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# China Report

SCIENCE AND TECHNOLOGY

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6 November 1984

# CHINA REPORT

## SCIENCE AND TECHNOLOGY

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## NATIONAL DEVELOPMENTS

### BENEFITS FROM RESEARCH ACCOMPLISHMENTS HARD TO MATERIALIZE

Guangzhou YANGCHENG WANBAO in Chinese 30 Jun 84 p 1

[Article by Wu Wenchao [0702 2429 6389] and Mo Dantao [5459 0030 3447]:  
"The Scientific and Technical Community Appeals To Be 'Unbound,' So That  
the Accomplishments of Science Can Earlier Be Transformed into Products;  
Industrial and Commercial Departments Tax Too Heavily, While Administrative  
Departments Manage Too Inflexibly"]

[Text] "The financial, industrial and some commercial departments tax  
too severely, so that scientific and technical units have funding  
difficulties; administrative departments manage too rigidly, so that  
scientific and technical units have difficulty transforming the accomplishments  
of research." Representatives of the scientific and technical community  
in attendance at yesterday's symposium held as part of the Province's  
Sixth National Peoples Congress Second Conference, called for the abolish-  
ment of these two shortcomings.

Many of the representatives at the conference pointed out that Guangdong's  
scientific and technical help is not high, plus the economic benefits  
are low. Responsible persons from the Provincial Science and Technology  
Commission at the conference revealed that one of the major reasons for this  
is that the funding of scientific research is seriously deficient.  
Provincial level scientific research units average per capita outlay for  
research is still less than 4,000 yuan per annum, including wages. Provincial  
level departments engaged in scientific research average only slightly  
over 2,000 yuan. The figure for local, municipal and county level units  
is only about 1,500 yuan. In addition, while these units working in  
technology are compensated for transferring technology, and can raise a  
little money from consulting services, offering the products of research  
for sale, etc., still they are relentlessly monitored by financial,  
industrial and commercial departments. The resultant outlay for income,  
corporate and new product taxes, or for expenditures for such items as  
transportation and communication, energy and construction, etc., is about  
70 percent.

The representatives also requested that administrative departments  
'unbind' scientific research units, so that the accomplishments of research

can be speedily transformed into products and commodities. Comrades from the Provincial Science and Technology Commission who participated in the conference made it known to reporters that in 1982 the Guangzhou Municipal Light Industries Research Institute signed a contract with Huizhou, with the intention of planning production. However, because it was disapproved by higher level administrative leaders, the contract was invalidated.

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## NATIONAL DEVELOPMENTS

### SPECIAL SCIENTIFIC, TECHNICAL ZONES PROPOSED

Beijing GUANGMING RIBAO in Chinese 20 Jul 84 p 1

[Article by Xue Fukang [5641 4395 1660]: "Professor Tan Jiazhen [6151 1367 2823] Proposes the Establishment of Special Scientific and Technical Zones: Adopt Certain Policies for Research Organizations, in Order to Raise Their Efficiency Rate and Promote the Full Use of Models Acquired from Foreign Scientific and Technical Exchange"]

[Text] Our Washington correspondent Xue Fukang reports: The internationally renowned geneticist, Fudan University Presidential Advisor Tan Jiazhen recently told visiting journalists that, "The policy of establishing special economic zones has already proven successful in practice; I think we should now consider establishing 'special scientific and technical zones.' What I mean by 'special scientific and technical zones' is not necessarily the setting aside of several special areas, but rather permitting some research organizations to by-pass the current organizational system, and put into effect certain special policies. 'Special S&T Zones' will in the future act as a window and also as a bridge, promoting the development and use of models acquired from foreign scientific and technical exchange.

During the middle 10 days in April of this year, Professor Tan Jiazhen, under the auspices of the "Sino-U.S. Distinguished Scholar Program," was in the United States for a series of lectures at the invitation of the U. S. National Academy of Sciences. During that time, York University in Canada and the California Institute of Technology in the United States separately conferred upon him the "Honorary Doctor of Science" degree and the "Distinguished Alumnus Award." At the beginning of July, after Professor Tan's visit to Canada, he returned to New York. He told reporters at that time, "During these several months that I have been visiting many universities and research institutes in the United States and Canada, exchanging views and information with traveling companions, I have felt deeply that the new technology situation is a pressing one. China must welcome the challenge, and must pay especially careful attention to research and development of biotechnology. There are two reasons for my saying this: First, biotechnology internationally has emerged as a discipline only over the last 8 to 10 years, at the most; one could say it has just gotten off the ground. Among the various fields that are a part of the new technical revolution, biotechnology

offers our best chance to catch up and excel. Second, China has a population of 1 billion, with agriculture at the base of the people's economy. In developing new technologies, we must get to the root of problems, not merely treat their symptoms, and above all we must pay close attention to the development of agriculture. By agriculture I mean agriculture on the large scale, including herding and sideline fishing in the rural areas. In this regard, biotechnology can have major impact; it can change the face of agriculture, and change the face of the entire national economy.

I had heard that Tan himself was just in the midst of actively supporting the establishment of a biotechnology "special S&T zone," so I took this opportunity to ask him to combine his impressions in this interview with some discussion of specific ideas. He said, "Both here and abroad, those doing research and development in the new technologies are a long ways from using a combination of the government, the academy and business. The state has allocated the capital, but it is most important that we formulate a policy which will encourage and support the opening up of new technologies, with the universities providing the manpower and industry providing the money. I also want to set a precedent, by operating an international biotechnology development center in Hong Kong, which will have agricultural problems as its focus, doing basic as well as applied research. Funding can be partially subsidized by the government, and partially drawn from surplus capital in Hong Kong. A large number of personnel is not necessary: 40 or 50 people would be sufficient. To assume responsibility of head, the development center should invite a scientist of renown, with scholarly attainments; after that person is selected, he should definitely be given both personnel and fiscal authority. I believe that a development center of this kind can definitely produce efficiency and results." Tan very happily told reporters that central leading comrades and the State Scientific and Technological Commission were very supportive of this tentative plan, and opening the Second Meeting of the Sixth National People's Congress was another timely east wind; he wants to brave the winds and waves, and step up the pace of putting this plan into effect.

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## NATIONAL DEVELOPMENTS

### BEIJING ANNOUNCES S&T MANAGEMENT REFORMS

Beijing RENMIN RIBAO in Chinese 16 Jul 84 p 1

[Article by Huang Wei [7806 1218]: "Beijing Municipality to Carry Out Major Reforms in its System of S&T Management; 80 Scientific Research Units Will Try Out a System of Compensation Contracts or a Funding System"]

[Text] The Municipality of Beijing has decided to implement major reforms in its system of scientific and technical management. By the end of next year, 50 units throughout the Municipality engaged in development of technology and in spreading the application of scientific research, will all try out a compensation contract system. Thirty scientific research units engaged in non-technical development will try out a S&T funding system. At the same time, Beijing has also selected 10 temporary measures for the experimental units. This information was learned by reporters yesterday at a meeting on the reform of the Beijing scientific and technical system.

Beijing Municipality has decided that the scientific research units trying out the compensation contract system will use nationally selected enterprise funds for funding scientific and technical development. The relationship between higher level departments and scientific research units will change from an administrative system to a contractual management system, and research units institutes will progressively become more technical in nature. In the experimental funding system, nationally selected enterprises will progressively shift to funding science research units which will submit proposals for funds to do certain tasks; the department responsible for funding will let out invitations for bids, then select the best for support.

In order to adapt to the needs of reforming the S&T system, Beijing Municipality has also selected 10 temporary measures concerning the experimental units. Principal among these are: these experimental units can put into practice a system of jobs based on talent; within the scope of the compensation contracts, units will have the power to either use themselves the results of their research or transfer it to others; research institutes will have the power to recruit and invite applications from the best personnel in the municipality's population; research institutes will have, as far as it accords to national regulations,

discretionary power over their funds, making rational adjustments in how they employ these funds; research institutes may reward workers who make truly outstanding contributions; in those units which are implementing the compensation contract system, no one will be locked into their job, regardless of their rank; and, research institutes will have the power to give promotions and raises to workers who make outstanding contributions, and this can amount to approximately three percent annually.

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## NATIONAL DEVELOPMENTS

### LU CHUANZAN ADDRESSES S&T CONFERENCE

Shijiazhuang HEBEI RIBAO in Chinese 30 Jun 84 p 1

[Article by Yang Wen [2799 2429], Xu Chunlin [1776 2504 2651], and Li Shusheng [2621 2579 0581]: "Provincial Conference on Scientific and Technical Cooperative Experience Exchange held in Hengshui; Liberated Thinking and Bold Reforms Can Accelerate Economic Construction"

[Text] From 26 to 28 June, the Provincial Scientific and Technical Commission held in Hengshui a conference on cooperative exchange of experiences in science and technology. The central aim of the conference was to bring about a reformed spirit of large-scale cooperation in advancing science and technology, through an exchange of experiences, and also to promote scientific and technical economic construction, in order to vigorously develop the Hebei economy.

The opening address at the conference was delivered by Lu Chuanzan [0712 0278 6363], Member of the Provincial Standing Committee. In his speech, Lu stressed six issues:

1. We must go forward in freeing ourselves from old ideas by making bold reforms. In the past 2 years, along with the production of rural commodities and the rapid development of burgeoning production, plus the continuous involvement in reform of the urban economic system, there has arisen throughout the province a "science fever" that was never there before. But there are still some localities, departments and units where the thought and actions of the leadership has not kept up with the situation or the masses. In scientific and technical work, this includes insufficient stress being placed on technical cooperation, or on the importation and transfer of technology. It has even gotten to the point that there are still some localities, departments and units which, in their handling of production or of the economically are basically just going along with the old methods of the past, the same old stuff, with the result that scientific and technical work in these places is never pushed to a higher level, let alone be realistic. Practice and experience tell us that things of the "left" and the old, traditional concepts have not been eradicated. If thinking has not been opened up, then reform will not be carried out properly. Right now we should be emphasizing solution of the following: (1) The fundamental policy of

modernization requires more study, more understanding, more practice, with an increased awareness and sense of urgency concerning what is "reliable" and appropriate. (2) We must establish a sense of the worth of science and technology. (3) We must free our science and technology from a totally "government controlled," sealed-off system, so that the nation, the collective and the individual can grow as one. (4) In our system of scientific and technical management we should encourage industry to be concerned with technical advancement, to accelerate products going to higher levels of quality. (5) We must smash the "communal pot" and "iron rice bowl" which tie up our scientific and technical personnel. (6) We must break through the "large and complete," "small and complete," and the "local," or "departmental" systems of ownership, thereby promoting a rational flow of technology and talent.

2. Develop to the fullest every form of scientific, technical and economic cooperation. Viewed from the standpoint of what has started to develop, economic departments, production units, scientific units and academic institutions are carrying out various forms of cooperative ventures, some in the same localities, some in the same industries; there are also those which cut across localities and industries. There are cooperative efforts which focus on the production technology of a single industry, there are those which concentrate on joint efforts to develop a certain class of new product, and there are those which put their emphasis on popularizing the use of scientific and technical results, etc.

3. Open up more types and more channels of technical cooperation. Development must be based upon what is appropriate for a particular location, according to the local needs and circumstances, putting chief emphasis on economic benefits, choosing what is excellent and less expensive. Chiefly, these should take the following forms: production departments and units along with scientific research units and academic institutions should establish cooperative relationships; open up technical markets; develop technical consultation and technical service; put into practice a system of compensation for the transfer of scientific and technical achievements; cooperate on tackling technical problems; provide and train technical personnel; engage specialists and consultants; transmit messages on technical information.

4. Make great efforts to put into practice a system of technical quota responsibility. No matter whether it be from within or outside a plant, whether local or outside, whether individual, collective or unit, anyone can enter a bid. Select that which is excellent, select that which is inexpensive, then conclude the contract and carry it out.

5. There should be a policy of support for technical cooperation and technical transformation, provided that there may be results which will advance technical progress, or results which will raise the level of economic benefits. A good method would be for the nation to receive a sufficient amount, the unit to benefit sufficiently, and the individual

to receive a sufficient amount. In addition, there should be a policy of relaxed restrictions on people.

6. Work should be well organized and coordinated. Every locality, every department, every academic institution and all qualified scientific research units and industrial enterprises should be organized into a relevant system of technology, personnel consultation, development and service, so that high and low, left and right can more readily be mutually linked up throughout the entire province into a technical service organizational network.

At the conference, advanced units and individuals gave presentations on their experiences. For those units and individuals which had made outstanding contributions there were awards of money, cups and certificates of merit.

Participating in the conference were the Provincial Economic Commission, the Provincial Education Bureau, the Provincial Agricultural Bureau's Department of Village Industries, the Provincial Office of Technical and Economic Cooperation, the Chinese Academy of Agricultural Sciences, Qinghua University, Nankai University, Tianjin University, Hebei Agricultural University and other academic institutions from within and outside the province, representatives of scientific research units and the directors of various local and municipal science commissions.

