handicrafts and correspondingly develop transport and commerce on the basis of developing capital construction and carrying through socialist transformation; (4) to make vigorous efforts to train personnel for construction work and strengthen

scientific research to meet the needs of the development of socialist economy and culture; and (5) to reinforce the national defenses and raise the level of the people's material and cultural life on the basis of increased industrial and agricultural production.

Of the twelve concrete assignments of the First Five-Year Plan, one is applicable directly to the scientific and technical community. It is as follows: "We must develop cultural, educational and scientific research work, raise our scientific and technological level and actively train personnel needed for national construction, particularly for industrial construction."

There are sixteen itemized assignments in the Second Five-Year Plan. Two of them are directed to the scientific and technical community. Since they are quite lengthy, they are reproduced in the Appendix. The gists of these two assignments are (1) to further technical reconstruction of the national economy with emphasis on heavy industry, particularly the machine-building industry; and (2) to start building up in the country the most advanced branches of science and techniques known to the world, such as atomic energy, electronics, and automation and remote control, and to achieve marked results in other important fields of scientific and technical research so that within the period of the Third Five-Year Plan, China can, in many important fields of science and technology, approach the most advanced levels attained in the world.

This, then, is the background of stated planning goals with which to review the scientific development in contemporary China.

II. GLIMPSES INTO THE SCIENCE BUDGET

In the planned development of any activity, the expenditures budgeted for it will greatly influence its course and in all probability will seal its fate. The science budget for 1950-60 and its relation to the national budget⁽³⁾ is shown in Table 1.

Table 1

Science Budget	Year										
	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960
Millions of Yuans	1	8	11	32	34	38	244	293	384	820	1081
Per Cent of National Budget	0.015	0.07	0.07	0.15	0.14	0.14	0.8	1.0	0.9	1.57	1.54

The variation of the science budget indicates three major decision periods: 1952-53, 1955-56, and 1958-59.

The China Academy of Sciences (CAS) was founded in October 1949 through the merger of the Academia Sinica of Nanking (founded in 1928) and the National Academy of Peiping (founded in 1929). Its budget constituted the whole of the science budget up through 1955. In 1956 and 1957, its budget constituted about 27 per cent of the science budget. Thus, up through 1955 the scientific activity in China was vested in the China Academy of Sciences. The number of research institutes operated under the CAS during this period (1950 to 1955) went from 17 to 47. Those related to physics, mathematics, chemistry, and the technical sciences are listed in Table 2.⁽⁴⁾

Table 2

Research Institute	Date Founded	Date Re-organized	Date Scientific Committee Founded
Institute of Metallurgy and Ceramics	1929	1952	1955
Institute of Mathematics	1941	1952	--
Institute of Applied Chemistry	1948	1954	1956
Institute of Applied Physics	1950	--	1956
Institute of Physical Chemistry	1950	--	--
Institute of Organic Chemistry	1950	--	1956
Institute of Metals	1951	1953	1955
Institute of Chemical Engineering and Metallurgy	?	?	?
Coal Research Laboratory	1952	--	1955
Institute of Petroleum	1952	--	1955
Institute of Mechanical and Electrical Engineering	1954	--	1955
Institute of Civil and Architectural Engineering	1954	--	1956

This list shows the limited scope of the advertised scientific activity during this period. There is the conspicuous absence of the modern technologies, such as atomic energy, jet propulsion, and electronics. However, this activity may have responded adequately to the demand of the First Five-Year Plan. Notice the meager institutional setup in 1950 and 1951 and the change as the result of the first major decision (1952-53) accompanying the step rise of the science budget. This change is in the direction of increasing the scientific activity in the unsophisticated technologies, which

are more directly related to capital construction, heavy industry, and the machine-building industry.

The major decision of the 1955-56 period, accompanying the sixfold increase in the science budget, includes rather sweeping reorganization.

