FTD-ID(RS)T-0171-91

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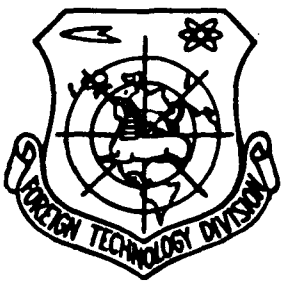
FOREIGN TECHNOLOGY DIVISION

INTERNATIONAL AVIATION

(Selected Articles)



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HUMAN TRANSLATION

FTD-ID(RS)T-0171-91 5 June 1991

MICROFICHE NR: FTD-91-C-000420

INTERNATIONAL AVIATION (Selected Articles)

English pages: 35

Source: Guoji Hangkong, Nr. 5, 1990,
pp. 8-9; 10-11; 12-13; 14-15

Country of origin: China
Translated by: SCITRAN
F33657-84-D-0165
Requester: FTD/TTTMM/Moorman

PREPARED BY:

TRANSLATION DIVISION
FOREIGN TECHNOLOGY DIVISION
WPAFB, OHIO

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TITLE: PRODUCTION BASE FOR TEST MANUFACTURE OF NEW LARGE MODEL UP AND COMING PASSENGER PLANE

AUTHOR: Jing Deyuan, Tao Renguan

In 1984, the Shanghai Aviation Industrial Company (SAIC) was set up by permit of the Shanghai City Peoples Government. It is composed of the Shanghai Aircraft Manufacturing Plant, the Shanghai Aircraft Design Research Institute, the Shanghai Aviation Engine Manufacturing Plant, as well as the Far East Aviation Technology Import Export Company, and other similar commercial and industrial units. It has close to ten thousand workers. It occupies an area of 1 million 470 thousand square meters, and its buildings cover 3 million square meters.

The Shanghai aviation industry has a long history. Its foundation is the China Aviation Company and the Central Aviation Company from before liberation. From the 1950s onward, it mostly did repairs on fuselages.

In the early 1970s, Shanghai City organized the strength of the aviation industry and began to test manufacture the 110 ton Y-10 large passenger plane. Through a 10 year history, the industry went through model research, design, and manufacture, to test flights, and sending the aircraft up, establishing the conditions for the creation of a company.

In 1985, the Shanghai Aviation Industrial Company and the U.S. McDonell-Douglas Company signed a "General Agreement for the Production of the MD-82 Aircraft and Compensatory Trade", beginning cooperation in the production of the MD-82 large passenger aircraft. From 1987 onward, the year by year receipt of aircraft was at a pace of 2,4,7,7, and 5 planes, to a conclusion in 1991. The Mc Donell Company expanded into Shanghai with an amount of general aircraft assembly work which comprises approximately 10% of the total amount of work on the aircraft. It involves taking the nose section

and tail section of the aircraft, and large components such as the wings and shipping them to Shanghai for general assembly. Following that, they carry out installation of systems involving the whole aircraft, functional tests, and the running of flight tests. Because the middle fuselage reaches 33 meters in length, shipping it is not convenient. As a result of this, it is supplied in the form of parts. As a result of this, the Shanghai Aviation Industrial Company, besides the amount of work involved in completing the overall assembly of the whole aircraft, also must rivet together the central part of the fuselage and make by itself the 10 types of sets of parts that are sold back to the State, including the aircraft's horizontal stabilizers. This is mandated by the overall agreement. This comprises 15% of the price of the deal associated with compensatory trade (another 15% of the Peoples goods compensatory trade items is dispersed inside the country). Looking at it from the point of view of completing work on unit aircraft, there is hardly any difference from the McDonell Company.

[International cooperation and market competition are twin phenomena in this era's civil aviation industry and air transport enterprises. The Shanghai Aviation Industrial Company and McDonell Company's 10 year cooperation has brought forth eminent accomplishments. Because of this, we composed and published the article, "The MD-82 in China". The objective was to announce the accomplishments which reforms had set in motion, to bring together the experience and lessons from the cooperation in order to make use of them in advancing the course of the modernization of our aircraft industry, promoting the development of international technological trade cooperation. In this article, we have brought out various types of questions, and these only represent the point of view of the author himself. --Editor--]

ADVANCED EQUIPMENT AND TECHNOLOGY

The Shanghai Aviation Industrial Company possesses over 3500 pieces of equipment. These include over 160 large model precision 5 coordinate digital control machine tools and over one thousand items

of various types of electronics, instruments, computers, and measuring and testing equipment.

In the process of cooperatively producing the MD-82, the Company carried out large scale technological reforms. It acquired a 45000 ton rubber sack or capsule molding machine press, a 4 by 9 meter digitally controled skin tensile or stretching device, a three axis, 5 coordinate digital control planar type milling machine with a bed face 18 meters by 4 meters, and other similar sorts of advanced equipment. They got possession of close to one thousand pieces of 1980s level equipment for aircraft measurements and testing, calibration, checks for the absence of wear, and other similar aspects. They constructed 20 new computer information management systems in order to carry out total control of all aspects of the equipment involved in the whole engineering process, data, materials, personnel, and production. The 12 hot and cold production lines that have already gone into production, have, in a relatively startling way, reflected advanced technological means for the modernized overall assembly and production of large model passenger planes. Among these, a modernized spray painting shop is capable, with the exclusion of passenger planes corresponding to the B 747, of carrying out full body spray painting of all medium and small models of civil aviation aircraft. It possesses filtered air, controlled temperature conditions and 10 large systems of similar kinds. It is the current state of the art in our country's spray painting facilities.

In such high technology fields as aircraft manufacture, assembly, and testing, the Company has grasped and become familar with the precise fitting and connection of aircraft fuselage and wings as well advanced industrial techniques of assembly and design, industrial techniques of manufacture, and has firmly grasped large volume (30 m^3) air tight and water tight rivetting connections. It has done ground installation and testing of onboard equipment, has composed processing programs for large model or complicated parts, done tensile forming of mirror skins, welded connections in the interior of fuel conducting devices and tubing, and similar types of cutting edge industrial techniques and operating technologies. It has also firmly grasped a number of new leading edge domestic production techniques, new technologies, new materials, and the corresponding technological standards.

COMPENSATORY TRADE AND THE CREATION OF CREDIT

At the present time, the production efficiency for a single MD-82 aircraft, when compared to the first aircraft in 1987, has been raised more than 100%. The time period has been shortened by 35%. The amount of production has been increased by three and a half fold. The actual work time on each plane, when compared with the U.S. McDonell Company, is basically 2:1. This is explained by the cooperation of the companies in the realms of high science and technology, which has already reached a quite considerable level.