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## NATIONAL DEVELOPMENTS

### JIAOTONG UNIVERSITY REFORMS S&T RESEARCH ADMINISTRATION

#### Reforms at Jiaotong University

Beijing GUANGMING RIBAO in Chinese 17 Jul 84 p 2

[Article by correspondent Zhang Binglu [1728 0365 4389] and reporter Zhang Yifu [1728 6318 5958]: "Management Reforms Advances the Form of Research Centers. Part one of a Survey of the Reforms in Scientific and Technical Research Administration at Shanghai Jiaotong University"]

[Text] Editor's note: Following the line, principles and policies of the Third Plenary Session of the 11th Party Central Committee, Shanghai Jiaotong University in recent years has understood the major contradiction of their school's administration not being satisfactory. Therefore, they implemented a series of administrative reforms, which included reforms in the spheres of teaching and research. As part of the reforms, they mobilized positively numerous teaching and administrative workers, in order to raise the quality of teaching and the level of research. Shortly thereafter, this paper published four articles which surveyed the administrative reforms at Shanghai Jiaotong University; now, we are publishing four more articles which survey that institution's reforms in the area of scientific and technical research administration, for the reference of institutions of higher learning.

The line of the party's Third Plenary Session of the 11th Central Committee, and Comrade Deng Xiaoping's stressing that colleges and universities should be centers of achievement as well as teaching, along with his directive that they should also be centers of scientific research, has brought about a scientific springtime for our academic institutions. For several years now, administrative reforms at Shanghai Jiaotong University have advanced the development of scientific research, and its basic form has already become that of a teaching and research center. In 1983, nearly 1,800 faculty members and graduate students were involved in scientific research work at Jiaotong, with an annual publication output of more than 1,000 articles. Over the past several years, they have received over 1,700 national awards for important achievements; 60.4 percent of entire university's fixed assets goes for laboratory equipment

and instruments, provided in the course of accomplishing the scientific research mission.

#### A Group of Organizations, One Staff

That colleges and universities are an important forward army in scientific research is largely due to their having considerable numbers of relatively high quality scientific and technical contingents. Augmenting the establishment of academic science research organizations is important in ensuring relative stability among these research organizations is important in ensuring relative stability among these research contingents and maintaining continuity in their scientific work. For this reason, setting up research organizations and a full-time science research staff is the foundation for the formation of research centers in colleges and universities. At present, Jiaotong has already developed these for Naval Architecture and Ocean Engineering, Computer Science, Materials Science and Engineering, Die Technology, Systems Engineering, Management Science, Engineering Mechanics, Large-Scale Integrated Circuit and Electrical Technologies, etc., a total of 10 research institutes and 41 research offices, with 580 full-time science research personnel. A group of research organizations and a stable research staff: both from organizational and manpower standpoints, this has laid the foundation for a research center.

#### A Leadership Example: Seek Rice In the Pot

In Jiaotong's administrative reforms, the "common pot" idea was fixed upon as a means of mobilizing into a critical mass the faculty's socialist enthusiasm. This kind of released energy will inevitably lead to their seeking ways of fully exploiting its application. For a long time, the state has given relatively little research responsibility directly to its institutions of higher education, and given them insufficient funds, far from satisfying faculty requirements. As a prerequisite for accomplishing the teaching and research missions transmitted to it by the state, Jiaotong has energetically sought out new research markets. It has done this by sending its school and departmental leaders everywhere, hurrying everyday to provincial and municipal leading organizations and industrial enterprises, competing for research assignments. Over the past several years, Jiaotong University has: concluded 13 long-term cooperative agreements for scientific and technical research with concerned provincial, municipal and county government departments; signed 1,445 research contracts with factories, businesses, etc; undertaken 406 consulting projects; established 25 teaching, research production and trade joint research and development enterprises; and moreover has nationally carried out with more than 2,000 units nearly 10,000 assignments for testing, experimentation and analysis.

## A Comprehensive Program With the Stress on Building

Building up key academic disciplines is crucial to the success or failure of building key academic institutions. If there is not a group of first-rate key disciplines, there will not be a first-rate key university. Jiaotong, while formulating its long-range development program, mobilized the mass of its faculty to make a forecast of developments in several important scientific areas for the rest of this century. Then, setting out from the school's original base, determined what they themselves would stress in development. For example, they selected optical fiber technology, development and application of microcomputers, large-scale integrated circuits, ocean engineering, energy engineering, bioengineering, materials science and engineering, mechanical and electrical sciences, and other fields on which to focus development. Jiaotong will stress these development areas, with a focus on funding, and on building up their teaching staff, laboratories and research funds.

## Urgent And Long-Term Needs Are Both Considered

Although the school's scientific research is urgently needed as a solution to economic construction, long-term needs are also taken into consideration. While assuming the majority of society's applied research problems, they still pay attention to basic theoretical research which exploratory or having application only in the long run. This part is maintained at a proportion of not less than 20 percent. They know that this basic theoretical research is an important aspect of exploring and understanding the world's objective laws, and will also guarantee that from start to finish the school's scientific research will stay ahead of production. As for research into applications of technology, they will develop these from new areas of basic theoretical research.

As the school develops its scientific research, the quality of its teaching will also improve. The latest research results supplement teaching, and lay a foundation for making known the latest modern scientific and technical developments in a large number of elective courses. In the course of developing its scientific research program, it was made explicit that for the research mission in important subjects, there should be fixed funding. This was done so that large numbers of graduate students could be recruited, and the necessary material conditions supplied for them, in order to accelerate the increase in their numbers. At the present time, Jiaotong has the largest number of graduate students of any university in Shanghai.

## Solving the Problem of "The Family Second, The Guest Third"

In the course of exploiting the faculty's research potential, and in competing for still more research projects, the school has frequently encountered the frustrating problem of "the family second, the guest third." There are some leading departments which are only willing to give research assignments to "their own troops," and with their own unbitable "hard bone," will transmit but a small portion of funds to the school, treating the university as a "mercenary army" participating in the attack.

Because of this, Jiaotong University has proposed that concerned departments responsible for the work should cast restricting binds and implement a system of inviting bids, then choosing the best and concluding a contract. This will use the least amount of time, the least money, and will bring the largest benefits.

#### Developing New Technologies

Beijing GUANGMING RIBAO in Chinese 18 Jul 84 p 2

[Article by correspondent Zhang Binglu and reporter Zhang Yifu: "Meeting the Challenge of Developing New Technologies: Part Two of a Survey of Administrative Reforms at Shanghai Jiaotong University"]

[Text] For several years, Shanghai Jiaotong University has been meeting the challenge of the worldwide technological revolution, adopting positive measures, striving to open up new technologies, and improving the vigorous development of the school's research work.

#### Vigorous Development of New Technologies

The clear lesson drawn from the rise and fall of colleges and universities internationally has made it clear that if scientific and technical universities do not pay attention to newly developed technologies, these schools can age rapidly and decline. For this reason, Jiaotong has since 1978 strongly encouraged faculty in some traditional subjects to change direction and develop new technologies, in order to contribute strength to the development of China's new industries. Starting out from the original base, it was determined to strengthen 37 key subjects within 8 fields, of which one-third were newly established subjects.

Concerning these newly emerging and frontier subjects, Jiaotong established the necessary research organizations and provided appropriate modernized testing equipment and authorized definite personnel strength. Due to faculty and technical staff with higher levels of professionalism assuming roles as academic leaders, and the backbone of research, the strength of these types of subject fields is assured, both in organization and in research. Very recently, Jiaotong decided that 60 percent of the school's total investment will be used for Information and Electronic Engineering, New Materials Engineering, Ocean Engineering, and other newly emerging fields, in order to ensure that there will be research work in newly emerging technologies.

#### More Academic Subjects' "Triphibious Warfare"

Currently, with science and technology developing on a massive scale, and with new, frontier subjects emerging constantly, our schools must obliterate the dividing lines between academic departments and teaching and research sections, and establish an organization that cuts across departmental and disciplinary lines. Shanghai Jiaotong from the very

beginning in 1980 set up six interdepartmental committees for biomedical engineering, systems engineering, ocean engineering, energy engineering, environmental engineering and thermal science, plus two interdepartmental research institutes for computer science and large-scale integrated circuitry. These interdepartmental, interdisciplinary organizations link up with major units, by carrying out organization coordination and unified planning for jointly developed research topics and academic exchange activities. For example, the interdepartmental committee on ocean engineering carried out a research and design project on a new model well drilling platform, involving the organization of four departments and seven teaching and research groups, with a research staff of nearly 50 people, and at the present time the research work is proceeding smoothly. Experience has demonstrated that this kind of interdepartmental, interdisciplinary organizational setup is not only of benefit in molding the university's many departments and disciplines into a complete, superior organization for jointly tackling comprehensive, important topics, but can also promote the development of emerging subject fields.

#### Old Fields "Blossom Anew"

While new fields are being developed, there is also a need for traditional disciplines to advance newer levels, making them more appropriate to the needs of the new era. Such traditional areas at Jiaotong as Naval Engineering, Dynamic Mechanics, Communications and Electrical Engineering, and Mechanical Engineering have a solid foundation and a dominant position. Jiaotong is giving close attention to integrating these traditional disciplines with the new, emerging fields, causing them to rise to new levels, and recapture their youth. For example, mechanical engineering is an old subject at Shanghai Jiaotong, with four doctoral degrees it can confer upon graduate students, and a comparatively solid base in both faculty and equipment. However, in recent years, there has been a very great change in the research areas of mechanical engineering internationally, and there have developed new mechanical and electrical engineering subjects, closely integrating these fields with such others as automation, robotics, biomedical engineering and combustion. Under these new circumstances, Shanghai Jiaotong firmly grasped the new areas of carrying out building and research in representative disciplines' development directions, and in 1978 set up in the Department of Mechanical Engineering the nation's first research office for robotics, launching an industrial robotics organization for control and intelligence work. Moreover, in 1979, Jiaotong was the first institution in China to develop a computer-controlled industrial manipulator replicated for instructional use.

Still another old department, the Department of Dynamic Mechanical Engineering, appropriate to the needs of society, increased its development of both mechanics and acoustics. Moreover, it established a new, emerging discipline of "vibration, shock and noise," having an intimate relationship to industrial production; this has become the national unit for bestowing the doctoral degree in this subject.

## Research Successes Pile Up In New Fields

At the present time this school has already put its highest priority on the establishment of microcomputer development and application (including image processing and pattern recognition), optical fiber communications and optical waveguide technology, new model materials, energy engineering, bioengineering and molecular biology, marine engineering, etc., 12 emerging and frontier disciplines in all. Moreover, they have already attained important results in these. Since 1981 Jiaotong has striven to develop microcomputer science, and has made it a priority to develop successfully a Chinese language microcomputer system, with a Chinese character-capable terminal and 16-bit machine, etc., a total of 11 new varieties which occupy first place among China's microcomputer products. Moreover, they have popularized their use by batch processing several thousand of these. Fiber-optical color image transmission and data transmission have already received widespread application in such departments as Public Security, Communications, Electric Power, Higher Education and Television Stations. Very recently, in close collaboration with the Silicate Research Institute, Jiaotong developed a long fiber optic image transmission system, which communicated with a clear image in a test over 12.5 km. Medium and large-scale integrated circuits retro-processing automation research has already completed a register stage logic simulation system. It has been successfully used to carry out simulated demonstrations of new products being developed nationally, and has drastically curtailed the research and planning period. In systems engineering, they have given high priority to accomplishing the proof of 19 important problems. A very recent example is that of bringing the Shanghai port site up to parity and excellence, by carrying out scientific decision-making and consultation, making important new contributions to port area construction.

### Efficiency Stressed

Beijing GUANGMING RIBAO in Chinese 19 Jul 84 p 2

[Article by correspondent Zhang Binglu and reporter Zhang Yifu: "Stress Efficiency, Seek Benefits, Pay Attention to Responsibility: Part Three of a Survey of Administrative Reforms at Shanghai Jiaotong University"]

[Text] In scientific research work, there must be a stress on efficiency and a search for benefits, with a resultant stress on responsibility. This is an important aspect of the reforms in scientific research work at Shanghai Jiaotong University.

Classify Management: Powers, Rights and Responsibilities in an Organic Whole. Before Jiaotong carried out its administrative reforms, funds for scientific research were concentrated in the university's administration, with the result that the university's departments, research institutes, teaching and research sections had their rights, powers and responsibilities divided up by administrative levels. Departments, research institutes and teaching and research offices regarded the school as a large pocket, recognizing that "one's parents having something is not as good as having

it oneself." As a result, they would blindly content for investment funds or equipment. At the end of the year, there would be a rush to spend the money, which the higher levels found difficult to control, and causing a squandering of surplus instruments and equipment and a year-end financial deficit. According to statistics for the first half of 1980, of 315 pieces of equipment costing in excess of 10,000 yuan, fully one-fourth of these were unused during that half of the year. The 1979 outlay of funds for scientific research was 150 percent of the total appropriated for that year.

In 1981, Jiaotong promulgated a "Notice that expanded departments and research institutes in scientific research work can act on their own for certain problems," giving these units the right to act on their own initiative in the administration and use of research funds. In carrying out research budget responsibility, accounting is done on a basis of tasks undertaken, and the surplus is carried over. What is overspent is deducted from the following year's allocation. This way, the money in the large pocket is divided into several small pockets, due to the departments and institutes being masters of their own funds, and through careful calculation and strict budgeting, save large amounts of money. When 1981 is compared to 1980, the number of research projects increased by nearly 50 percent, while the total outlay decreased by nearly one-fourth, thereby basically resolving the problem of the year-end spending rush.