1. The CAS's share of the science budget dropped from 100 per cent to about 27 per cent.
2. The CAS was restructured to include:
 - Department of Physics, Mathematics and Chemistry, founded in June 1955
 - Department of Biology, founded in 1957
 - Department of Geography and Geology, founded in 1957
 - Department of Technical Sciences, founded in June 1955
 - Department of Philosophy and Social Sciences, founded in June 1955
3. In essentially all of the institutes of the CAS, a scientific committee was formed during 1955-56.
4. The activity in agriculture and medicine of the CAS was reorganized into independent academies during 1956-57.
5. Various institutes of modern technology were founded as follows:
 - a) In the Department of Physics, Mathematics and Chemistry
 - Institute of Chemistry in 1956
 - Institute of Mechanics in 1956
 - Institute of Nuclear Physics in 1957
 - Institute of Atomic Energy in 1958
 - b) In the Department of Technical Sciences
 - Institute of Computer Technology in 1956
 - Institute of Semiconductors in 1956
 - Institute of Electronics in 1956
 - Institute of Automation and Remote Control in 1956
 - Institute of Optics and Precision Instruments in 1957
 - Institute of Propulsion in 1957

This reorganization reflects the requirement of the Second Five-Year Plan and the Twelve-Year Plan for Science and Technology to "start building up in the country the most advanced branches of science and techniques known to the world." As will be discussed later, the activities of these institutes of modern technologies during 1956, 1957, and the first half of 1958 appear to be primarily organizational and those of a technical nature may be restricted to the more classical type of problems.

III. THE COMMAND DECISION OF 1958

Liu Shao-Chi, ⁽⁵⁾ in his "Report on the Work of the Central Committee of the Communist Party of China to the Second Session of the Eighth National Congress," dated May 5, 1958, made the following pronouncement:

"In view of the basic victory of the socialist revolution already achieved on the economic, political and ideological fronts, the Central Committee of the Party and Comrade Mao Tse-tung consider that the time is ripe to set new revolutionary tasks before the Party and the people, that now is the time to call for a technical revolution and, along with it, a cultural revolution."

The main tasks of the technical revolution were described as follows:

"To put the national economy, including agriculture and handicrafts, systematically and in a planned way on a new technological basis, i.e., the technological basis of modern, large-scale production, so that machinery can be used wherever feasible and electrification is brought to all the cities and villages of the country;

"To turn all big and medium-sized cities throughout the country into industrial cities; to build up new industrial bases in those places where the necessary conditions exist, to enable all the country towns and many townships to have their own industries, and to increase the value of industrial output of all the provinces and autonomous regions and even most of the special administrative regions and counties so that it exceed the value of their agricultural output;

"To set up a transport network and post and telecommunications services equipped mainly with modern facilities, reaching every part of the country; and

"While introducing as far as possible the world's up-to-date techniques, to launch a widespread mass movement in the cities and villages throughout the country to improve tools and introduce technical innovations so that semi-mechanized or fully mechanized operations can be properly combined with the necessary handwork."

And the goals were stated as follows:

"This will enable our industry to catch up with and surpass Britain within 15 years or less in the output of iron and steel and other major industrial products, enable our agriculture, on the basis of carrying out the National Programme for Agricultural Development ahead of schedule, to surpass quickly the agricultural achievements of the capitalist countries, and our science and technology,

on the basis of carrying out the twelve-year Programme for the Development of Science, to catch up with the world's most advanced levels in the shortest possible time."

This pronouncement, in effect, launched the mass movement for the appreciation of science and the scientific method. This mass movement is described by L. A. Orleans⁽⁶⁾ as people's science. The implementation of the mass line in scientific and technical work has been linked by Nieh Jung-chen⁽⁷⁾ with the elimination of superstition and the liberation of thought (by the masses).

This campaign ought not to be viewed as superfluous or extraneous. In China the thought process of the bulk of the people is non-scientific. Here, in the United States, the scientific method is practiced by the scientist, the technologist, the technician, the hobbyist, the amateur, and even by the general layman. What differentiates these practitioners is their proficiencies in the art of applying the scientific method and the amount in depth and breadth of scientific mental furniture which they have to work with. Their respective activities give the appearance of a regenerative system for scientific growth. One may say that we possess the spirit of science and that the CCP is attempting to generate this spirit of science by starting a mass movement which in essence resembles the activities of our hobbyist and amateur.

Although the institution of this campaign seems to confirm the persistence of a low-level, unsophisticated technology, some efforts are almost surely directed toward acquiring the world's up-to-date technology. Some eighteen branch academies were established during 1958 under the Chinese Academy of Sciences. Though most are meant for the local needs of the respective provinces, some do serve the needs of the basic sciences and modern

technologies. Also regional Scientific Supply Centers were established in Tientsin, Peking, Shenyang, Shanghai, Canton, and Wuhan. Perhaps the single most important development in 1958 was the establishment of the University of Science and Technology of China. Its departments include nuclear physics, nuclear engineering, technical physics, chemical physics, physical thermodynamics, radio electronics, automation, mechanics, radiation chemistry and infrared chemistry, geochemistry, rare earths, high-polymer chemistry and physics, applied mathematics and computer technology, and biophysics. This was followed by establishments of other universities of science and technology. And to top it off, the science budget was more than doubled in 1959.