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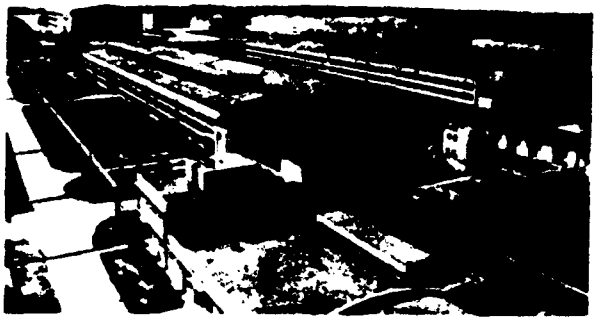

Fig.1 An Overview of the Large Shanghai Aviation Company Plant (Photo by Fu Tongyi [unclear])

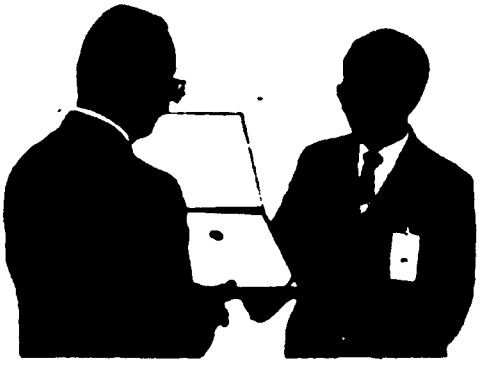

Fig.2 FAA Representative Awards Production Permit to Manager Jing Deyuan

The Company, in cooperative production, got the vigorous support of Chinese civil aviation and the nation. Going through the work of assembly, compensatory trade and the creation of credit, and calculating in the fact that the selling price of the aircraft was somewhat below the international price, as well as other similar

their users, achieving clear social benefits.

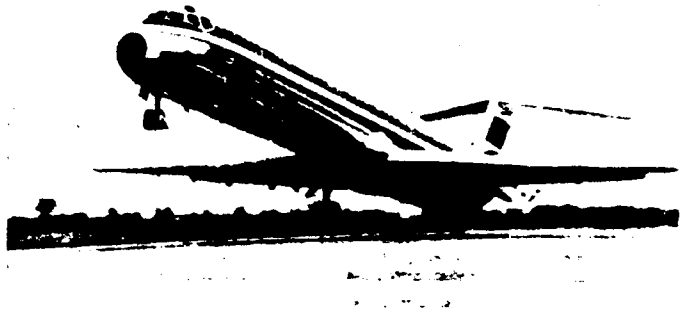

Fig.3 The First MD-82 Model Aircraft Successfully Co-Produced by China and the U.S. (Photo by Fu Tongyi)

The Company was engaged in compensatory trade associated with aircraft parts beginning in 1980. At that time, for the main landing gear bay doors of the DC-9-80 produced by the McDonnell Company, due to the fact that their quality was unusually good, the Company was awarded the McDonnell Company's Bronze Prize and an exemption from inspections as a special honor. In the process of the cooperative production of the MD-82, compensatory trade rapidly expanded, and, up to the present, has already expanded to include 10 parts such as the main and forward landing gear bay doors, the aft service bay doors, electronics bay entry covers, interior flap conveyor frames, forward, midships, and aft cargo bay doors, horizontal stabilizer surfaces, rear service bay door frames, and other similar parts. Overall, the amount of money involved in the deal is 25,740,000 U.S. dollars. The Company plans to complete a total of more than 1313 produced sets, establishing 12,400,000 U.S. dollars of credit. In recent years, the increases in magnitude have been relatively large. Only in 1989, were just 435 sets produced, establishing 4,300,000 U.S. dollars of credit.

HIGH STARTING POINT "STRETCH" MANAGEMENT AND FAA QUALITY CONTROL

U.S. federal aviation rules and regulations, all changes to geographical environment, and establishing conditions for aircraft production, must go through Federal Aviation Agency (FAA) renewed review. Because of this, in the cooperative production of the MD-82, in Volume 5 of the "Quality Guarantee Handbook" prepared for the Chinese side by experts from the McDonnell Company, they clearly brought out the concept of "stretching or extending licenses to manufacture". What is called "stretching" or "extending" is that the Changtan Douglas Aircraft Plant, which belongs to the McDonnell Company and has already been set up in Shanghai, has production procedures and systems which have gone through checks and decision processes. In conjunction with this, it is necessary to go to the FAA to go through a supplementary review. In actuality, this amounts to taking the Shanghai Aviation Industrial Company and seeing it as one part of the production area of the McDonnell Company outside the country. As a result of this, all the reviews and awarding of certificates are directed at the McDonnell Company. This is much faster than the process would be for taking "production licenses" and "airworthiness certificates" and directly giving them to a newly built plant outside the U.S. This type of method of airworthiness management, internationally, is still in its first try. It is fundamentally different in nature from giving "fitness certificates" to aircraft parts produced by other countries inside the U.S.

This type of high starting point "stretch" or "extension" management and stringent quality control cause the Shanghai Aviation Industrial Company, from engineering on up, to begin to want to shed off the traditional management modes of the past and implement a modernized management.

From the cooperative production onward, the seven stringent inspections which the FAA has done of the Company have clearly shown that the Company takes the three great systems of engineering (that is, design), production, and quality assurance as the core of normal management system operations. Among these, the quality assurance system has already been recognized as meeting the FAA regulation, FAR Section 21, Part G, concerning the requirements for approved quality assurance systems in aircraft production at assembly and manufacturing

plants, and it has already reached an advanced world level. After the Company obtained, one after the other, two production permits and certificates for the assembly of aircraft and the manufacture of spare parts, the whole Company's management system, at the present time, has reached stability, high efficiency, a reliable status, a rate of aircraft meeting inspection standards of 100%, and an aircraft pass rate of 100%.

A SPECIALIZED CONTINGENT TO DEAL WITH TRANSNATIONAL COOPERATION

The Shanghai Aviation Industry Company includes over 3000 managerial, engineering, and technical personnel of various kinds. They constitute 31% of the total number of employees. Among these, there are close to 400 people with high level job positions and more than 1200 people with medium level job positions. The strength of this group is in its abundant experience in refitting or doing major overhauls on various types of aircraft. They designed and manufactured our country's first large passenger plane, the Y-10. They also participated in cooperation with foreign countries on the test manufacture of feeder line aircraft and turbofan aircraft. They went through the assault on the Y-7 and the model changes on the Y-8.