On this foundation, the expanded departments and institutes have other areas in which they can act on their own initiative in research work, which puts responsibility for implementation with the heads of departments, institutes and offices. For example, departments and institutes have the authority to decide whether to accept a research assignment; they have the authority to examine, approve and purchase instruments and equipment priced at less than 50,000 yuan per unit; they have the authority to turn incompetent personnel over to the school's personnel department in order to improve work arrangements; they have the authority to assign or transfer research personnel within the university; they have the authority to employ temporary personnel or supplementary personnel from outside the school; they have the authority to allocate or deduct from research profits, in order to give rewards or penalties. Projects are organized and implemented in a responsibility system under the office heads' leadership. Last year, the entire university's research projects, research funds and S&T responsibility funds increased over 1982 by 46 percent, 77 percent, and 157 percent respectively.

#### The "Beard" is Shaven

Since 1979, besides the research assignments planned and transmitted from higher levels, Jiaotong has implemented an unprecedented contract system when entrusted with research work from locations outside the university. Not only have contracts been signed by the university with outside plants and industries, even basic units of the industry have concluded contracts among themselves. The contracts stipulate the total outlay of funds, the number of years till completion, the technology goal and the provisions for rewards and penalties. This guarantees the

seriousness of the research plans and enhances the sense of responsibility of research personnel. Since they trust in the contract provisions, year after year they carry out well the projects planned and transmitted from higher levels. This is because, if neither the planners at higher levels nor the ones responsible for a project have economic responsibility, neither will they have a clearly defined technical responsibility, so that there will be a number of "beard" items which will delay the annual planning. For this reason, Jiaotong has since 1982 been experimenting with a system of contracts for contracts transmitted from the Municipal Science and Technology Commission. In that first year, the university concluded 31 contracts between the university administration and its departments and institutes. As a result of the contracts' restrictive powers, everyone has been carefully considering, seriously proving, carefully weighing their technical and economic responsibilities. As a result, that year's plans were completed in excellent fashion, and the "beard" was shaven off. This school still employs a system of inviting bids where there is competition for research projects at grass-roots levels, selecting those with the shortest time for completion, the least funds required, the greatest benefits then concluding the contract.

#### For Complex Labor, Implement Quantitative Checks

In regards to the various kinds of faculty necessary to obtain both quality and quantity work, Jiaotong has established a set of standards, the "Faculty Work Standards." Under these prerequisites, the faculty create their working and living standards, and promote bringing about an activity arena of professional skills. Those who are dedicated and attain a given level, are then awarded with appropriate ranks and titles. In such areas as pay, bonuses and distribution of profits, the principle of distribution according to work applies. According to the standards, a university-wide check is made annually. In 1982, Jiaotong tried out the "Science research establishment and teaching profession examination system." On an annual plan they are examined in six set areas: conditions, research accomplishments, professional writing, economic benefits, teaching situation and miscellaneous duties. At present, each professor's academic year teaching load of 1,680 class hours has been decreased by 1 percent, and it was decided to divide the aforementioned 6 areas into 17, with allocations then being made on the basis of each person's work accomplishments. This has quadrupled the accomplishment of scientific research missions in just 2 years.

#### Technology Transfer

Beijing GUANGMING RIBAO in Chinese 20 Jul 84 p 2

[Article by correspondent Zhang Binglu and reporter Zhang Yifu: "From Technology Transfer Development to Research and Development Enterprises: Part Four of a Survey of Administrative Reforms at Shanghai Jiaotong University"]

[Text] Beginning last year, Shanghai Jiaotong University has placed highest priority on establishing many forms of linking its scientific research with production systems--research has created 25 industrial enterprises, greatly improving the linkage of school and society, education and economics, research and production. In the school's complete and continual administrative reforms, this reform of the system of scientific research is an important one.

#### Open A New Path For Science and Technology Geared to Economic Construction

In order that the fruits of scientific research coming from the laboratory can be transformed into products and merchandise, Shanghai Jiaotong University in 1979 began to carry out extensive technology transfer in society. Besides the majority of the results which are chosen directly by responsible scientific research units, research results which are transferred for compensation can also have obvious societal benefits in production and manufacturing. When the transfer of technology is compared to past circumstances of research and production, it is undoubtedly a step forward; moreover, it is still being put into effect, and being used positively.

However, this kind of simple technology transfer still places definite limitations on the mutual promotion of research and production. The reasons for this are: first, in technology, the school lacks final responsibility, that of assisting the plant; second, professors do not care about, nor comprehend, marketplace information--production and sales have nothing to do with them; third, there is no continuity between research on developing new products, and the work to produce new generations of old products, thereby affecting the mutual promotion and improvement of research and production.

In order to better carry out the party's policy on science and technology, and besides starting up research and development enterprises with collective enterprises, has also opened up a "special zone," within government managed enterprises, and within the "special zone", has established research and development enterprises, carrying out a collective enterprise management model. The alliances have adopted different administrative levels, different ranks and different forms, with a differing distribution of economic benefits. Most important is managing from the specific realities of the situation, according to each side's situation, technology and characteristics of the products involved. Some are joint research organizations, some are joint companies, some are modeled after a general company managing a certain number of plants or subsidiary companies, some are joint management ventures with Hong Kong companies and still more are involved in international technology and information exchanges. The basic method is to implement the principle of the "Seven Commons," that is, common planning, common research and development, common funding, common management, common assumption of risks, common sharing of results, and common division of benefits. Under these principles, particular emphasis is given to division of labor, in order

to benefit both sides by raising up the long and avoiding the short, thereby moving to position of superiority.

### Knowledge and Technology are Wealth

Among the various aspects that have arisen in establishing research and development enterprise, one in particular has really burgeoned. Jiaotong University leaders at all levels have encouraged administrative and technical personnel to show initiative everywhere, by building up cooperative relationships. Knowledge and technology are like magnets, attracting those who have a genuine devotion to suit the needs of the "four modernizations," Jiaotong rapidly built up a group of educational, research, and production and trade joint research and development enterprises. They started a new route for science and technology, geared to the needs of economic construction. This kind of system overcomes the limitations placed on simple transfer of technology. Its chief characteristics are: plant and university are merged, with joint rights, responsibilities and benefits; while the university does not bear sole responsibility for technology, it plays a definite role in management, with a resultant concern for the realities of the marketplace and trade. The university has a production base, and the plant has a reliable technical backup. Research and development work can then move forward continuously, with mutual assistance and joint improvement. As an example of this, Jiaotong has jointly operated an organic chemical plant with Nianqiao in Wuxi; in 1978, this university developed a type of negative photoetching glue, and this was transferred gratis to the plant. At the outset, this situation was all right, but owing to a lack of stable technical support over a long term, the product's quality lessened from time to time, gradually endangering its market. Last year, after agreement was reached on joint operation, the outlook changed rapidly. The university improved the original product, turned improved new results over to the plant for production, thereby restoring and capturing new markets. With Shangyu in Zhejiang, Jiaotong established a fiber reinforced plastics cooling tower research and development enterprises, and laid the foundation for technology transfer.

### A Technical Alliance and an Economic Entity

This sort of research and development enterprise is a technical alliance of plant and university, and is also a kind of economic entity. The university, their work, people determined to vigorously develop the economy. Some units have already derived benefits from this kind of alliance. A typical example is the aforementioned Lianfeng glass fiber reinforced plastic plant in Shangyu, Zhejiang, where three plants allied with Shanghai Jiaotong in the production of glass fiber reinforced plastics cooling tower. By relying upon advanced technology, the output value increased from 500,000 yuan in 1979 to 13 million yuan in 1983.

### Professors and Entrepreneurs

In establishing research and development enterprises, the basic goal is to carry out the policy of "economic construction relies upon science and

technology, science and technology are geared to the needs of economic construction." As far as the university is concerned, this policy can advance scientific research and improve the quality of education. Jiaotong University recognizes that, when these research and development enterprises are established, the university's functions are expanded, so that while it is still a teaching and research unit, its talents and knowledge also make it a technology treasure-house, which can be used to manage enterprises. The skills of the university faculty are increased, and among these there are those who can understand that education can be of benefit to management. This way, the relationship between universities and economic construction can become even closer. This kind of "blooming" system now links the university with society, education with the economy, research with production, as well as joining all aspects of managing school and trade, and will certainly be of the utmost benefit to the "four modernizations."

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## NATIONAL DEVELOPMENTS

### INTELLECTUAL INVESTMENT IN SCIENCE, TECHNOLOGY DISCUSSED

Beijing KEYAN GUANLI [SCIENCE RESEARCH MANAGEMENT] in Chinese No 2, Apr 84 pp 9-14

[Article by Zhao Xinpei [6392 1800 1014] of the Natural Dialectics Research Institute of the Social Sciences Academy of Heilongjiang Province: "On the Strategic Priority of Raising the Economic Results of Intellectual Investment in Science and Technology"]

[Text] At present sufficient attention has still not been aroused on the problems of paying attention to the law of value and to economic results in the fields of science and education, and there are many problems in both theoretical research and practical activity which must be explored. This article intends to discuss certain simple views on the problem of the strategic priority of raising the economic results of intellectual investment in scientific and technical education.

#### I. The Meaning of the Economic Results of Intellectual Investment in Science and Technology

All economic results can briefly be summed up as a comparison between cost and usefulness and between expenditure and income. The economic results of intellectual investment in science and technology is a comparison between fiscal policy in the area of intellectual development in science and technology and its produced usefulness, and these results are more particular than the results of economic activity. This particularity is reflected in raising the quality of the labor force, and is more favorable to raising labor productivity than merely increasing production facilities or the labor force. Once labor productivity is raised, social wealth can be greatly increased. For instance, although the Japanese labor force only increased 0.7 times during the 55 years from 1905 to 1960, since intellectual investment increased 22 times, national income increased nearly 9 times. The Japanese economy improved rapidly from 1960 to 1975 and the GNP increased 2.75 times, but the labor force only increased 18 percent. This was inseparable from paying attention to intellectual investment and its results.

Generally speaking, the produced usefulness of a specific amount of intellectual investment in science and technology can be roughly divided into two types. One type is the expression of its internal usefulness, such as the number of qualified personnel which a specific cost will train, and can be measured by the following formula: The results (internal) of all types of intellectual investment in science and technology equals the total amount of all types of intellectual investment in science and technology divided by the total number of all types of qualified scientists and technicians. The other type is the expression of its external usefulness, such as the degree of suitability of intellectual investment to the needs of macroscopic national economic development and the socialist spirit and civilization and the size of the promotion effect, and it is difficult to use a certain mathematical formula to make a quantitative analysis of this. The economic suitability of these intellectual investments in science and technology can still be roughly measured with the following formula: The suitability (external) to economic development of all types of intellectual investment in science and technology equals the number of all types of scientists and technicians who are "appropriately trained" divided by the total number of all types of qualified scientists and technicians. This of course is only an approximate measurement method, and still does not reflect a complete picture of the problem.

## II. The Necessity of Raising the Economic Results of Intellectual Investment in Science and Technology

In addition to the degree of scientific and technical development depending on a specific period of economic development levels and on the amount of intellectual investment in science and technology, the extent of the results of intellectual investment in science and technology is most crucial. Even if there is sufficient investment, if we are not good at using it and do not pay attention to its economic results, we will still be unable to obtain the proper results.

### A. The Necessity of Paying Attention to Economic Results Judged by the Quality of Intellectual Investment in Science and Technology

Since the founding of the PRC, because we have not understood the productive nature of intellectual investment in science and technology, we have one-sidedly stressed its consumption and welfare nature. We have believed that since expenditures in national income and distribution for scientific and technical education are part of social consumption funds and of the cause of working people's material and cultural welfare, they do not have the nature of increasing social wealth. We have thus paid very little attention to and have done relatively little research on the problem of the economic results of intellectual investment in science and technology. The phenomena of many units paying without counting costs, not paying attention to depreciation, not seeking results and eating out of "one big pot" are very serious, and have become a strong difficulty blocking the prosperous development of the cause of scientific and technical education.

Although intellectual investment in science and technology is not used in the cause of material production, it is used in the profession of producing spiritual products. Whether teaching activity or scientific research work, all activity in developing scientific and technical intelligence is a production process for spiritual products, it must all consume mental and physical strength, energy resources and material, and its products are expressed in the form of such activities as writings, theses and lectures. Although these products do not have the use value of the material form, yet they have the use value of the knowledge and information form. Intellectual investment in science and technology is an investment used to produce labor capacity, and is an investment in manpower, in developing intelligence and in enhancing the quality of manpower. This investment can be transformed into material labor to improve the social productive forces and to increase social material wealth and national income. Research by a group of economists overseas has proved that intellectual investment is a productive investment. It is thus absolutely essential to study the problem of the economic results of intellectual investment in science and technology judged by the quality of intellectual investment.