IV. THE DEVELOPMENT OF MECHANICS - AN EXAMPLE OF
SCIENTIFIC DEVELOPMENT IN CONTEMPORARY CHINA

The recent progress in the natural sciences has been discussed very well in various details by Du Ruen-sheng,⁽⁸⁾ by J. A. Berberet,⁽⁹⁾ and by the AAAS Symposium.⁽¹⁰⁾ Herein this progress is illustrated in a representative manner by exploring one of the subjects of engineering science, or rather by reviewing a review paper on mechanics. Engineering science is the creative and many times highly mathematical application of the theories of the natural sciences to engineering technology. It is the result of the inspiration of Dr. Theodore von Karman and it was nurtured during the early years at the California Institute of Technology. A set of the subjects of engineering science listed by Ch'ien Hsueh-sen,⁽¹¹⁾ who returned to China in 1955 after a brilliant career at Cal Tech, includes the following:

1. Chemical Fluid Mechanics
2. Physical Mechanics
3. Electromagnetic Fluid Mechanics
4. Rheology
5. Mechanics of Soil and Rock
6. Theory of Nuclear Reactor
7. Engineering Control Theory
8. Computer Technology
9. Engineering Spectroscopy
10. Operational Technology

Mechanics, then, is quite basic as it concerns a good share of the subjects listed. Its development in China during 1949-59 has been reviewed in an article⁽¹²⁾ in Acta Mechanica Sinica. Chronologically it proceeded in the following manner:

1950 - In order to train the workers who have a higher level of knowledge in mechanics, the Ministry of Education has been sending students in that field to study in Russia since 1950.

- 1952 - The Mathematics Department of Peking University was enlarged and renamed the Department of Mathematical Mechanics. This was the first step in the education of skilled workers in mechanics.

The first educational research building of mechanics was founded at the Harbin Industrial University.

Since 1952, more than 50 kinds of books about theoretical mechanics, strength of materials, structural mechanics, and hydraulics have been translated.

- 1953 - The Institute for Research in Mechanics was founded in the Department of Mathematics Research of the Chinese Academy of Sciences. It was the first organization for special research in mechanics.

- 1956 - The Institute for Research in Mechanics was enlarged to the Institute of Mechanics.

A research class of engineering mechanics was established by Ching Hua University and the Chinese Academy of Sciences together.

- 1958 - A program of mechanics was set up in from ten to twenty places in the country by the institutions of higher education to meet the demands of national industry and scientific research.

Mutual collaboration laboratories have been established, of which some were established by combining former individual laboratories.

The work performed was divided into the pre-mid-1958 period and the post-mid-1958 period. The two topics of the earlier period were solid mechanics and fluid mechanics. These are studies of classical problems, such as the influence of plate curvature on the boundary layer, and the stabilization of the turbulent incompressible boundary layer.

The topics of the latter period discussed were (1) industrial and agricultural production, (2) the establishment of experimental equipment, and (3) the development of the new domain of mechanics. The subjects of research under industrial and agricultural production included stress analysis of dams under the action of gravity, sedimentation of mud and sand,

percolation under the dam, etc. In the discussion of experimental equipment, it was mentioned that the laboratories of strength of materials and of hydraulics still have simple equipment and that the equipment of the new laboratories, such as the laboratories of vibration, depend wholly upon imports from abroad. Under new domains of mechanics, only the subject of magneto-fluid mechanics was mentioned.

The reviewer concluded: "From the above it is plain that the past decade was the period of construction in mechanics in which the main job was concentrated on training the skilled workers and establishing the organizations. The research work was still in the beginning stages."

V. THE OUTLOOK FOR 1967

China hopes to approach, in many important fields of science and technology, the most advanced levels attained in the world by 1967.

This will be ten years after the establishment of the University of Science and Technology of China, the first university to devote itself to the advanced sciences and technologies without the burdens of the problems of economic construction or the problem of technical reconstruction.

This will be ten years after the acknowledgment by the planners of having attained an adequate but low-level state of the art in the unsophisticated technologies and after the redirection by the planners from economic construction to technical reconstruction.