In the process of cooperatively producing the MD-82 aircraft, the Company transfered over 3000 workers as well as engineering, management, and technical personnel to engage in the cooperation. In order to deal with the requirements of transnational cooperation, the Company dispatched over 330 people on trips to the U.S. for training. Over 4753 personnel were also sent for training within China. This contingent prepared the conditions for the test manufacture of large passenger aircraft inside our country.

In more than 4 years of cooperative production, we translated and reproduced 25 tons of diagrams and paper materials, digested, absorbed, and thoroughly implemented large amounts of programs and technical management standards. Besides clearly raising the innate quality of industry, there were also very great strides made in the translation of foreign languages and conversational capabilities. Now, in the Company, Deputy Foremen and first level personnel on the production lines have all already firmly grasped the reading of English and basic conversational ability. They have already come to

acquire the initial experience and capabilities to carry out international cooperation in high level science and technology.

OUTLOOK

The Shanghai Aviation Industrial Company will adequately make use of the superior environment and advantageous conditions of being in Shanghai in the introduction and production aspects of aviation products and other products, paying great attention to absorbing advanced international technology and management experience. It will pay great attention to strengthening industrial links to the various nations of the world and economic and technological cooperation. At the same time, the Company is in the midst of exerting a step further technology that has already been picked up as well as dominant trends in areas of management and dominant trends in labor forces of relatively high innate quality. It will devote its strength to the launching of various types of new products and the improvement of product quality, the aggressive searching out of broad exports, and the pioneering of international markets. In 1991, after the completion of the production of the MD-82, the Company will continue to take the road toward broad international cooperation.

THE MANUFACTURING CAPABILITIES OF THE SHANGHAI AVIATION COMPANY LEAP TO A NEW LEVEL

Yang Xinbang Zhang Shiyuan Zheng Huilin

The Shanghai Aviation Industrial Company, in the process of the cooperative China-U.S. production of the MD-82, paid serious attention to carrying out serialization of technological transformations, the building of technological contingents suited to the task, the setting up of scientific manufacturing management modes or types, and management that makes use of the help of computers in all areas of development.

THE SERIALIZATION OF TECHNOLOGICAL TRANSFORMATIONS

For the sake of making the cooperative production of the MD-82 develop smoothly, the Shanghai Aviation Industrial Company, from the beginning of the 1980s--according to the industrial technology standards of the McDonnell Company--carried out a transformation in all areas of the calorimeter handling machine shop. After the middle 1980s, it also, one after the other, introduced an 8 meter air cycling quench hardening furnace, the 45000 ton rubber sack (unclear) fluid pressure bed QC4570, the 4 meter x 9 meter computer controlled aircraft skin stretching device VTL400, and the 18 meter x 4 meter three axis 5 coordinate planar type milling machine CIN 5 A3P. Besides that, there was also the three coordinate reclining type processing center 10 HC2500, the three coordinate standing processing center 15 VC-1500, the 5 coordinate standing type milling machine 20 V-80, the three coordinate processing center 20 V-2000, and two sets of Apollo programming work stations, AUTO-TROL CAD/CAM systems, and

so on. This led to the Shanghai Aviation Industrial Company being possessed of an 8 meter serialization capability, capable of manufacturing complicated spare parts.

On the assembly lines, it introduced and produced on its own a full set of rivet connections at an advanced world level, as well as assembly mounting equipment. It newly built an advanced domestic spray painting bay for whole aircraft. At the same time, it introduced and manufactured itself close to 400 pieces of aircraft production and test equipment possessing capabilities able to carry out functional tests on navigation, instrumentation, communications, electronics, controls, de-icing, fuel, atmospheric regulation, fluid pressures, and propulsion in modern large passenger planes. Among

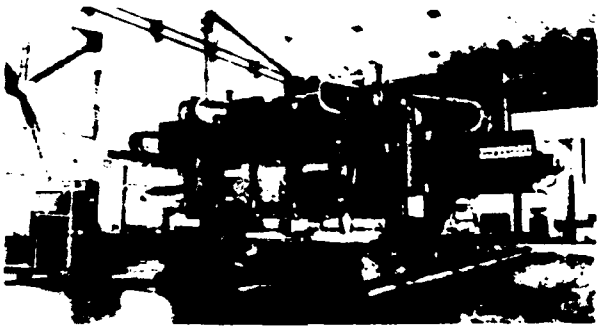

Fig.1 Three Axis Five Coordinate Digitally Controlled Planar Type Milling Machine (Photo by Fu Tongyi)

these, several pieces of equipment, such as high temperature, large flow volume atmospherically adjusted test equipment simulating the operational status of engines and fuselage dynamic airtight seal test equipment are all advanced for China. The Company also introduced over 150 sets of calibration equipment at the international level of the mid 1980s, and composed over 80 test regulations for production test equipment. Among these, the frequencies on the frequency meter are capable of reaching 18,000 MHz. Its accuracy is 10^{-11}. The synchronizer verification test accuracy has already reached 2 seconds. The 90 thousand volt-amp A.C. load box K580 is capable of carrying out calibration tests on a 400 Hertz, 3 phase, 115 Volt electrical current device. These are also relatively good domestic equipment at the present time. Besides this, the Company also possesses modernized field terminal facilities and runways.

Going through the cooperative production of the MD-82, the Company, in the area of industrial arts technology, has also experienced relatively large improvements, such as, interference rivetting of whole body fuel tanks, airtight seal rivetting of fuselages, the butt fitting of aircraft wings and fuselages without any excess, the pressure stamping of large forged parts to increase life, the cold extrusion of apertures, and other similar techniques. In the area of calorimeter handling, such as cold oxydation, chromic acid anodization, aluminum alloy chemistry milling, the brush painting of structural steel, aluminum alloy heat treatment, aluminum alloy argon arc automatic welding, searching for defects without damage, precipitation hardened stainless steel heat treatment, automatic welding of stainless steel oil tubing, and so on, and so on, an internationally advanced level has already been reached in all these areas. At the present time, there are already 419 McDonnell Company industrial arts standards which have achieved acceptance and been thoroughly carried out in the production of the Shanghai Aviation Industrial Company. There are more than 1600 people who have obtained McDonnell Company certificates for special types of industrial work.