#### B. The Necessity of Paying Attention to Economic Results Judged by the Actual Conditions of Intellectual Investment in Science and Technology

Based on the major link in our country's intellectual investment in science and technology, i.e. an investigation of higher scientific and technical education, our institutes of higher education had reached 704 by the end of 1981, or a 3-fold plus increase over the 205 at the time of the founding of the PRC in 1949; and students in school had reached 1.28 million or approximately an 11-fold increase over the 117,000 at the time of the founding of PRC. This shows that although the cause of our higher scientific and technical education in the past 30 odd years has experienced various complications, yet it has after all forged ahead. But we must also see that since knowledge and research have long been deficient in problems such as the economic results of intellectual investment and the need for coordinated intellectual, social and economic development in order to obtain good comprehensive social results, this has resulted in many problems existing in intellectual investment in science and technology, and has caused many negative effects.

1. Labor Use Quotas are High. Labor use is a major factor in measuring economic results. Labor use generally indicates material labor use, and is normally calculated by fund use. The concept of fund use is especially hazy in higher scientific and technical educational units, and purchased goods and materials are often overstocked. Manpower use is also a kind of labor use, and although our higher scientific and technical educational units have fixed authorized strength quotas, yet for various reasons, the phenomenon of exceeding quotas can be found everywhere, and manpower use is very irrational. There are too many teaching and administrative staff and too few students; and among teaching and administrative staff, there are too many staff members and workers and too few teachers. There were 46,000 teaching and administrative staff in the 205 institutions

of higher education throughout the country in 1949, an average of over 200 per school. There were 633,000 teaching and administrative staff in 675 institutions of higher education throughout the country in 1980, an average of over 930 per school and an increase of nearly 5 times, and there were over 50 percent more staff members and workers than teachers. The proportion of college students to teachers in China in 1980 was only 4.6 to 1, and after several years of efforts has now only risen to 5 to 1. But it is generally 10 to 1 in countries where the economic results of intellectual investment in science and technology are advanced, and 18.1 to 1 in Japan. The ratio of teachers to staff members and workers in China is 1 to 1.5, but in advanced countries is generally 2 or 3 to 1. The great difference can be seen in the economic results of our intellectual investment in science and technology. If we can revise the imbalanced proportion and replenish essential school buildings and equipment, it is estimated that it will not be too difficult to expand enrollment one to two times. In this way, problems such as the national shortage of qualified personnel, the difficulties in young people going to college, and the lack of economic results in the intellectual investment in science and technology will be greatly alleviated and comprehensive social results will also clearly improve.

2. Labor Consumption Business Accounting is Imperfect. In measuring economic results, in addition to the need to investigate labor use, it is even more essential to investigate labor consumption, and this is an indispensable factor in studying economic results. The labor consumption accounted for by our higher scientific and technical educational units is imperfect. The existing accounting system only accounts for personnel, material, equipment purchase and renovation costs, and does not calculate depreciation costs based on the total use of fixed assets. This makes it impossible to reflect the total cost of higher scientific and technical education, is unfavorable to strengthening economic business accounting and to promoting the improvement and renewal of the fixed asset ratio, and makes it difficult to calculate the total cost of training qualified personnel.

C. The Necessity of Paying Attention to Economic Results Judged by the Harm Caused by the Lack of Economic Results from Intellectual Investment in Science and Technology

Because we have long neglected the economic results of intellectual investment in science and technology, this has caused one-sidedness in the direction of investment, the composition of scientific and technical education is irrational and the proportion of trained qualified personnel is imbalanced, thus the composition of qualified scientific research personnel is irrational and in a lack of economic results in intellectual investment in S&T, this has affected both the increase in the number of and the improvement in the quality of qualified scientists and technicians. Judged macroscopically, the proportion of the whole nation constituted by our scientists and technicians is very low, there are only 3 full-time scientific research personnel per 10,000 people, but 23 in Japan and 25 in the U.S. Scientists and technicians only account for

2.8 percent of the total number of our staff members and workers, but generally account for 30 percent in scientifically and technically advanced countries. There are only 330,000 agricultural scientists and technicians in the 800 million agricultural population, an average of only 2 per 10,000 mu of cultivated land, and only 4 per 10,000 agricultural population, but there are 18 agricultural scientists and technicians per 10,000 agricultural population in Japan.

The harm caused by the lack of economic results from intellectual investment in science and technology is also manifested by its being unsuited to the needs of developing specialized installations and the national economy. According to a 1981 investigation of graduates of institutions of higher education, an "amazing shortage" of approximately 190,000 people has arisen in 330 types of qualified professional personnel; and in another area, "surpluses" of over 100,000 people have arisen in 150 kinds of qualified professional personnel. In addition to creating the consequences of low economic results, this kind of deficient planning for the intellectual investment in qualified personnel can also have the effect of making it difficult to assess macroscopic comprehensive social results.

Again, based on discoveries by a contrasting investigation of the textile industry in the two areas of Shanghai and Jiangsu, under roughly similar conditions of mechanical equipment and raw and processed materials in 1979, the output value per 2 million spindles in Shanghai was 11.8 billion yuan, and 2.3 billion yuan of profits was turned over to the state; the output value of 1.97 million spindles in Jaingsu was only 8 billion yuan, and 1.1 billion yuan of profits was turned over to the state, or less than half that of Shanghai. Even though there are many reasons for the great disparity between the two places, and there are great proportional disparities in areas such as intellectual composition and investment results, we must say that they are a major factor. Scientists and technicians constitute 3.4 percent of the total number of Shanghai's textile staff members and workers and the economic results of intellectual investment are rather high, but they only constitute 1.1 percent in Jaingsu. Intellectual differences create production differences, and production differences also create differences in economic results. We know from this that the fundamental crucial reason for our lack of economic results lies in the lack of results in intellectual investment.

### III. The Strategic Priority of Raising the Economic Results of Intellectual Investment in Science and Technology

After we understand the necessity of raising the economic results of intellectual investment in science and technology, we naturally wonder where we should begin to do this. Judging this problem from a strategic point of view, in addition to continuing to energetically do a good job of managing the intellectual development of higher, intermediate and vocational scientific and technical education, since the related problem of "continuing education" for scientists and technicians has long been neglected, now is the time we should give priority to exploring it.

#### A. Continuing Education for Intermediate Scientists and Technicians is a Strategic Priority

China's intellectual investment in science and technology can be roughly divided into four administrative levels: higher scientific and technical education, intermediate specialized scientific and technical education, vocational scientific and technical education, and continuing scientific and technical education. In all of these four administrative levels, whether judged by the degree of attention paid to them by people or by actual development, problems exist in descending order of higher scientific and technical education being more important than intermediate specialized scientific and technical education, of intermediate specialized scientific and technical education being more important than vocational scientific and technical education, and of vocational scientific and technical education being more important than continuing scientific and technical education. Fund distribution for intellectual investment in science and technology in past decades has been based on this form. Higher education and intermediate specialized education have become the dominant areas, and continuing scientific and technical education has been in a neglected and forgotten position. A descending mathematical order has also appeared in personnel composition of continuing scientific and technical education, i.e. the opportunity for elementary scientific and technical personnel to receive education has been greater than that for higher and intermediate level ones. In other words, there are relatively few opportunities for personnel of intermediate level and above to obtain continuing education, and this phenomenon runs counter to the new circumstances of scientific and technical development.

Along with scientific and technical development in the present age, the total amount of scientific knowledge is rapidly increasing, and its growth rate is roughly in direct proportion to the square of the material production growth rate. The total amount of scientific knowledge in recent decades has approximately doubled every decade. The knowledge growth rate of certain new and developing disciplines has been even faster, and the trend of a "knowledge explosion" has indeed appeared. In another area, along with rapid scientific and technical development, knowledge has been becoming obsolete more rapidly year by year. A national staff members and workers educational working conference in 1979 estimated that the knowledge learned in school by a college student will be mostly obsolete in 5 years, and that most of it will be inapplicable in a decade. This produces a "scissors difference" between the amount of increased knowledge and the amount of absorbed knowledge.

Middle-aged scientists and technicians are the nucleus and backbone of our scientific and technical ranks, and they fight in the forefront in scientific research, production and teaching, playing a major, connecting role. Based on research on the "best age category" for qualified scientists and technicians, 35 to 55 years of age is the peak period for scientific creative ability. Most of the over 5 million qualified personnel of all types who have been trained in our country since liberation

are within the best age category for creative ability. But most of them have been out of school for a decade or two, and along with rapid scientific and technical development and the rapid shortening of the knowledge obsolescence period, and particularly the devastation of a decade of turmoil and the backwardness in our continuing scientific and technical education, resulting in the gradual, serious ageing of the knowledge of this large group of middle-aged scientists and technicians and the great weakening of their ability to blaze new trails, the disparity between the important tasks they are responsible for and their intellectual foundation is becoming greater. If we do not carry out the continuing education of "knowledge renewal" for them, it will be difficult to complete the historical task entrusted to them of the four modernizations.

The history of modern scientific and economic development has clearly shown that of all factors in economic growth, the proportion occupied by factors of scientific and technical progress is continuously increasing. But the prosperity of science and technology is directly related to the condition of qualified scientists and technicians, and the quality of qualified personnel must rely on the development of scientific and technical intelligence. People thus regard scientific and technical education as "potential scientific ability", and development of scientific education can realize the reproduction of scientists and the improvement of research ability. This also explains why certain economically advanced countries spare no expense now to strongly stress the factor of "on-the-job education" (also called "continuing education") in developing intelligence. Japan especially stresses a "second education" for scientists and technicians, and in order to be economically competitive, all enterprises are highly competitive in carrying out "continuing education". Eighty percent of all U.S. enterprises have plans for training scientists and technicians, and require "at least 1,200 hours a year of on-the-job study for engineers". France has specially established a "National Academy of Technology", widely opening a convenient door for scientists and technicians to engage in advanced studies. Even in industrially undeveloped India, engineers must still use 15 percent of their time annually to improve their standards. Under these comparisons, our disparities are self-evident.

Again, judged from the viewpoint of raising the economic results of intellectual investment in science and technology, the national investment cost to train a college graduate in China is now approximately 12-15,000 yuan; and it normally only costs approximately 9,000 yuan to train a graduate student for 3 years for a Master's degree. But this group of people who have been trained still need a suitable period of 3-5 years in order to gradually be suited to the needs of scientific research and production. In addition to the large expenses, it is also characteristic that the period of training qualified personnel is longer than the material production period. Training an intermediate specialized student requires approximately 12 years (referring to those recruited from junior high school), training a college student requires approximately 16 years, and training a graduate student for a Master's degree requires approximately 18-19 years. We are now seeking qualified

personnel in order to realize the four modernizations. But when can we achieve the magnificent goal of having an abundance of capable people by only depending on higher and intermediate scientific and technical education to run this race? Maybe never, and even if we can expand intellectual investment somewhat and recruit more students, and even if this group of people can truly develop their roles, it will still drag out at least until the late 1980's or the early 1990's, and we will still be worried that the aid will be too slow in coming to be of any help. If we change the strategic direction of intellectual investment in science and technology, it will change the policy of stressing the continuous increase of the quantity of scientists and technicians into one of stressing the continuous improvement of the quality of scientists and technicians, and particularly the improvement of the quality of intermediate backbone scientists and technicians. The former can be regarded as a "hard" investment quantity in developing science and technology, and the latter as a "soft" one. If we pay attention to the "soft" investment quantity, we will have good "output", enabling a qualitative leap to occur in our scientific and technical ranks and especially in the nucleus. But it will be difficult to estimate the chain reaction set off by this such as development of the ability to blaze new trails, scientific and technical progress and an increase in social wealth. It should be pointed out that if corresponding funds can be released from intellectual investment in science and technology and put into "continuing education" for middle-aged scientists and technicians, the funds spent and time needed will be far less than in training a college or graduate student. After these middle-aged scientists and technicians who have many years of practice and experience and a theoretical foundation repair through continuing education their scientific research deficiencies in such areas as new theory, new research methods and practical work capacity, they will appear on the scientific and technical stage with brand new attitudes, and the economic results of their scientific research will be much better. Many facts have long proved that this is a route which will save investment, reduce time and accelerate effectiveness in training qualified scientists and technicians and in raising the economic results of intellectual investment in science and technology. Administrators who are engaged in the work of intellectual investment in science and technology should approach this question from the high plane of strategy, firmly grasp this strategic measure which is related to the vigorous development of the scientific and technical cause and to raising the economic results of training qualified personnel, and carry it through to success.

#### B. Continuing Education for Scientific and Technical Management Cadres is a Second Strategic Priority

Along with scientific and technical development and social progress, the position of scientific and technical management is becoming higher. Modern scientific and technical management has become the key factor in developing science and technology, and is called the "resource of resources".

Scientific and technical administrative personnel are the policy-makers and executives in carrying out scientific and technical management, a major component of the scientific and technical ranks, and an important front army. What the quality of this front army is, how they develop their roles, and whether the individual and collective composition of scientific and technical management is outstanding, all have a decisive effect on scientific and technical development, and on the speed, quality and quantity of the output of results and qualified personnel on the scientific and technical front.

This proves that doing a good job of building the scientific and technical management ranks is indeed not an insignificant matter, but is a major affair of strategic significance in developing the cause and in raising the results of intellectual investment in science and technology. If our continuing scientific and technical education is backward, continuing education for scientific and technical administrative personnel is even more backward. This backward situation which is unsuited to the trend of the times will inevitably result in an inferior quality of scientific and technical management ranks and in backward science and technology. The time has now arrived to strengthen continuing education for scientific and technical administrative personnel.