This will be ten years after the start of the mass movement to instill the scientific way of thought among the populace through such campaigns as the elimination of superstition, the liberation of thought (accentuate the positive), the backyard furnace and equivalent activities, investigation and research, and study and practice.

Assuming that the 1967 goal is to be achieved by the mature graduates of the new universities of science and technology and is to be backed or supported by a technically reconstructed industry, China will only have firmly established a base for such an attainment, but it can be quite an impressive base. However, by maximum concentration of efforts, China can perform a limited number of scientific feats in 1967, especially those which can be performed merely with the support of a high-level state of the art in the unsophisticated technologies and with the technical personnel trained since 1958 in the institutes of the China Academy of Science.

VI. CLOSING REMARK

In closing, perhaps a couple of appraisals made by two eminent personages in China are in order. The first is by Nieh Jung-chen, the chairman of the Science and Technology Commission. On September 27, 1959, he wrote: (7)

"At present, this is the general state of affairs in the field of science and technology in China.

"First, simultaneously with studying to master the advanced scientific and technological achievements of foreign countries, we have begun to carry out a large amount of creative research work. We want to intensify our research work in the light of the concrete conditions in China, so that modern science and technology may strike root, develop, blossom forth and bear fruit in China.

"Second, through production and construction, and the carrying out of investigation and research into science and technology, we have accumulated an abundance of data concerning the natural resources and natural conditions. This, together with the materials gathered in industrial and agricultural production and construction and from the fields of medicine and public health in practice, will be used to lay down the foundation for further developing scientific and technological research work.

"Third, we have unearthed a large amount of scientific and technological legacy from the people and books, such as traditional techniques in the fields of agriculture, medicine, meteorology, metallurgy, light industry and technology, and have set out to arrange it for study. After these traditional theories and techniques are analyzed and studied, and brought up to the level of modern science, they will provide new clues for the development of the different branches of knowledge, and may have made some important contributions.

"Fourth, we have filled in many blank spaces in the field of knowledge. In the case of many branches of knowledge which were conspicuous by their absence in the past, we are now capable of carrying out research and experimental work. In the old China, nothing was known about jet technology, computing techniques, radio astronomy, petroleum chemistry, and biological physics. After several years of effort, thanks to the energetic assistance of the Soviet Union and other socialist countries, we have preliminarily set up appropriate bases, fostered some cadres, and carried out research work."

The second appraisal is by Ch'ien Hsueh-sen, the director of the Institute of Mechanics. On June 10, 1961, he wrote:⁽¹³⁾

"There was a way of thinking according to which teaching of fundamental mathematics, physics, and chemistry was empty and meaningless because such teaching only explains natural laws which are unreal since they have no connection with production. Therefore, it was proposed that fundamental scientific lessons should be curtailed or scrapped and that the mathematical, physical or chemical notions required in specialized trades should be taught in the trade schools.

"This, in fact, is not a new idea. In capitalist countries there were some capitalist factory owners who taught the young in this way. Their intention was not that young people should really study but that they should only learn the things necessary in the factory so that later they could be exploited by the factory. We cannot act in this way in our Socialist system. We want our students really to study and to acquire a greater working capacity.

"It is wrong to want to teach technology first and then the fundamental scientific notions."

These two sets of quotations suggest the true conditions of science and technology in China.

Appendix

THE TWO ASSIGNMENTS FOR THE SCIENTIFIC AND TECHNICAL COMMUNITY IN THE
SECOND FIVE-YEAR PLAN*

ASSIGNMENT 10

We should press ahead with the technical reconstruction of our national economy and, first of all, technical reconstruction in heavy industry, so as to raise swiftly the technical level of our industry. In the Second Five-Year Plan period, we should, so far as conditions permit, install up-to-date technical equipment, make use of the latest scientific achievements and master the new techniques involved in the important industrial and mining enterprises concerned with machine-building, metallurgy, chemicals, power, oil, coal and radio equipment, which are being newly built or are undergoing major reconstruction, so as to bring our industry on to the road of modern technique. In existing enterprises all latent productive capacity should be made full use of, and, in accordance with the demands of the actual situation, some of their out-of-date equipment should be renovated systematically and step by step so as to raise their technical level. To get a rapid increase in output the best experience and methods of production, whether foreign or domestic, should be spread effectively and systematically to all newly built, reconstructed, and other existing enterprises, with due regard to actual conditions in each enterprise.