SETTING UP SCIENTIFIC MANUFACTURING MANAGEMENT MODES OR TYPES

The Shanghai Aviation Industrial Company not only poured its attention into the manufacturing of hardware. It also aggressively developed software construction. During the realization of the cooperative China-U.S. production of the MD-82, right through the whole project, it gave out a set of scientific management modes or holotypes which were not only in consonance with U.S. management principles, but also brought them in together with the practical situation in our country. The special points of these modes or types were:

I. Change the traditional situation of technical preparations, production preparations, and production management (including control) each running its own show in manufacturing without cooperation and with low efficiency. In organization, take the manufacturing engineering department, the manufacturing equipment department,

production control, manufacturing support, manufacturing equipment control and put them under the unified control of the manufacturing department, synthesize technology and production into one thing, clearly distinguish the division of labor between job functions, as well as having unified leadership. At the same time, one also goes through a full set of management programs and takes the missions of the various functional departments and mutually relates them in organic connections. As a result of this, there is an overall optimization, that is, a mutual synthesis of localized optimizations and holistic optimization, a mutual synthesis between the optimization of industrial arts technology and the optimization of production planning, raising the economic efficacy of the factory.

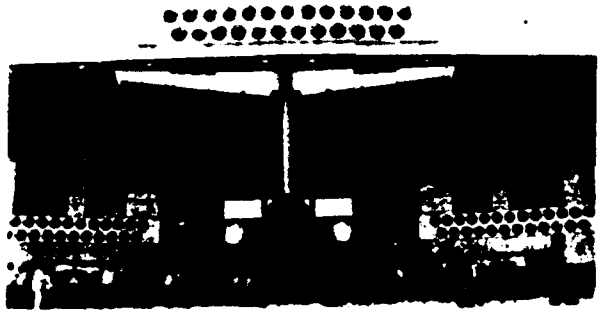

Fig.2 The Largest Aircraft Spray Painting Shop in the Far East (Photo by Fu Tongyi)

Fig.3 Rivetting Workshop (Photo by Fu Tongyi)

II. Establish two sets of tight and vigorous planning systems, making it possible, on the basis of common requirements, and on short term operational use familiarization and training curves, to work out a delivery plan for the passenger planes. Following that, according to the requirements for the pace of production, each functional job organization should draw up a departmental plan for taking the work as a whole in hand, for example, plans for the transformation of workshop facilities, technical preparation plans, education and training plans, labor preparation plans, plans for the management of funds, plans for assembly and manufacture, plans for managing income and expenditures from the issuing and operation of spare parts, going through horizontal and lateral coordination yet again, overall balancing up, and the formation of the total plan. On the basis of the overall plan one carries out the creation of the "waterfall (spin off or subsequent) plans": the aircraft assembly plans, work position plans, manufacturing plans for the batch production of spare parts, and, finally, before the beginning of the work, a full release of all the work directives or orders that are to be used in the workshops. As far as delays and mistakes in the progress of the work caused by incidents are concerned, it is also necessary to make the corresponding plans for handling the work. The planning system is put into practical effect echelon by echelon and is firmed up cycle by cycle. The practical realization of this has been demonstrated to be capable of guaranteeing macro control and coordination which is able to adapt itself to changes in the marketplace, and, along with that, timely reorganization.

III. Within manufacturing engineering departments, set up industrial engineering offices and work order control (WOC) offices, destroying the traditional arrangement with the industrial arts technology departments only managing technology. These principally deal with methods for making improvements and time-work studies. As far as practical industrial tasks are concerned, they do the composing of industrial technology flow charts or processes (OSP) and the drafting of work control optimization programs (OSC). The composition time periods are standard, and the establishment of standardized work times is managed. On the basis of a precise determination of the corresponding manufacturing work days (MRD) and the formation and

composition of "waterfall (spin off or subsequent) plans", they carry out the rationalization and balancing of labor and facilities. The key lines or paths are precisely determined, and, along with this, they search out the optimum ways of shortening the overall period. Besides this, they also go through the WOC offices, and, on industrial technology documents, clearly specify the opening and closing days for the periods of production work, definitely guaranteeing that it is possible to have an organic link up between industrial technology preparations and product production.

IV. Have a complete production process control system. In the process of producing the MD-82, through the circulation of such directive documents as those of the assembly net (AO), manufacturing net (FO), and work assembly directives (TO), as well as other similar documents, the whole process of production was pushed forward and controlled. Taking the large manufacturing net as an example, it is involved with industrial technology regulations, work dispatch lists, work transfer lists, contact or transfer lists, work times, quotas, control, checks and tests, updating records, and various other separate aspects that go together to make one comprehensive set of industrial technology documentation. This is done in order to provide the key foundation of control of production, tracking, inspection and management. At the same time, it also constitutes complete quality files and realizes, for product quality, the capability of back-tracking control.

In the last several years, this new manufacturing management mode or type, has constantly improved in its practical realization in production, and has already been embraced by the personnel of various levels and series. It has guaranteed for the MD-82 the effects of on-quality, on-time delivery. This is particularly true for the 7 aircraft last year which had their on-time delivery guaranteed and of the effects of aggressively accumulating credit by compensatory trade, demonstrating clearly that management itself is nothing else than a productive force which is a type of "internal correspondence."

THE DEVELOPMENT OF COMPUTER ASSISTED MANAGEMENT

One MD-82 aircraft, in its assembly, involves up to 350,000 A4 standard charts, in order to respond to different customer requirements. These charts always possess various types of technical states. For example, the after service diagram for the aircraft then has 18 types of technical states or stages. Even if it is only one diagram, following along with familiarization and progress in design, it is also set into the midst of normal changes. In order to produce one aircraft, it also involves ten thousand of the above industrial fittings or technical operations, assembly, manufacturing, and purchasing orders (large networks). Moreover, these orders (large networks) also follow along with changes in engineering and progress in the industrial arts, and are, therefore, ceaselessly changing. Besides this, there are also myriad numerical quantities of stored information and production tracking information, as well as quality information, and other similar types of data. Following along with an increase in production speed, in order to carry out effective dynamic control on a huge amount of information such as this, the Company set up over 20 microprocessor management systems aimed at all the factors of production management--people (the effectiveness of licences and seals), equipment (the effectiveness of periodic equipment checks),

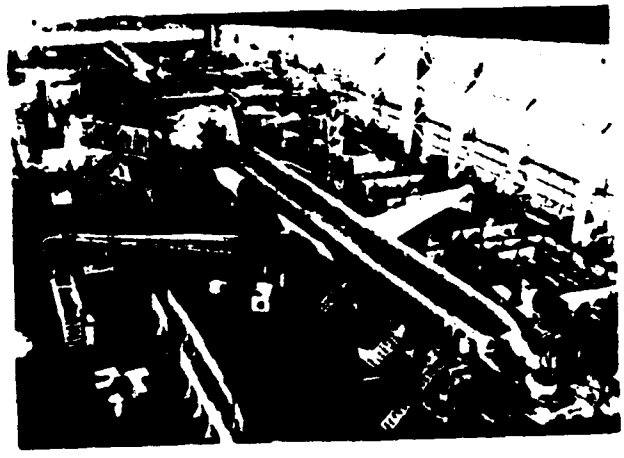

Fig.4 MD-82 General Assembly Line (Photo by Fu Tongyi)

data (effective ordering of editions of engineering diagrams and papers as well as industrial technology documentation), materials

(standard stockage items, serialized stockage items, raw materials storage, supplementary materials storage, tool storage), production feedback information (the tracking of technical operations orders, manufacturing orders (FO), and assembly orders (AO), weekly/monthly report tables), and other similar items, realizing computer management. It covered all aspects of the various key realms of quality control systems, engineering systems, and manufacturing systems, definitely guaranteeing that production as a whole was placed in a well controlled status.