#### C. Continuing Education for Auxiliary Scientific Research Staff Members is a Third Strategic Priority

Because science is developing in depth and the increased difficulty of blazing new trails in scientific research, individual scientific research methods have gradually changed into collective ones. The problem of the collective scientific research composition is increasingly arousing people's interest and exploration. A rational and superior scientific research knowledge composition should form a whole based on fixed proportions of people having high, intermediate and elementary knowledge levels. In other words, there must be a proper proportion of backbone scientific research forces to auxiliary ones. Based on overseas data, the proportion of U.S. scientific research personnel to auxiliary staff members is 1 to 2-2.5, and the Soviet Union's is 1 to 3-3.5. Due to a lack of strategic planning, training of our high, intermediate and elementary qualified scientists and technicians has long been in a state of imbalanced proportions. During the period of the first 5-year plan, there were 270,000 higher institute graduates and 400,000 technical high school graduates, the proportion between the two being 1 to 1.5. Later, for a variety of reasons, technical high school graduates rapidly decreased. The proportional figures for the two have now decreased to 1 to 1. If we go by conditions in China, a proper proportion of 1 to 3 should be generally maintained. A low quota of intellectual investment in auxiliary scientific and technical staff members, creating conditions of a lack of auxiliary scientific and technical staff members and proportional imbalances in the knowledge composition of the scientific and technical ranks, is also a major factor in the lack of economic results in intellectual investment in science and technology.

Due to a lack of qualified auxiliary scientific and technical staff members, some scientific research units have had to employ personnel without any specialized training, and the disadvantage has thus arisen which the masses call "one gun and two eyes". On one hand, since these personnel's professional quality is low, they cannot truly play an auxiliary scientific research role, there are many internal costs, and any good economic results are of course out of the question; on the other hand, the phenomenon of personnel "surpluses" has also appeared in many units.

Auxiliary scientific research staff members are a major component of the scientific research ranks, they are the "eyes and ears" and "pioneers", the "staff officers" and "aides" of scientific research work, and a force not to be neglected in the collective scientific research composition. If we can strengthen the management and training of these forces and "continuing education" for auxiliary scientific research staff members, and repair this "short leg" of the scientific and technical ranks which was created by various factors, it will enable the role of the entire scientific and technical ranks to be greatly strengthened and also the economic results of intellectual investment in science and technology to be greatly improved.

#### IV. Ways to Strengthen the Strategic Priority of Intellectual Investment in Science and Technology.

From the foregoing discussion, we can see that development and raising the economic results of intellectual investment in science and technology should proceed from our national conditions, continuing scientific and technical education should be regarded as a strategic priority in intellectual investment and be given adequate attention, and conscientious research and exploration should be carried out based on a combination of theory and practice. We will now discuss views on several problems.

##### A. There Must be a Change in Our Knowledge

Paying attention to the problem of the economic results of intellectual investment is related to the major strategic problem of the development of the cause of socialist science, and has not only theoretical value, but also fairly great practical significance. There must thus be a great change in our knowledge.

We must first change those past erroneous tendencies such as one-sidedly stressing the consumption nature of intellectual investment in science and technology and neglecting its productive nature, only considering needs and not labor use and consumption, and only bothering to spend money and not to count results. We should bring intellectual investment in science and technology onto a path centered on raising economic results.

Second, in strategic decisions on intellectual investment in science and technology, we must do a good job of coordinating relations between higher, intermediate and vocational and continuing scientific and technical

education, and improve the position of continuing education. We must now strive to redress the prejudiced "theory that a one-time education is complete" which exists in the minds of many people, and require people to establish a viewpoint of continuously accepting education and "studying as long as they have breath in their bodies". Leaders in some units particularly are shortsighted, see continuing scientific and technical education as "a soft job", and put too much stress on intermediate scientists and technicians, simply using and not training them, and causing them to lack the conditions for "knowledge renewal". According to statistics, the 35-45 year-old scientists and technicians who get the opportunity to engage in advanced studies constitute only 14 percent and 46-55 year-olds constitute only 7 percent of all scientific research personnel.

Once again, we must pay attention to studying business accounting forms for the economic results of intellectual investment in science and technology. Comprehensive and systematic business accounting of intellectual investment in science and technology is very complicated work, and there are still many unknown fields in need of people to explore them. Some people now propose the business accounting form of "taking fund expenditure as the center", and this requires formulating classified fund quotas, rationally determining fund responsibility totals, and formulating fund use quotas in order to promote fund economy. There are also people who propose the business accounting form of "taking the cost of qualified personnel as the center", and this requires distinguishing various categories and administrative levels of scientists and technicians. If the category and administrative level are different, costs will also be different.

#### B. We Must Create the Necessary Conditions

Continuing scientific and technical education involves a wide range, and is a fairly complex item of work which has just arisen; its foundation is deficient and there is also a great difference in people's attitudes; there are more difficulties than in regular school education, and it is so deficient in the essential backing conditions of personnel, money and material that it is too dreadful to contemplate. It is absolutely essential to establish full-time organs, and to provide management and teaching personnel, enabling the work of continuing education to proceed from organization to actuality and to become normalized. Material conditions necessary to continuing education such as school buildings, teaching aids, equipment, teaching material and experimental materials should also be properly provided with overall consideration. In order to guarantee this strategic priority of continuing education under the conditions permitted by national financial resources, it will be absolutely essential and also quite worthwhile to increase the investment in continuing scientific and technical education.

### C. We Must Adopt Flexible and Diversified Forms

Continuing scientific and technical education is difficult and painstaking work, and the major condition to achieve success in this work is to fully arouse the enthusiasm of all areas, enterprises, academies and scientific research units, and to adopt flexible and diversified forms suited to local conditions. Judged by experience both at home and abroad, fairly suitable forms are: 1. To manage or jointly manage by scientific research departments "colleges" or "continuing education centers" in which all classes of scientific research personnel, based on arrangements by the school, combine their needs and choose the essential professional theoretical knowledge; 2. To establish close contact with colleges and scientific research units, sign contracts, and send people out for training by stages and in groups; 3. To classify and establish scientific and technical colleges or schools for advanced studies; 4. To organize related personnel to participate in studying in college by television, spare time college, correspondence college or study classes which are socially-run and suited to the needs of scientists and technicians; 5. To organize academic public lectures and discussions; 6. To send people abroad on investigation tours or to engage in advanced studies from units which meet requirements; 7. To organize experts to raise assistants; 8. To vigorously support and organize independent study; and 9. To provide leave for scientists and technicians above the intermediate level to engage in advanced studies.

### D. We Must Formulate Corresponding Policies

In order to ensure the thorough, enduring and effective development of continuing scientific and technical education, and that it truly becomes a strategic priority, we must formulate certain practical and effective policies and measures. For example, based on the laws of development of the national economy, we must formulate training and annual plans for scientists and technicians; regard the success of the development of continuing education as a major index in examining the success of a unit's management work; stipulate that salary be unchanged for scientists and technicians during on-the-job study periods; establish a system of treatment for personnel engaged in continuing study such as examination, rewards and punishments, and records and titles for course completion; and establish a filing system for "continuing education".

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12267

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ENVIRONMENTAL POLLUTION CAUSED BY COAL MINES DISCUSSED

Beijing MEITAN KEXUE JISHU [COAL SCIENCE AND TECHNOLOGY] in Chinese No 7, 1984 pp 37-40

[Article by Dan Zhongjian [0830 1813 0256] of the Graduate School of the China Minerals Institute, Beijing]

[Text] Protection of the environment from damage by coal mines is still in a preliminary phase in China, as the level of environmental pollution from coal mines increases, it further arouses people's concern. Obviously, there is a direct connection between consumption of energy and environmental pollution, and energy consumption is steadily on the increase. The increase in world energy consumption is shown in table 1, with a projection of the use of 20 billion tons of standard coal.

Table 1. Increase in Energy Consumption in the 20th Century

Year	Total Consumption (100 million tons of standard coal)	Per Capita Consumption (kg of standard coal per person per year)
1900	7.75	493
1925	15.65	796
1950	26.64	1080
1975	85.70	2140
2000	> 200.00	> 4000

(figures for 2000 are a minimum estimate)

Coal accounted for 29.8 percent of world energy resources in 1978. In China it was above 72 percent in 1981. China's overall energy efficiency index was only 30 percent in 1978, as compared to 51 percent for the United States, 40 percent for England and 57 percent for Japan (Table 2). This low an index of efficiency must clearly create a great deal of pollution.

Table 2. Comparison of Energy Utilization Efficiency Index (Percent) for China and the Industrially Developed Nations

Index	USA (1970)	England (1973)	Japan (1970)	China (1978)
Overall utilization index	51	40	57	30
Industry	77	67	78	35
Electric power	30	27	30	24
Transportation	25	20	25	15
Domestic Use	80	70	80	25

If China consumes an annual 600 million tons of coal, we will produce 1.2 hundred million tons of ash and clinker, 20 million tons of smoke and cinder, 15 million tons of SO<sub>2</sub> and other noxious gases, and most of this will be concentrated in the cities and towns near high sulfur coal mines. This will lead to the serious pollution of several hundred towns. Household use of coal in China consumes 100 million tons per year, 17 to 18 percent of the total national consumption of coal. But coal accounts for 80 percent of the infrastructure of household energy use. Our kitchen stoves have a heat utilization index of only about 15 to 20 percent, while those in industrially developed nations have an index of 50 to 60 percent. To get to the root of this problem, we must raise the quality of the coal, improve the construction of stoves and implements, and then we can reduce pollution to the greatest degree.

Many facets of the problem of environmental pollution from coal exist in the areas of mining, transport, dressing, storage, etc. But the following three aspects command special attention.

#### I. Environmental Problems due to Coal Mining

Coal mining brings different degrees of pollution to the environment. Underground mining can cause the earth's surface to settle, as it has at the Fushun and Haogang mining areas where the surface has settled more than 10 meters, and perhaps as much as 20 meters at the Laohutai mine, in Fushun. Rock strata and surface shifts imperil industrial and agricultural production, home construction, railway bridge building and other engineering projects. To take just Fushun for example, according to statistics from the Ministry of Coal Industry's Office of Environmental Protection, the coal fields in the region have an area of 36 km<sup>2</sup>, and the settling has affected 18.7 km<sup>2</sup>. The area of vegetable plots in the settled zone is 7,592 mu, and of this 1,182 mu have been declared useless, and 1,628 mu can no longer be irrigated or drained. The value of the produce per mu of

vegetable plot has been halved, and the moving and reconstruction costs are estimated at 600 million yuan. Thus more than one national law stipulates that after mining is completed in an area, the agricultural fields will be restored. At the China National Coal Environmental Protection Meeting held in June, 1983, it was proposed that part of the tonnage coal maintenance fee be made into an environmental pollution control fee.

Open pit mining brings double jeopardy. Farm fields are destroyed making the pits and the tailing piles. The Fushun open pits and waste piles take up 62,000 mu of land. The other danger is the things dug up in the mines pollute surface water and groundwater. While the effect on surface water is more evident, the effect on groundwater is just as serious. For an analysis of underground water and 20 water wells 200 to 300 meters from the Wangliang dumping site at the Fushun West strip mine, see table 3. An inspection of 5,000 people around the dump site discovered 54 percent had a rapid pulse, high blood pressure was common, and a majority had digestive disorders.

Table 3. Water Quality Around the Wangliang Dump Site

Pollutant	Content mg/L	Standard mg/L	Overplus %	Water Source
Sulfate (1)	1,007	250	400	Ground water
Sulfate (2)	200-900	250	above normal	Well water
Fluorides	23	1	2,300	
Nitrates	38	10	300	
Water hardness (in degrees)	40-60[1] >100 [2]	25	+200 400	
pH	7		normal	

Notes: [1] Rainy season. [2] Dry season.

## II. Environmental Problems Caused by Coal Washing

To raise the rational utilization of coal, we must increase our capacity for washing raw coal. Right now only 21 percent is washed, and it is hoped that it will be increased to 30 percent by the year 2000, raising the washing capacity to 3.6 hundred million tons. If under normal conditions it takes 1.2 tons of water to wash 1 ton of raw coal, and the corresponding amount of coal mud and water discharged will be close to 1 ton, then in the course of coal washing 4.3 hundred million tons of water will be polluted, of that about 3.6 tons will return to the surrounding water environment and pollute that water. With this large an amount of water containing coal particles polluting the surrounding water environment, both

the surface water and groundwater will be polluted. According to results of our institute's graduate school investigation of 106 coal washing plants, all of them discharge water which affects the pollution level of the water environment surrounding them. According to incomplete figures, the concentration in the water discharged by 41 of 53 plants was higher than the national standard.

According to an analysis of monitoring of several coal washing plants performed by the Environmental Engineering Research Office of the China Minerals Institute, Graduate School, the pollution caused by discharge water from coal washers is manifest in the following ways:

(1) A serious excess over the standards for suspended matter, some as much as 40 to 135-fold in excess. The main suspended substances are coal particles and clay, as well as additives absorbed by the coal particles, bringing various pollutants to the water. (Table 4).