Technical reconstruction of our national economy must be based mainly on our heavy industry, and the machine-building industry in particular, and furthermore, it should be commensurate with our strength in technical personnel, financial and natural resources, and labour power, and proceed gradually and with proper emphasis where needed. In certain most labour-consuming branches of economy, important work processes and major projects

*Quoted from Ref. 2.

and projects that cannot be tackled without machines should be gradually mechanized, and to an ever increasing extent; in other places, our tremendous reserves of labour power should continue to be used. The technical renovation of transport, and postal and tele-communication services should also be carried out step by step, commensurate with our level of industrial development, the possibilities of our economic and other resources, and the needs of transport and communications.

In the Second Five-Year Plan period, so far as technical improvements in agriculture are concerned, emphasis should be put on extension of irrigation and strengthening measures of flood prevention and drainage of water-logged areas, trial manufacture and popularization of improved farm tools suited to local needs, increased production of fertilizers, improvements in cultivation techniques, the growing of high-grade seeds and the breeding of better strains of livestock. At the same time, we should, in the light of specific conditions make suitable use of tractors on state farms, in reclaimed areas, and in areas raising industrial crops.

ASSIGNMENT 11

We should energetically develop scientific research with emphasis on particular subjects in accordance with the needs of national construction. During the Second Five-Year Plan period, we should continue to learn from the latest scientific and technical achievements in the Soviet Union and other countries, and start building up in our country the most advanced branches of science and techniques known to the world, such as the science of atomic energy, electronics, and the techniques of automation and remote control; we should also achieve marked results in other important fields of scientific and technical research so that within the period of the

Third Five-Year Plan we can, in many important fields of science and technology, approach the most advanced levels attained in the world.

In this five-year period, giving proper emphasis to particular fields, we should gradually strengthen research work in the Chinese Academy of Sciences, in the research institutes of the various government departments and enterprises concerned, and in universities and colleges, and effectively bring about division of work and cooperation among them. We should gradually build up a national network of scientific research institutes.

We should carry through the Party's policy of uniting with, [sic] education and remoulding the intellectuals and the principle of "letting diverse schools of thought contend", and encourage them to cultivate independent thinking and engage in free discussion. We should make more suitable use of the services of intellectuals, and pay attention to improving their working conditions and give full play to their enthusiasm and creative ability so as to meet the needs of development of scientific research and economic and cultural development.

During the Second Five-Year Plan period, we should do all we can to train personnel for construction work, to develop higher education and secondary vocational education; continue to send graduates from universities and colleges and teachers abroad to study subjects which are still lacking in China; systematically and step by step develop spare-time higher education and secondary vocational education, so as to train more of the various kinds of specialists we need for national construction. At the same time, attention should be paid to the development of workers' technical schools, and efforts should be made to train skilled workers in various ways.

In developing higher education, we should lay stress on engineering and the natural sciences; make vigorous efforts to promote the study of pedagogy, agriculture and forestry, and give attention to other subjects. In this five-year period, the number of university and college graduates is expected to reach approximately 500,000, which is roughly 80 per cent more than the number aimed at in the First Five-Year Plan. In 1962 the total enrollment in universities and colleges is expected to reach approximately 850,000, which is roughly double the number aimed at in 1957.

We should vigorously increase the number of senior and junior middle schools and enlarge the existing ones to provide adequate enrollment for the universities, colleges and secondary vocational schools, and to satisfy properly the needs of government departments, factories and mining enterprises for specialized personnel and skilled workers. At the same time, we should step by step extend primary education to ever larger sections of the population and do all we can to help agricultural producers' co-operatives organize literacy classes for children in order to make up the shortage of primary schools.

We should make efforts to wipe out illiteracy throughout the country; carry out the reform of written Chinese step by step according to plan; and step by step establish spare-time primary and secondary schools for workers and peasants so as to ensure a constant rise in the cultural level of the mass of workers and peasants.

We should continue to adhere to the principle of "letting flowers of many kinds blossom", foster art and literature on an extensive scale, encourage in every way creative work in art and literature, promote art and literary criticism, actively carry on the work of editing, revaluing and

popularizing the best part of the heritage of our national culture so as to make the various types of folk art and literature dearly loved by the masses still more perfect in form and varied in content.

We should energetically foster the growth of the cinema, and step by step and according to plan, improve our work in publication and radio broadcasting.

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