In order to support the scientific manufacturing management modes or types that have already been set up, the Company resolutely took the lead in introducing the U.S. Management Science Company (MSA)'s advanced manufacturing and purchasing system (AMAPS/M), that is, the management resources plan (MRP-II), and, along with that, in 1988, they loaded it onto the Company's medium model IBM 4381 computer. At the present time, it has already begun to be used operationally in the manufacture of the MD-82's horizontal stabilizers. It has set up a horizontal stabilizer "engineering" form, "manufacturing" form, and "manufacturing/technical assembly" form of product structure, realizing technical status control. As far as the storage of purchased items, raw materials, and manufactured items is concerned, it realized effective management, carrying out quota management and assembled item serialization. With reference to each part's level and series, industrial technology code, standard work time, transfer/wait time, preparation time, average batch, production efficiency, and other similar items, it precisely determined their preset times. Plans were made on the basis of materials requirements, and it calculated the technical assembly or operation start times and finish times for each assembly part, manufactured part, and purchased part, definitely guaranteeing that production would be carried out in a balanced way. For each large assembly network, large manufacturing network, and technical assembly or operations directive it carried out dynanmic tracking. It entered all work steps in the contents of each manufacturing order (large net), deliniated the basic units--work centers, and so on--for balanced manufacturing capabilities. These materials have already come to be key bases for the work of production direction departments. The next step is to aggressively create

conditions to develop work step tracking and capability balancing. Following along with the delivery of the first batch of horizontal stabilizers, the Company will give out, in a comprehensive way, the experience from the initial steps in the execution of the plan for manufacturing raw materials and the setting up of a complete set of corresponding work programs in order to practically realize, in all areas of production management, the laying of a firm foundation for MRP-II.

SETTING UP A QUALITY CONTROL SYSTEM AND GUARANTEEING PRODUCT QUALITY

Zhang Hongxiao Ren Jian Fan Qifu

THE SET UP OF QUALITY CONTROL SYSTEMS

As far as the China-U.S. cooperatively produced passenger plane MD-82 is concerned, going through repeated consultations on both sides, it was definitely decided to opt for the use of the concept of "production permit extension or stretching". In this way, the Shanghai Aviation Industrial Company could be capable of carrying out with adequate thoroughness the quality control systems which had been approved by the Federal Aviation Administration (FAA) for domestic factories within the U.S. and set up corresponding quality control systems.

From June to September of 1985, the Shanghai Aviation Industrial Company consulted the McDonnell Company's quality control materials, composing a "Quality Assurance Handbook" for the cooperative production of the MD-82 and the corresponding quality assurance programs. In conjunction with this, it then set up quality control structures, scopes of job responsibilities, and carried out discussions with the U.S. on such questions as procurment of the various needed types of test equipment. In October 1985, the Shanghai Aviation Industrial Company Quality Control Department was formally set up.

The FAA coming to Shanghai to carry out certification inspections was required to be done on the basis of the FAA Directive 8120-2A, Chapter 14's "Quality Assurance System Analysis Review (QASAR)". From April 1986 to October 1989, the FAA conducted a total of seven inspections of the Shanghai Aviation Industrial Company. From the nature of these inspections, it is possible to divide them into three types.

1. Preliminary Reviews. These are initial pre-inspections before the formal review to guide the factory in meeting the requirements of the FAR. The first three FAA inspections (May and August 1986 and April 1987) all belonged to this type. After the third inspection, the FAA pointed out a number of programs which still were not thoroughly in place and said that the Company should take steps immediately. The Shanghai Aviation Industrial Company immediately organized all personnel for training, thoroughly implemented the programs at all levels, and practically carried out all improvements. At the same time, the Douglas Aircraft Company also sent a quality inspection team to assist in carrying out simulated inspections.

2. Formal Review. The review is carried out by the FAA organized Production Certification Board (PCB). The fourth and fifth inspections (October 1987 and June 1988) belonged to this type. In the fourth inspection, seven experts carried out the inspection divided into four teams. Finally, they recognized that the FAR requirements were met, and they awarded the MD-82 aircraft an assembly and production certificate. The fifth inspection was of the parts processing area. Finally, they awarded the MD-82 parts processing a production certification.

3. Inspections for Compliance After Certification. After obtaining a production certification, the FAA must also conduct periodic inpsections of plants to see whether or not the quality assurance system which has already been established is being thoroughly maintained. The sixth and seventh FAA inspections (April 1989 and October 1989) belonged to this type. The FAA inspected in detail the technical materials, industrial technology controls, functional testing, storage, airworthiness, and other similar areas. They expressed satisfaction at the state in which the quality control systems of the plant were being maintained.

Each time the FAA does a QASAR review, due to the fact that the inspecting personnel's inate professional quality is high, and the inspection methods are scientific, in only approximately 10 days, it is possible to do an accurate inspection of problems. Before the inspection, they first earnestly digest the programs and precisely

check out the important points. Following that, they go directly to the production sites to observe. Generally, they opt for the random selection of samples, the inspection of records, raising questions on site, discovering problems, tracking them, and doing follow up inspections. They do analyses of the nature of problems (coincidental or systemic), and arrive at conclusions with such procedures as these. The good quality maintanence of various types of records is a very important matter. This is because they are objective proof of the thorough implementation of programs. They are the basis for the carrying out of various types of inspections later on, and they make it possible to eliminate any kind of subjective memory lapse problems.

SPECIAL FEATURES OF QUALITY ASSURANCE SYSTEMS

Due to the fact that the production of modern aviation products requires the immediate grasping of feedback information and the implementation of dynamic management, quality assurance departments carry out computer management of all such areas as "seal and certificate control", "technical materials status control", "aircraft quality file records", "quality inspections", and other similar areas. Now, we will speparately discuss 10 areas below.