Table 4. Metal Iron Content in Water Discharged from a Coal Washing Plant

Water type	K <sup>+</sup>	Na <sup>+</sup>	Ca <sup>++</sup>	Mg <sup>++</sup>	Cu <sup>++</sup>	Fe <sup>+++</sup>	Mn <sup>++</sup>	Zn <sup>++</sup>
Fresh	1.4	23.6	61.7	87.5	----	----	----	----
Discharge I	6.2	103.4	417.4	150.5	2.0	100	3.44	2.79
Discharge II	2.4	109.0	83.3	87.5	----	1.17	0.18	0.10
Coal Tail-ings III	3.4	112.6	135.9	91.5	----	----	----	----

(2) Content of metal ions and trace elements increases, as table 4 indicates, the metal ion content is several times higher in the discharge water than in the fresh water before washing coal in the coal and washing plant described. This causes definite changes in the general ionic make-up of the water, creating severe pollution.

(3) The oil content of the water goes up. Generally, before washing the oil content of the water is extremely small, but at a certain washing plant of the Xuzhou Mine Bureau the oil content in the coal tailing water is 25 mg/L or more. The highest allowable oil content for aboveground processing water is 0.3 mg/L, and the highest concentration allowed for industrial waste water is 10 mg/L. When the thickness of the oil film on the water surface reaches  $1 \times 10^{-4}$  cm, it affects the ability of the water to be re-aerated with oxygen, with a profound effect on the longevity of fish. Thus it is certain that we must strictly control the oil content of water discharged from washing processes that use great amounts of oil additives

(sometimes the amount of coal oil used is 1 kg or more).

(4) The dyeing action of coal creates scenic pollution. The water discharged from washing plants or mines carries a black coloration which affects the transparency of water, with its worst effect in tourist areas.

(5) Pollution from organic additives. All sorts of additives are used in the processing of coal mud and water, among them frothing agents, arresting agents, regulating agents and agglutination agents. When their content exceeds a definite standard they bring serious hazards to water and to human health. When the phenol content of frothing agents is high, to the point of making the cresol level of the water exceed 6 to 50 mg/L, the plankton may die. Cyanide is a deadly poison, it should be limited to less than 0.5 mg/L of water, and when it exceeds 0.04 mg/L it can cause fish to die.

(6) Thermal pollution. According to research on the water discharged from certain mines and washing plants, the temperature may be as much as 5 to 7° higher than water in the surrounding environment in the winter, and as the water temperature rises it causes a drop in the amount of dissolved oxygen, intensifying the toxic qualities of the pollutants.

(7) Acid mine discharge (AMD) is a worldwide problem for mines and washing plants. It is not only connected with mine discharge water but also with water discharged from processing sulfur bearing minerals. To prevent pollution by sulfides, we must pay attention to the problem of removing sulfur from high sulfur coal and the problem of vadose water in gangue heaps. Severe acid pollution may result to the drinking water for the surrounding population, to agricultural irrigation water and to aquatic organisms.

(8) Pollution from the coal itself. As everyone knows, coal was formed principally from higher plants under definite external conditions over a period of 10 to 20 million years to several hundred million years. Minerals contained in coal include quartz, clay, pyrite, marcasite, calcite, feldspar and mica. These minerals are composed of such elements as silica, iron, calcium, magnesium, potassium, sodium and sulfur. Because coal producing areas differ, because the chemical make-up and analysis of the minerals varies, so too does the chemical make-up of coal vary. Inorganic substances in coal may also harm the environment, as for instance excessive calcium and magnesium ions caused by excessive coal ash dumped into rivers can change the degree of water hardness. Phosphorus and chlorine in coal also pollute the environment. Phosphorus content of coal is about 0.001 to 0.1 percent, mainly as inorganic phosphorus, which not only affects the quality of pig iron, but also makes it extremely hard to remove precipitate in boilers, affecting their heat utilization efficiency. Chlorine exists in coal mainly as sodium and potassium chlorides, their content is about 0.01 percent to 0.2 percent, but when their content exceeds 0.3 percent they exert a powerful corroding effect on the walls of coking ovens and on boiler tubes. Furthermore, if the concentration of trace elements and radioactive elements

like gallium, uranium and germanium gets too high, then they will pollute the environment if they are too low grade for industrial recovery.

Table 5 shows that the content of the extremely toxic radioactive element  $^{210}\text{Po}$  in the gangue coal of several mines in Jiangxi is generally fairly high. The water discharged from coal washing plants in the Gan river drainage has almost 600 percent more uranium and 1300 percent more radium than Gan river water itself. These circumstances dictate the strict monitoring and control of mine and washing plant discharge water; coal processing and gangue piles containing radioactive elements particularly should be watched.

Table 5. Radioactive  $^{210}\text{Po}$  in Coal (pCi/g)

Mine	Mixed coal samples	Gangue coal	Thin coal	Coking coal
Anyuan	0.89 ±0.36	--	1.68 ±0.49	0.88 ±0.17
Qingshan	0.75 ±0.16	1.18 ±0.24	--	--
Fengcheng	1.37 ±0.35	1.51 ±0.25	1.74 ±0.08	0.82 ±0.17
Gaokang	--	1.53 ±0.11	--	1.21 ±0.06

Inorganic compounds also have a direct effect on polluting the environment. In particular there are the Polycyclic Aromatic Hydrocarbons (PAH), known carcinogens found in many coals in China, and in fairly high concentration in the young bituminous coal of Datong and elsewhere.

The pollution caused in the course of burning coal is also very great, the density of fly ash formed being directly related to the ash content. When coal with an ash content of 10 percent is burned, the smoke density is  $9.35 \text{ g/m}^3$ , but when ash content is 47.05 percent, the smoke density is  $83.2 \text{ g/m}^3$ , naturally this also has to do with the conditions and equipment for combustion as the relationship of fly ash density to ash content for boilers using pulverized coal can be calculated from the following formula:  $C = 940A \text{ mg/m}^3$  (A being the ash content of the coal). Clearly the more ash the greater the seriousness of the pollution, but as the screen size of the coal decreases, the smoke also increase. The most serious pollutants from the burning of coal are  $\text{SO}_2$ ,  $\text{NO}_x$ , CO and PAH. Generally, 100 cubic meters of coal smoke can produce 300 ug Bap, which quickly attaches itself to the dust in the air, particularly airborne dust  $< 10 \text{ um}$ , causing severe atmospheric pollution. According to an American study, each increase of 1 ppm of Bap results in a 5 percent increase in lung cancer in the population. Acid pollution from high sulfur coal is also extremely severe. The acid rain incidents in Chongqing and Guiyang are serious dangers to peoples lives and agricultural products, as well as seriously corroding scenic spots and historical sites. In 1981,  $\text{SO}_2$  was released into the atmosphere in these amounts in the following cities: Chongqing, 498,000 tons; Beijing, 290,000 tons; Shanghai, 196,700 tons; Tianjin, 243,000 tons. In 1980 the particulate matter released into the air in these same places was 450,000 tons, 420,000 tons, 310,000 tons and 260,000 tons respectively. This kind of pollution resulted in the serious situation in Beijing in 1980 when rainwater

with a pH value of 5.28 fell.

### III. The Problem of Pollution Resulting from the Transportation of Coal

China's railways hauled 3.3 hundred million tons of coal in 1981; rail is the major transportation mode for coal in China, accounting for over half the total coal transported. Highway transport is characterized by short hauls and small loads, with trips generally 100 to 200 km or less. Water transport accounts for one-third of the coal transported. Coal made up 31.7 percent of the total cargo moved on the Chang Jiang in 1981. Coal for export depends on harbor transport. The transportation of coal can bring pollution to the air, water and land, principally in the following two ways:

(1) Coal dust. The coal dust pollution generated in the transportation of coal is considerable. Losses of coal to coal dust in transport and storage are really large, and more attention must be paid to their contribution to the creation of air pollution as suspended substances. Ordinarily 15 to 40 percent of the dust has a diameter of 5 to 25  $\mu\text{m}$ , it does not settle easily, and when it is in a suspended condition it can be hazardous to health when inhaled.

(2) Noise. The means of transportation described above all create a great deal of noise, and tractors are the worst. Noise is harmful not only by creating deafness and insomnia but also by affecting the nervous system and circulatory system, and causing congenital malformations.

To summarize, the mining, transport, processing and burning of coal all contribute to environmental pollution. If coal production continues to increase, the seriousness of the pollution will increase by the day. Air, water and noise environments can all be damaged seriously, as can the ecological balance. Thus, an environmental impact assessment should be made before the preliminary construction of a coal mine begins, the effects on and damage to the environment during normal coal production should be monitored, and emphasis placed on pollution control engineering for mine areas, so that the coal resource may serve the four modernizations and the peoples' livelihood, without damaging the environment, so that pollution is eliminated, for the betterment of the people.

12663

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LIFE SCIENCES

AVIATION MEDICINE'S ROLE IN MODERN AIRFORCE DISCUSSED

Beijing JIEFANGJUN YIXUE ZAZHI [MEDICAL JOURNAL OF THE CHINESE PEOPLE'S LIBERATION ARMY] in Chinese No 2, 20 Apr 84 p 143-144

[Article by Xu Weipu [1776 4850 3877], of the Institute for Aviation Medicine: "The Basic Mission of Aviation Medicine and Its Role in Modern Airforce Construction"]

[Text] "Aviation medicine" specializes in researching a resolution to the whole series of special medical problems encountered in flight activities when mankind, piloting or riding in airplanes or other aircraft, leaves the natural environment of the earth's surface that he has been adapted to for generations. After the emergence of airplanes at the beginning of this century, and particularly in the wake of the rapid progress of aviation and space-flight science and technology in the last 40 years, aviation medicine has developed into a field of "aviation and space medicine," with a distinctive content and system. Since the beginning of the 20th century, many nations in succession have established specialized academic organizations and learned societies, published specialized books and periodicals and launched frequent specialized academic activities related to this field. This has not only made outstanding contributions to the development of military aviation, civil aviation and astronavigational undertakings, but in certain respects it has also enriched the content of general medical science and advanced the progress of general medical technology. Current aviation and space medicine can be divided into military aviation medicine, civil aviation medicine and space (space flight) medicine. Here we will focus on a discussion of the basic mission and the major components and job characteristics of "military aviation medicine," as well as its role in modern airforce construction.

By virtue of the day by day increasing role of aircraft in military affairs and the rise, over time, in the tactical technical performance of military aircraft, military aviation has taken on distinct specific characteristics of its own within the field of aviation. Looking at it from the angle of aviation medicine, the major specific characteristics of military aviation can be summarized in the following three points:

1. Today's high-performance military aircraft, particularly interceptors and attack planes, have the ability to fly day or night at high altitudes (more than 20,000 meters), at ultra low altitude (below 100 meters), at high speed (more than twice the speed of sound) and perform high-G maneuvers (up to 10 G or so), over all sorts of terrain and under all weather conditions.

2. Pilots are limited and restrained in the narrow, airtight cockpit environment, and may be influenced and endangered by various factors in the aviation environment and factors of flight dynamics in the course of flight activities or life support. They also must be outfitted with individual protective life-support flight equipment, thus further aggravating intense in-flight work loads.

3. Flight personnel must be endowed with excellent, suitable physiological and psychological characters. The job demands rapid, accurate, practised and agile operating skills, a strong will to fight and highly efficient, high quality completion of intense, complex flight training and combat missions.

Obviously, military aviation places high demands on the physical quality of its pilots. This then requires "military aviation medicine" to work hard to research and resolve the following problems in accordance with the above-mentioned characteristics of military aviation: (1) there is the problem of improving the performance of protective life-support equipment--a problem posed by the contradiction between the rigors of the aviation environment and factors of flight dynamics on the one hand, and the limits on human physiological functioning on the other hand. (2) There is a contradiction between the tactical technical performance of the aircraft and the pilot's in-flight work load, and there is a problem in raising the combat capabilities of flight personnel. These problems must be resolved in order to achieve the basic goals of military aviation medicine "to safeguard the physical health of flight personnel, to guarantee flight safety and to maintain and increase airforce combat effectiveness." Therefore, military aviation medicine must strive to accomplish five fundamental tasks in conformity with the practical demands of aircraft types (interceptor fighters, attack planes, bombers, reconnaissance planes, transport planes, helicopters and so forth), and of flight training and combat missions. These five tasks are as follows:

1. We must study the physiological, psychological and health requirements for all kinds of aircraft cockpit equipment and for the design of all sorts of aircraft protective life-support equipment (oxygen supply, pressurization and ejection life-support systems and so forth). This will enable the aircraft and equipment produced to conform to the characteristics of human physiological and psychological functioning, thereby continuously raising the efficacy of in-flight work and ensuring flight safety.

2. Research and formulate the technical methods for physical and psychological examinations of flight personnel and the physical qualification standards for flight personnel on the various aircraft. This will enable the flight personnel chosen to conform to the tactical and technical demands of the various aircraft so that they can better accomplish flight training and combat missions.

3. Research and formulate all kinds of physical and mental aviation training equipment and methods, research and advance various health protection measures, maintain and increase the air-combat capabilities of flight personnel and lengthen their flying years.

4. Study the problem of preventing and curing illnesses caused by aviation factors, ailments common to flight personnel and frequently occurring diseases. Study flight mishaps and their indicated medical causes, advance preventive medical countermeasures, ensure the physical health of flight personnel and reduce the occurrence of flight mishaps.

5. Study the organization, equipment, tasks and implementation methods of logistic health service at all airforce troop levels in peacetime and in war (particularly the working conditions and methods of airforce medical officers), and raise the efficiency and quality of flight medical safeguards.

For the purpose of accomplishing the above-mentioned fundamental tasks of military aviation medicine, in China we have divided the discipline of military aviation medicine into the following five branches: aviation physiology, aviation hygiene, aviation psychology, medical appraisal of air logistical personnel and airforce logistic health service. However, in books and journals published abroad in the last few years, although there is no division of the discipline there is generally discussion of special topics. Arrangement and division of components in the various fields is not entirely uniform, and the special establishment of academic organizations is also dissimilar. The scientific composition of modern military aviation medicine is tending toward a general division of the field into six specialized branches based on a principle linking theory to practice. The major components are as follows:

#### 1. Aviation Environmental Physiology

This branch stresses research into the influences that various high altitude factors in the atmospheric environment--low atmospheric pressure, lack of oxygen, extremes of temperature and ionizing and non-ionizing radiation--have on the human body, and corresponding protective measures. Among these, the problem of life support under conditions of rapid decompression at high altitude occupies an important place.

## 2. Aviation Biodynamics

This branch stresses research into the influences that various factors in flight activities--acceleration, impact, gusting wind currents, acoustical noise, vibrations and so forth--have on the human body, and corresponding preventive measures. It also studies safety measures to follow under emergency conditions when one is forced to eject from the plane, and the series of aviation life-support problems that follow therefrom.

## 3. Aviation Psychology and Work Efficiency

This branch stresses research into methods of examining and assessing the psychological characters of flight personnel, and into the psychological and physiological requirements of assorted aircraft cockpit equipment and instrument panel display and control systems (flight control and weapons fire control). It also studies various flight training and combat mental hygiene measures and the problem of obstacles to spatial orientation in flight activities.

## 4. Flight Work Hygiene

This branch stresses research into the characteristics of in-flight work loads and their methods of clinical measurement and evaluation on various flights. It also researches and advances reasonable hygiene and health care measures concerning in-flight work and rest schedules, guarantees of nutritional soundness, physical training and proper use of medicines, as well as problems of aviation toxicology.

## 5. Clinical Aviation Medicine

This branch stresses research into methods of examining and assessing the state of flight personnel health and physiological functioning and the standards of physical qualifications for the various aircraft. It also researches medical treatment and prevention measures for illnesses caused by aviation factors, ailments common to flight personnel and frequently occurring diseases, as well as problems in the medical forecasting of physical health.

## 6. Study of Logistic Airforce Health Services

This branch stresses research of logistic health services at all airforce troop levels in peacetime and in war. It also studies flight mishaps and their indicated medical causes and preventions, search and rescue of flight personnel in distress and air evacuation of wounded and ill personnel, as well as problems of health protection from nuclear, chemical and biological weaponry.

Following from the above-mentioned fundamental tasks and primary composition of military aviation medicine, it can be seen that although military aviation medicine is still a component of the entirety of medical

science and military medicine, and although it shares a similar guiding ideology, theoretical foundation and technical method, nevertheless it has its own individual characteristics. Aside from the essential characteristic of having a different object, four job characteristics may be summarized as follows:

(1) In view of the difficulties and rigors of military aviation, and in view of the necessity of expending a large quantity of human and material resources in constructing an airforce, implementation of the principle of giving "priority to prevention" is particularly important in military aviation medicine. We must insist upon applying the theories, viewpoints and methods of predictive and preventive medicine to scientific research work and to work on medical flight safeguards in each branch of military aviation medicine. We must research and advance effective preventive measures and as far as possible guarantee the physical health of flight personnel and the safety of flying, maintain and increase the air-combat capabilities of flight personnel and lengthen their effective flying years. We must conscientiously work to achieve a transformation of the accomplishments of military aviation medicine into a truly effective fighting capability.

(2) The principle that "scientific research must move to the forefront" is particularly stressed in military aviation medical research work. This is because the process of designing and producing military aircraft is arduous, the requirements are strict, the cost is high and the turnover time is lengthy. Aviation medicine cannot wait until after the aircraft design is finalized to set about studying or examining whether the aircraft tallies with physiological, psychological and health requirements. Furthermore, the mission of airforce troops to refit and fly new types of aircraft is very urgent and very strenuous, placing even greater demands on the physical quality of flight personnel and on assurances of flying safety. We must have a set of pre-prepared, pre-selected medical safeguards. Therefore, military aviation medicine must pay close attention to developmental trends in the aviation industry and in airforce construction. It must thoroughly investigate and study these, and from the beginning it must use foresight and planning to enhance fundamental theoretical research and research with direct advance applications.

(3) To develop military aviation medicine, we must organically integrate medicine and aviation medicine with the theories, technologies and methodologies of such disciplines as psychology, biophysics, biochemistry, biomechanics, biomedical engineering, aeronautical engineering technology, flight training tactics and so forth. We must apply modern scientific and technological methodologies, such as information theory, cybernetics, systems theory, and applied mathematical and electronic computer technologies. We can only produce more accomplishments and qualified personnel if we cooperate closely, under the leadership of airforce leading bodies (departments of scientific equipment research, combat training and logistical health service), with the aviation industry

sector, with airforce troops and with airforce hospitals and convalescent homes. In order to enable accomplishments to be extended to in-flight medical safeguards, to clinical aviation medical work and into aircraft design and production, we must better accomplish military aviation medical tasks.

(4) In military aviation medical work, we must provide and make use of various special large-scale testing equipment, such as low-pressure cockpits, rapid decompression cockpits, high- and low-temperature cockpits, manned centrifuges, flight simulators, and ejection, impact and vibration equipment. Under simulated flight testing conditions and in the actual flight activities of flight personnel, we must adopt certain special technical methods and telemetric and magnetometric testing measures to observe and study closely various flight factors with regard to their effects, their active mechanism and the compensatory adaptive capability and biological endurance limits of the human body. Further, we must test and verify the biological, psychological and health performance parameters of aircraft cockpit equipment and all kinds of protective life-support equipment, as well as the functional physical condition and in-flight work capabilities of flight personnel.

In short, military aviation medicine is an important discipline that cannot be dispensed with and absolutely cannot be ignored in modern airforce construction. Its accomplishments have a rather important guaranteed role in the design and production of military aircraft and in airforce flight training and combat. "Airforce health work must highlight military aviation medicine and must place an emphasis on resolving problems posed by airforce construction and expansion." "The airforce's primary combat strength is embodied in the persons of flight personnel, and we must safeguard the combat strength of airforce troops." "Within the field of military aviation medicine there is still a great deal of work that needs to be done with respect to safeguarding the physical health of flight personnel, guaranteeing flight safety, lengthening the effective flying time of flight personnel and increasing the combat strength of flight troops. This is extremely significant work." These directives represent the foresight, sagacity and scientific policies of the Headquarters of the General Staff and of airforce leading bodies. They attach great importance to and reflect a profound concern for military aviation medicine, and have clearly expressed its role in modern airforce construction.

Prior to liberation, China's airforce was basically nonexistent. After the establishment of new China, in the wake of development and construction of the people's airforce and aviation industry and the successive establishment of specialized academic organizations, airforce hospitals and convalescent homes, scientific research jobs were launched one after another. For the past 30-plus years, under the leadership of the party, specialists in aviation medicine and the numerous airforce medical officers have cooperated closely with airforce troops and the aviation industry sector. They have done a great deal of work

in the cause of developing China's military aviation medicine and they have advanced or gained some particularly Chinese viewpoints, scientific data and technological achievements in the various academic fields. They have fundamentally ensured what is needed to develop and construct airforce troops and the aviation industry.

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## LIFE SCIENCES

### SYMPOSIUM ON MILITARY AVIATION MEDICINE SUMMARIZED

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[Summary report organized by Xu Weipu [1776 4850 3877], of the Institute for Aviation Medicine: "A Summary of Papers Presented at the Second Armed Forces Symposium on Military Aviation Medicine"]

The second armed forces symposium on military aviation medicine was held from 4-8 September 1983 in Kunming. The symposium received and selected a total of 85 papers, a summary of which appears below:

#### Aviation Physiology and In-Flight Protective Life Support

##### 1. Research and Formulation Of Physiological Standards for Oxygen Supply Equipment in Chinese Aviation

The Institute for Aviation Medicine conducted a survey of the values of pulmonary ventilation capacity and maximal breathing flow in 480 flight personnel. They arrived at a resting mean pulmonary ventilation capacity of 9.58 l/min, and a mean maximal inspiration flow of 23.56 l/min, as well as some other important interrelationships of parameters and relevant variables. This institute, using dummies under rapid decompression conditions, determined the maximal decompression point within a face mask. The result indicated that human respiration time and the ultimate altitude of rapid decompression have little influence on the maximal decompression point. Rather, the elapsed time of rapid decompression has the most obvious influence on the maximal decompression point. The Fourth Army Medical University studied the physiological and psychological effects, under a minimal physical load, of combined resistance formed by coordinating different proportions of expiratory and inspiratory resistance. The result demonstrated that, in combined resistance, the greater the proportion of inspiratory resistance, the more serious the effect. When this additional respiratory resistance increases, the five primary factors in the sensation of respiratory upset that arises include the overall level of combined resistance, a fluctuating pressure range in the oral cavity, and so forth. The institute also reported eight types of relationships between pulmonary ventilation capacity and heart rate, and between these and the volume of oxygen consumed. They

compared the accuracy of the heart rate method and the pulmonary ventilation capacity method as used to estimate the volume of oxygen consumed, as well as their ranges and conditions of application.

## 2. Research Into the Effects of Low Pressure and Oxygen Deficiency on Visual and Auditory Sense Organs

The Fourth Army Medical University reported that under conditions of a 5,000 meter altitude maintained for 30 minutes, there is an influence on unaided ametropic vision amounting to a 43.38 percent vision decline. In hearing, the mean values of osseous auditory thresholds at all frequencies rise. The high frequency range over 2,000Hz rises and relatively low frequencies are evident, but only minimal hearing decline occurs and there is no effect on voice communication with flight personnel. The Institute for Aviation Medicine examined 120 healthy flight personnel for night vision under conditions of minimal oxygen deficiency, and the results revealed that oxygen deficiency at altitudes over 2,000m has a clear effect on night vision.

## 3. Laboratory Research on Acceleration Physiology

The Fourth Army Medical University reported that rabbits and dogs had greater endurance to negative ultra-acceleration than to negative ultra-acceleration than to positive hyper-acceleration. They proposed that, under conditions of hyper-acceleration, the decrease in heart rate to 1-3 beats per second and the appearance of arrhythmia are often indicators of maximum endurance level. They studied the effects of positive acceleration on the experimental formation of arteriosclerotic plaque in rabbits. The results indicated that total serum cholesterol content, total area of arteriosclerotic plaque in the tunica intima of the arcus aorta and incidence of fatty liver all were higher in the experimental group than in the control group. At the conclusion of the experiment, there was a notable decline in endurance to positive acceleration on the part of the control group.

## 4. Research into Flying and Brain Function

The Institute for Aviation Medicine recorded and analyzed electroencephalograms taken during flight activities of eight flight students. These indicate that under the effects of aerobatic acceleration, EEG mean frequencies shift to a more rapid frequency and the percentages of  $\alpha 2$ ,  $\beta 1$  and  $\beta 2$  power spectrums increased. They also reported the characteristic and constant visual evoked potential values for 195 flight students. The result was that the graphs of all the subjects were relatively stable, but the differences between individuals were quite large.

## 5. Research Into In-Flight Protective Life-Support Equipment

In order to resolve the problem of abdominal tenderness that occurs with use of the style of pressure suits that have lateral tubing [g-suit], the Institute for Aviation Medicine developed an air pocket style

abdominal bladder and also obtained performance trial results on it. The Naval Medical Institute carried out tests on Chinese-made insulated, submersible flight suits with regard to thermal preservation, waterproofing, decompression ejection, gusting air currents and aircraft test flights. They testified to the basic achievement of original design requirements and proposed further ideas for improvement. The Institute for Aviation Medicine reported that using the composite pouch-pack "model 81 flight emergency grain rations" has advantages over the original grain ration in that it is composed of a reasonable mixture, is lightweight, is small in volume, has a long shelf-life and lends itself to packing in pack frames.

#### Flight Personnel Syncope and Acceleration Endurance

##### 1. Application of Research on Negative Lower-Body Blood Pressure to In-Flight Pilot Syncope

The Naval Medical Institute, using a negative lower-body blood pressure intensity of -50mmHg, studied the physiological effects of negative lower-body blood pressure. The result proved that after 204 hours of exposure, the change in cardiovascular functioning in the syncopal group was distinctly different from that in the healthy group. The Institute also reported that 43 physical education students, under the effects of negative lower-body blood pressure, all experienced a distinct change in cardiac contraction time--a change that was most distinct when the negative pressure was -50mmHg. Airforce General Hospital reported that the institute's syncope-related aircraft groundings in the last 3 years comprised approximately two fifths of all groundings made by the department of neurology. It was pointed out that there were quite distinct differences between the renin regulatory system changes and EEG changes that occurred in the syncopal group, as opposed to the healthy group, under the effects of negative lower-body blood pressure. Negative lower-body blood pressure is deemed a possible method of examining and identifying syncope.