1. The setting up of structures appropriate to the scope of the production and, along with that, fitted to those of the Douglas Aircraft Company. In the management aspects of the cooperative production of the MD-82 and the production of compensatory trade, we opted for the use of engineering, manufacturing, and quality control departments separately taking responsibility for setting up methods, carrying out methods, and supervising in position functions and the quality control department under the leadership of the Assistant Plant Chief for Quality Control, setting up, with the engineering department and manufacturing department, control job function structures which definitely guarantee the ability to independently carry out positional powers.

2. Setting up complete sets of tight management programs and quality control programs. This includes an outline of the key points drafted to conform with the requirements of FAR 21-143 concerning quality. In conjunction with this, it takes the various departments in the plant and, in the area of quality, makes any plant level management program in which any separate responsibility is taken (SP) and respectively composes a quality control handbook for cooperative aircraft production and compensatory trade, a plant level management program (SP) 88 parts, a departmental management program (OI) 127 parts, a quality control program (QP) 90 parts, a program to work out or calculate parameter calibrations (CPC) 180 parts, a physical chemistry testing program (PCLP) 66 parts, and a no damage testing program (NDTP) 34 parts.

These programs are the principal basis for guiding production management and controling work. In the programs, the corresponding production and quality control forms are cited, giving it 419 parts.

It requires that the various items be filled out, one item after another, according to the regulations. Once it is approved, it must be strictly carried out. Due to the fact that things are constantly changing, alterations in the programing are also very frequent. In order to guarantee that the programming can be altered in a timely manner, the factory sets up a management system representative (MSR) system. From the factory enterprise management office, MSR representatives are organized and sent out from the various departments to take responsibility for coordination, and to work out and issue various types of management programs for the factory.

3. Setting up a strict technical materials control system to make all charts and papers as well as technical materials be regularly placed into a current and effective state. The industrial process standards supplied by Douglas (DPS), the materials standards (DMS), and the quality ranges (DQS) contained 14 large volumes. Extracts were made from all of them and turned into handbooks. They were given out at specific points as control methods. Due to the fact that civil aircraft structural management is complicated, and the requirements of each aircraft are different, the publications of the charts and papers as well as assembly documents are also random and different. Because of this, it is necessary to use computer tracking management. Checker personnel, when testing programs and products, must first verify the edition sequences of parts, charts and papers, as well as assembly documentation, in order to supply additional control and definitely guarantee compliance with airworthiness and other similar requirements.

4. Setting up a specialized industrial process control system. In quality control departments, establish industrial process control teams and industrial process control laboratories in order to carry out, on such matters as special types of industrial process, no-damage tests on the important points of the industrial processes in manufacturing, supervision and control of the entire process. On the basis of the requirements of DPS and DQS, have planned or patrol type inspections of the status of thorough implementation at production sites. At the same time, through furnace temperature test

measurements, trough fluid analyses, periodic control tests, and other similar methods, make timely discoveries of aberrations in industrial processes. At once, when aberrations are discovered, immediately hang up a "Stop Operations" sign, and go straight to testing to be absolutely sure that a correction is obtained. At the same time, every year, on the important points in the regulations about industrial processes, carry out systematic reviews, and, in conjunction with that, keep good review records.

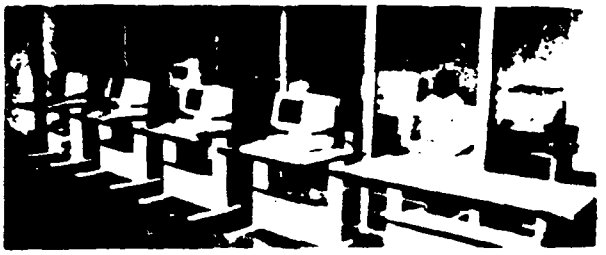

Fig.1 Computer Center (Photo by Fu Tongyi)

Fig.2 Advanced CE Test Equipment (Photo by Fu Tongyi)

Fig.3 The Leader of the FAA Inspection Team, Di Fanning, During Inspection (Photo by Fu Tongyi)

5. Setting up a perfected check and control system (CCS) to cause the key industrial or technical assembly, measuring tools, and measuring test instruments and equipment to be in a well controled state from beginning to end. According to DQS requirements, there are 10 large classes or types and 297 individual types of items that need to be controlled. At the present time, in the plant as a whole, there are over 24000 items being controlled. They have already been entered into the quality control department's "Equipment Recheck Data System (ERDS)". As far as equipment that has gone through calibration and met standards is concerned, in pasting up certification stickers, the effective periods were also clearly marked. With regard to the use of computers to track the periods for rechecking of equipment, the specified periiods for rechecks are put out in notifications. Also, in the various user departments within the plant as a whole, dual-hatted ERDS liaison personnel are supplied, forming an information feedback network responsible for the setting up of periodic equipment checks. The on-site inspection and testing personnel are responsible for supervision and preventing users from exceeding the periods for the equipment. 13

6. Establishing strict training for responsible monitoring personnel and control systems for certification certificates and seals. Production technology management personnel all must receive training and pass tests. Workers and testing personnel must go through tests on necessary matters, receiving materials certification certificates or certificates of successful training. Training materials and test questions must all go through the Douglas Aircraft Company for approval. Test scores are filed for review. Letters of introduction are given with the appropriate quality control seals (for workers) or testing seals (for testing personnel). Only then is it possible for them to assume their operating duties.

In the last few years, the factory has already put together a group of workers with the necessary capability for training. 330 people have been sent to the U.S. for training, and 4753 personnel have received training in China. It has obtained 3287 people with

various types of certificates of training and 891 personnel with certificates of qualification. The effectiveness of the training centers and the quality control department's taking responsibility for maintaining certificates of qualification and seals is such that, every month, to the various testing stations, it publishes a "Detailed Listing of Seals and Qualification Certificates". This is controled by testing personnel and, by this means, establishes the "legality" of the day-to-day use of seals. After workers complete operations on-quality and on-quota, on the documentation cover, a quality seal is affixed. After this is blessed by testing personnel, on the documentation cover, a testing or inspection seal is affixed. In all cases involving qualification certificates which are past term or operations in violation of certifications, leaking of tests, and other similar circumstances, quality control departments have the authority to suspend these seals, that is, cancel the operating rights of the key personnel.

7. Setting up a reliable system for controling equipment and materials as well as storage. All materials and equipment used in production must be selected for purchase at specific points according to regulations for industrial processes and materials standards. If there are deviations, it is necessary to go through the engineering department with a written request. All purchasing lists for materials and equipment must go through quality assurance personnel for approval. Materials coming into the plant to be certified must be stored according to lot sequence order. All materials which have operational life requirements must have marked on their containers the effective dates of their certification. In conjunction with this, they must be handled so as to stringently carry out the principle of "first in first out."