##### 2. Aspects of Examination Methods in the Study of Acceleration Endurance

The Institute for Aviation Medicine tested and measured the acceleration curves and the pilot electrocardial and auditory pulses that occurred on 3 interceptor fighter planes in 16 kinds of flight operations. They also compared the acceleration endurance differences among 22 pilots during centrifuge examination, passive flight and active-operation flight periods. They proposed a duration and a rate of increase in G-values for centrifuge examinations, and they formulated examination assessment standards for acceleration endurance on general training flights and combat training flights. They also analyzed more than 600 medical records and adopted a method that combines case histories and clinical examinations to forecast pilot acceleration endurance. On 20 pilots who suffer from in-flight syncope, they examined and compared centrifuge performance, negative lower-body blood pressure, vertical endurance and rotary-bed performance. The results demonstrated on 83.3

percent overall rate of coincidence between endurance predicted through this method of examination and centrifuge testing and measurement of endurance. This was higher in all cases than that of several other examination methods.

### 3. Clinical Analysis and Determination of Corrective Treatment for Syncope

Naval General Hospital analyzed 134 cases of syncope in flight personnel, most of which were cases of ground syncope: in-flight syncope represented only 18 percent. It is worthy of note that the two groups had equal incidences of epileptic-induced syncope, and the author suggested principles for determining levels of flight acceptability for all kinds of syncope. Beijing Airforce Hospital analyzed 100 cases of unsatisfactory pilot acceleration endurance, and, in light of the proliferation of groundings and cases of unsatisfactory acceleration endurance in the last few years, they proposed ideas for determining treatment. Beidaihe Airforce Convalescent Hospital used physical therapy plus traditional Chinese medical methods on 32 cases of pilot in-flight syncope. They carried out corrective treatment and physical exercise, with a 71.8 percent rate of cure and improvement.

### Examination and Clinical Observation of Cardiovascular Systems in Flight Personnel

#### 1. Examination and Appraisal of Cardiovascular Functioning

The Institute for Aviation Medicine researched and advanced the use during flight recruit physical examinations of a trial examination method that uses jumping-jack exercises, relies on a simplified scoring formula and is evaluated based on five grades of functioning: excellent, good, average, acceptable and poor. The institute conducted examinations of 525 flight student recruits, 95.24 percent of whom were up to standard. Airforce General Hospital conducted a 12-hour (including flight time) dynamic electrocardiogram observation on 101 interceptor fighter pilots. The rate of abnormal EKG's uncovered was 24.5 percent, with arrhythmia accounting for 19.6 percent and lack of the ST-T blood-group transformation accounting for 4.2 percent. When an extraordinary increase in heart rate or an inhibitory reaction may appear during the flight process, those with seriously abnormal EKG's should be sent to the hospital for examination to rule out the possibility of latent heart disease. The hospital also observed pre- and post-flight thrombocyte functioning in 38 cases. The post-flight aggregation pattern was distinctly higher in the arrhythmic group than in the normal control group, although there was no distinct pre-flight difference between the two groups. The hospital believes that this can be used as a diagnostic reference for flight-load induced latent coronary heart disease. The Fourth Army Medical University, using surface isopotential charting methods, made inferences of the locations of pre-excitation accessory fasciculi. They also pointed out that, by using the exercise-load method as a recovery measure and bringing the heart rate up to approximately 170 beats/min, the anticipated results can be achieved.

## 2. Prevention and Treatment of Cardiovascular Disease

Donghu Airforce Convalescent Hospital made a survey of the results of physical training in 567 cases of abnormal EKG's, and they proposed exercises, criteria for dividing exercises into groups and programs to organize courses of treatment. Certain results were achieved after physical training, when observation confirmed that self-perception, cardiovascular functioning scores, EKG examinations and athletic achievements had all taken a turn for the better or increased. The Institute for Aviation Medicine proposed that, in light of the state of foreign predictive medicine's application of and progress in the prediction and prevention of coronary heart disease, we also should conduct long-term, forward-looking investigations and accumulate data on our armed forces flight personnel to get an early jump on correcting dangerous factors. At the time of the physical examination, we should also bear in mind the dangers of falling ill and suggest comprehensive preventive measures such as therapeutic exercise, diet and change of living habits.

### Vestibular Functioning, Otological and Ophthalmological Examination and Clinical Treatment of Flight Personnel

#### 1. Electronystagmogram Applications to the Study of Vestibular Functioning

The Institute for Aviation Medicine examined the post-rotary electro-nystagmograms (ENG's) of 131 healthy flight personnel and of 88 patients having various relevant illnesses. They deemed a 60 degrees/sec and a 90 degrees/sec angular decleration to a stop as physiologically the most suitable quantities of stimulation for the two groups, respectively. They arrived at five special ENG characteristics, as well as normal values for various ENG parameters of healthy flight personnel, and they sifted out five parameters as norms for assessing vestibular functioning levels and for distinguishing and demarcation line between normal and abnormal. The institute initially observed those characteristics of air sickness, vertigo, severe vestibular illusions and vestibular diseases that were expressed on ENG's, with a diagnostic coincidence rate of 66.7-9 percent. Experimental evidence and experimental data had the same specific properties as a second-order mathematical model of vestibular oculomotor reflex. This provided a preliminary basis for the application of computer-generated models and parameters to analyze vestibular functioning. In this research, an institute-constructed "model 81 simple motorized rotary chair" was used, and its use had the concomitant advantages of precise parameters, stable performance, complete record control system and facilities, portability in usage and low construction cost. The Fourth Army Medical University and the Institute for Aviation Medicine also tested and researched the optokinetic ENG's of 200 and 150 flight personnel, respectively. They had a basic understanding of the graph characteristics and patterns of change, and they each arrived at normal values, but because their instruments and methods differed, their data were different. The Fourth Army Medical University also tested the positional ENG's of 312 flight personnel. They investigated six different

head positions and arrived at normal values for four analytical indices, as well as five characteristics of physiologically positioned ENG's performed on healthy, closed-eyed flight personnel. The Institute for Aviation Medicine also examined the visual-tracking eye movements of 267 flight personnel and arrived at four kinds of wave patterns. This institute advocates using a method with a stimulation frequency of 0.4-0.7Hz, and they also hold that the appearance of type-A waves at a stimulation frequency below 0.5Hz may be a manifestation of potentially unsatisfactory vestibular functioning.

## 2. Examination and Appraisal of Vertigo and Illusions

Airforce General Hospital analyzed 90 cases of vertigo in flight personnel: 46 cases were otologically induced and 29 of those were appraised as within acceptable limits; 23 cases revealed no particular physical signs in various examinations and 10 of those were appraised as within acceptable limits; and 21 cases were internally, externally or neurologically induced. They also proposed principles for appraising levels of flight acceptability for all kinds of vertigo. Naval General Hospital conducted 5 examinations of vestibular system functioning in 30 cases of in-flight illusions by flight personnel. The result indicated a bilateral vestibular asymmetry characterized by excitability in excess of physiological limits. This is possibly the latent factor that produces severe in-flight illusions. The Nautical Medical Research Institute also conducted experimental research on preventing vertigo from effecting the efficiency of human physical labor. The results of the examinations of five targets indicated that a single tablet dose of medication had no undesirable effect on the body, but it distinctly increased the volume of visual information transmission. It is deemed usable in aviation medicine (except by pilots).

## 3. Otolaryngological Examination and Clinical Treatment

Airforce General Hospital research proposed that, in conducting recruit physical examinations, an otoscope should be employed to observe the tympanic membrane, an audiometer should be used to examine hearing and, in pre-checking and reexamining vestibular functioning, nystagmal duration should be observed. They found that the otopharyngeal orifice merits serious attention; minute examination of the ventilation functions of the nasal cavity, the accessory nasal sinuses and the eustachian tube are indicated. They also analyzed 52 cases of ailments of the external and medial auditory canals in flight personnel, and reported their own treatment experiences. In addition, they employed the three laryngeal airflow dynamics methods--vital capacity, duration of vocalization and expiratory duration--to examine 50 normal people, and arrived at normal values for these. This method is deemed simple and easy, and it contributes to an assessment of the state of laryngeal ailments and the effects of treatment.

#### 4. Ophthalmological Examination

Airforce General Hospital, using a non-contact ophthalmotonometer, arrived at a normal ocular pressure value and a 24 hour normal ocular pressure curve for 132 pilots. There is no indication that ocular pressure in the normal eye is distinctly influenced by flying: the contraction rate for early simple glaucoma in flight personnel is 0.75 percent, and ocular pressure quickly falls to normal after successive flights. Ocular pressure examinations should be added to the regular physical checkups for flight-student recruits and pilots, with a normal range of 7-18mmHg set as optimal. The results of a Changchun Airforce Hospital assessment of visual reaction times in 1,300 flight personnel (students) revealed that, of those under 39 years of age, 97 percent reacted within 3 seconds, and of those over 40 years old, 41 percent took more than 4 seconds to react. It is recommended that when selecting flight personnel we should add this examination, with a standard reaction time of three seconds or less set as optimal.

#### Flight Health Safeguards

##### 1. Regarding Flight Work Loads and Health Safeguards in Interceptor Fighter Tactical Flight Training

The Institute for Aviation Medicine tested and determined the acceleration values throughout the flight courses on 192 sorties, including aerial combat, aerobatics, minimum-altitude flying, night flying, instrument flying and so forth, and they also tested and determined the electrocardial, respiratory and auditory pulse curves of the flight personnel. Using a computer, they did the relevant data processing and synthesized subjective sensory surveys, biochemical lab tests and ground tests, and proposed both suggestions for assessing the intensity of flight work loads and comprehensive evaluation methods based on heart rates. In addition, they tried out relevant health safeguards to raise acceleration endurance and so forth, with quite satisfactory results. Certain Fujian airforce divisions and regiments and the naval air force have independently conducted concrete analyses of flight work-load characteristics and proposed relevant flight health safeguards.

##### 2. Changes in Flight Safeguards on New-Model Interceptor Fighters

A Beijing airforce flight school and a Lanzhou airforce unit have investigated and researched both equipment performance on new-model interceptor fighters and flight load characteristics, and have proposed measures to improve work hygiene conditions in aircraft cockpits, measures to change physical requirements for pilots and measures to be adopted as in-flight health safeguards. The Institute for Aviation Medicine conducted cockpit tests and a forum investigation of cockpit illumination and instrument panel display and control systems on new aircraft models. From physiological, psychological and health angles, they advanced evaluative suggestions and concrete ideas for necessary further improvements. In addition, they authenticated the toxicity of the recently

developed "cockpit canopy adhesive," and proposed a tentative maximum permissible consistency and preventive measures that should be adopted when applying the adhesive.

### 3. Health Safeguards in Bombers and in High Altitude Flying

A Guangzhou airforce division reported on fatigue, vibrations, noise, high cockpit temperatures, ailments associated with flying on an empty stomach or with back and leg discomfort and other such bomber flight characteristics, and they advanced ideas for corresponding flight health safeguards and improved flight working conditions. The Fourth Army Medical University conducted a nutrition and health survey of certain bomber units and indicated reasonable ways to improve cooking and reduce losses of water-soluble vitamins. They also proposed a suitable increase in protein consumption and decrease in fat consumption to 12 percent and 15 percent of total caloric volume, respectively. Lanzhou airforce unit reported on the circumstances of altitude acclimatization among flight personnel, and advanced concrete ideas on the preparatory work prior to garrisoning troops, on changing field methods and on setting flight acceptability standards for acute high-altitude reaction and for high blood pressure.

### 4. Aviation Medical Work and Health Safeguards

A Shenyang airforce aviation medical unit reported on a preliminary inquiry into the use of system theory to analyze aviation medical work. A Fujian airforce aviation medical unit reported on the application of aviation psychology to institute an intimate understanding of the physical check-ups of flight personnel. The Naval Aviation Health Office inquired into problems of safeguarding the health of naval airforce troops in a future war to counter aggression. The above four reports all summarized practical work experience and knowledge and suggested concrete measures to do the jobs satisfactorily.

#### Other Areas

Aside from these, the symposium also exchanged research reports on the relationships of aviation psychology to flight mishaps, flight-student recruit physicals, common ailments among flight personnel, frequently encountered diseases and other areas. The Institute for Aviation Medicine has also developed 13 word coding approaches to form a telemetric magnetic recording system for aviation medicine, and test flights have proven the results to be excellent. By and large, the papers at this conference all intimately linked together airforce troop modernization and construction needs. The majority of achievements were strongly scientific and practical, and some valuable viewpoints, ideas, scientific data and technological accomplishments were gained. Aviation medical research in our armed forces has already moved on from simulation testing research under surface conditions, into the stage of practical observation research during flight activities. We also have already made impressive progress and taken a gratifying step toward the initiation of a new phase in aviation medical research in our armed forces.

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