Quality assurance department materials and equipment testing personnel carry out inspections every month of the status of stored materials and equipment to include environmental conditions. If these do not meet the standards, then, they take the abberation reports and form requirements for the personnel responsible for the warehouse with a limited period for corrections.

8. Setting up a stringent system for controling items that do not meet standards. During production, the requirements testing or inspection personnel not only inspect and test on the basis of work sequences, they also will strengthen patrol-type or circulating inspections and tests to discover work sequences or products which do not match up with the basis of the manufacturing. They will immediately open a report of refusal to accept a product because of malfunction (FRR), and, along with this, send the refused product to be entered at the center for review and control of products that do not meet standards (MRCC) in order to increase the isolation. When malfunctions occur on aircraft, then, they will take out and label the malfunction and hang an FRR on the bulletin board of the aircraft in question. Engineering department personnel who have received authorization from the Douglas Aircraft Company will present opinions on handling the problem. These will be approved through the quality assurance department, and, in conjunction with this, the results of the handling will be tracked right up until the time when the problem is solved. The responsible departments take on the task of finding the source of the malfunction and correct it within a fixed period of time. MRCC, with the management control of the quality assurance department, must destroy all products that are determined to be waste on the spot to prevent their erroneous use. At the present time, there have already been 29 engineering and quality assurance personnel who have obtained the Douglas Aircraft Company's authority to handle the review of products which do not meet standards.

9. Setting up aircraft ground function tests and calibration system, and, in conjunction with that, firmly grasping advanced testing methods.

10. Setting up, for industrial process orders (for example, AO and FO), document control and quality record filing and control systems. The industrial process order documents composed through industrial process planning departments must, in all cases, be reveiwed by quality control planning departments, precisely determining the key work sequences and key specifications for inspection control factors. Aircraft assembly orders (AO), from the time of their issuance, must then be placed under the control of the

quality assurance department. As soon as they receive the inspection cover seal of the inspecting personnel, they become quality files, and must be more strictly controled. It is only when the number of technical process orders checked as given out and their edition sequence numbers as well as the actual quality files which are returned match up that it is possible to deliver an aircraft. The secondary quality files on an aircraft are kept for a period of time which is two years more than the life of the aircraft. All records must be maintained clear and complete in order to act as the basis for checks later on.

A FEW KNOW POINTS

We must set up a quality control system which corresponds to the requirements of FAR and should firmly grasp the following few points below.

1. Work out good procedures. On the basis of FAR 21-143, for the materials of the main manufacturing businesses, there are 12 areas of requirements. Procedures that are set up must guarantee the coverage and satisfying of these several requirements. The procedures can be divided into levels and series, detailed and concrete, must be worked out corresponding to the specifications at the time, and definitely guarantee that they will be feasible and inspectable. They must frequently inspect procedures for conformance in order to make it easy to make the necessary modifications.

2. Thoroughly implement procedures. It is necessary to make each person understand his job responsibilities and how to carry them out, forming an atmosphere in which everything is done according to the procedures. The leadership must take the lead in observing them and implementing them. They must take the procedures and make them be seen as principles which are carried out in the whole plant from top to bottom with everyone participating.

3. Exercise good discipline. The thorough implementation of procedures is mainly dependent on self-awareness, however, it also carries with it a coercive nature. Violations of procedures are

nothing else than violations of discipline, and one must have a system with the necessary rewards and punishments. In terms of management, doing things according to procedures guarantees that quality control systems will be carried out down to the practical level. In production, strict discipline in industrial processes guarantees that products will comply with airworthiness requirements. Strict discipline in dealing with violations makes it possible to grant or withdraw seals right up to the transfer of the work.

4. Continuous self-improvement. Setting up a quality assurance system is not something which can be done once and for all. One must ceaselessly carry out improvements and supplementation to make it better every day. The quality review calculation structures, that are set up in the factory's quality assurance department as a specialized function, take responsibility for the thorough implementation of procedures by personnel at the various levels. In the arena of work quality, they carry out supervision, and, at the present time, they have already been brought together into a specialized group. The various workshops and departments all set up corresponding self review and analysis teams. These take responsibility for supervision of the quality situation in the department in question. They form review and analysis networks which take as their focus quality review and analysis. Besides this, in production, they strengthen the power of control over industrial processes, develop quality analyses, and work out correction procedures. They discover, in a timely manner, weak links in quality, trends in the development of quality, and stop the repetition of malfunctions.

SOMEWHAT PECULIAR ORGANIZATIONAL STRUCTURES

Wu Zuoquan Jiang Zijiang Zhang Hairu

I. THE ESTABLISHMENT OF ORGANIZATIONAL STRUCTURES

In the process of the cooperative China-U.S. production of the MD-82, once it was begun, it was then necessary, on the basis of the McDonnell Company's method of production permit extension or stretching, to carry it out. That is, it was necessary to set up the production procedures and systems which already existed in the McDonnell Company's subordinate Douglas Aircraft Company for doing checks and making decisions, borrowing organizational structures for the Changtan plant. However, because the national situations were different from each other, the scales of the productions were different, and the inate quality of the personnel were different, making a complete transfer was not the ideal plan.

In order to satisfy the requirements of cooperative production, what type of organizational structures should be set up? Going through research and analysis on several plans and sifting them out, the company decided to set up 9 departments and one section or office. This structure was not an exact duplicate of the McDonnell-Douglas Company, and it was also different from the original structure of the Company. Although it corresponded with every relevent organization in the McDonnell-Douglas Company, it also corresponded to the original structure of the Company.

This organizational structure, in actual operations, still had deficiencies. These were primarily due to a confused division of labor between departments for the production of aircraft and other civilian products and a lack of clarity in functional subordination relationships and lines for the transmission of orders, as well as other similar matters. This was not permissible with the U.S. Federal Aviation Administration. To deal with this, the Company, beginning from a coordination of on-site production, for the MD-82 and other

non-aviation civilian products, in personnel, sites, equipment (including various types of supplemental equipment) and other similar types of factors, set up in all cases clear indications of divisions and carried out a dividing up of the production line. Because of this, it basically solved the problem.

II. THE MATRIX ORGANIZATIONAL STRUCTURE TYPE

People in management circles throughout the world all recognize that the most effective types of organizational structures should make the capabilities of each member of the organization make the greatest contributions to the realization of the objectives of the enterprise. The McDonnell Company's organizational system basically opts for the use of the matrix management type. However, its internal organizational structure is still in the process of frequent changes or adjustments, even to the point where the basic type itself is changed. This type of dynamic organizational structure is primarily for suiting the changes and needs of both internal and external situations. This type of method of doing things stresses adaptability, even to the point where it does not reverence and publically violates several generally recognized principles of organization. For example, on the basis of the McDonnell-Douglas Company's matrix management organizational structure, projects are divided up in their management with reports being made to the project manager on the status of activities. In technology and administration, it is also necessary to have a division of primary leadership responsibility. The good point of doing things this way is that it is possible, in the most limited way possible, to exert effects on a small number of specialists. The weak point is that an organization member must report and request direction from two higher levels. This flies in the face of the "principle of unity of command." However, for the sake of the overall objective, they still selected the matrix management type.

During the cooperative production, we refered to the McDonnell-Douglas Company's organizational system. On the basis of the original linear job function staff system, we set up an additional

project management department--the project management office caused the engineering department, manufacturing department, quality assurance department, contracting department, market department, manufacturing support department, technical assembly department, and other similar functional departments to come together with each other in horizontal and vertical coordination with this office, forming a single project matrix organizational system with the project director being the nexus point of the departments. From the project director, they obtain what work to do and the indication of when to do it. From persons responsible in the departments, they get how to do it and the indication of what people to use. In conjuction with this and at the same time, instructions are requested from two higher levels and work is reported. When the two horizontal and vertical systems are in contradiction with each other, the situation is mediated by high level management.

During the cooperative production of the MD-82, this organizational management system exerted a dynamic effect.

1. Management of the Project Office

According to the McDonnell-Douglas Company's concept, project management should carry out the management of a product through the entire process from discussion and verification of the concept to design, manufacturing, mass production, after the sale service, and other related areas. However, the content of the cooperation was limited. The Company project office mainly took responsibility for the management of such aspects as the aircraft's general assembly, testing, flight tests, delivery, and after the sale service. In the matrix management structure, going through the establishment of project sub-directors in the various functional departments, it formed a project management system. The project office itself should establish the project director, the project industrial director, production costs accounting, departmental project directors, and a number of auxilliary personnel. They take responsibility for working out plans for the execution of the project and they plan its pace. They check out and approve project contract clauses and conditions, approves the disposition of taskings, supervises and evaluates the development of the project, controls the production costs of the

project, and customer relations. At the present time, the project office, in the areas of personnel provision and the perfecting of functions, as well as other similar areas, still awaits continued development. However, already, during the cooperative production, it has exerted important influence.

Project management also executes the compensatory trade production of aircraft parts, sets up the office for package transfer production, and, in conjuction with this, it is just in the midst of bringing in the matrix management structural organization.

2. Management of Workshops

According to the McDonnell-Douglas Company's management system, production workshops all do not set up functional structures. At the present time, the original functional structure by industry of the various workshops under the Company has, respectively, been taken over by the divided responsibilities of the corresponding functional departments. For example, the workshop's industrial processes, planning, dispatch, separation and storage of parts, separation and storage of materials, separation and storage of tools, and other similar areas are respectively directly managed by the manufacturing department, the manufacturing support department, and the technical assembly department, as well as other similar functional departments, and, in conjunction with this, provide service to the work site. In this way, they have reduced management layers, causing workshops to be capable of concentrating their energies and increasing production.

3. Management of Metallurgical Technology

The Company handles one third of the metallurgical technology management work on the MD-82. Industrial process standards, new industrial process standards, and everyday special types of industrial process control are, respectively, taken responsibility for by the contact engineering department, the manufacturing department, and the quality assurance department. In order to prepare to construct a new industrial process control laboratory and satisfy FAA inspection requirements, the metallurgical science center laboratory was shifted into the control of the quality assurance department which assumed responsibility for the work of industrial process control testing. The practical realization clearly demostrates that this type of change

in materials and industrial process (generally known as metallurgy) work has very great effects in promoting implementation.

4. Dynamic Management of Data

As far as the production charts, papers, and data of the McDonell-Douglas Company are concerned, in meeting the requirements of customers, and, in the process of trying hard to expand markets, one frequently goes through dynamic alterations. The management of these types of dynamic charts, papers, and data must also be dynamic. If it is not, it will create chaos on the assembly line. In order to do this, the Company set up the "product requirement information management system (PRIMS)". This is a comprehensive system which carries out dynamic management of engineering design data and production. It is used by the engineering department in order to control the data storage and programming for charts, papers, and parts. Its principal objective is, when aircraft are delivered, to guarantee for certain that the status of charts and papers as well as model number design data match up, directly supplying, to the production system, all alterations in activities by the engineering department relative to spare parts or assembly. Fitting in with this, at the production site, it set up a data read point under unified direction from the science and technology files library, guaranteeing the production site the use of data from charts and papers which are all current and effective versions. 15

Another type of management similar to this is the "equipment retesting system (ERDS)", and other similar systems. All of these opt for the use of advanced computers as means to assist in management.

III. Special Points Concerning Organizational Structures

The Shanghai Aviation Industrial Company set up the organizational structures described above. Going through the last 5 years of practical operations and seven FAA inspections has clearly demonstrated that it is

scientifically reasonable and effective when it is put into practice. Although there are a number of inadequacies which are still awaiting development and perfecting, there are also, however, some peculiar and excellent characteristics to it. Principally, these are:

1. In sum, it has demonstrated that, taking the three great systems of engineering, manufacturing, and quality assurance as the core of the various systems, not only is it possible to mutually relate them to each other in a close way and to form an organic whole, but that it is also possible to handle normal operations on our own. At the same time, we possess capabilities for perfection and renewal.

2. It has been sufficient to relatively clearly manifest the principles of management scope, functional division of labor, delegation of authority, and other similar principles of organization.

3. It possessed a full set of management programs for the normal operations of quality assurance systems.

4. It set up a specialized structure for the maintaining and perfecting of programs, management supervision systems for carrying out programs, and quality assurance review and planning networks.

5. On the basis of the China-U.S. cooperative production and the special points associated with joint management, it set up three-low, medium, and high-levels of management committee. For aircraft product quality assurance and control, it opted for the use of three levels of review control--the Chinese, the McDonnell-Douglas Company, and the FAA. It set up the review committee on products which did not meet standards and corresponding authorized structures.

The strong points of matrix management organizational structures are.

1. It is advantageous for lateral relationships and has relatively great mobility and flexibility.

2. It is advantageous for up and down and right and left concentrations of authority and divisions of authority for carrying out the optimum structural composite.

3. It is advantageous for the adequate utilization of limited resources, the adequate utilization of human talent, and the raising of its work level.

4. It is capable of responding to the variable nature of the marketplace.

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