Machine tool numerical control reforms

First, CNC systems and the development trend of history

1946 birth of the world's first electronic computer, which shows that human beings created to enhance and replace some of the mental work tools. It and human agriculture, industrial society in the creation of those who merely increase compared to manual tools, from a qualitative leap for mankind's entry into the information society laid the foundation. Six years later, in 1952, computer technology applied to the machine in the United States was born first CNC machine tools. Since then, the traditional machine produced a qualitative change. Nearly half a century since the CNC system has experienced two phases and six generations of development.

1.1, Numerical Control (NC) phase (1952 to 1970)

Early computer's computational speed low and the prevailing scientific computing and data processing is not affected, but can not meet the requirements of real-time control machine. People have to use digital logic circuit "tied" into a single machine as a dedicated computer numerical control system, known as the hardware connection NC (HARD-WIRED NC), called the Numerical Control (NC). With the development of components of this phase after three generations, that is, in 1952 the first generation - tube; 1959 of the second generation - transistor; 1965 of the third generation - small-scale integrated circuits.

1.2, Computer Numerical Control (CNC) phase (1970 to present)

To 1970, GM has been a small computer and mass-produced. So it transplant system as the core component of NC, have entered a Computer Numerical Control (CNC) stage (in front of the computer should be "universal" word omitted). To 1971, the United States INTEL company in the world will be the first time the two most core computer components - computing and controller, a large-scale integrated circuit technology integration in a chip, called the microprocessor (MICROPROCESSOR) , also known as the central processing unit (CPU).

1974 microprocessor to be used in CNC system. This is because the function of the computer is too small to control a machine tool capacity affluent (the time has been used to control more than one machine, called Group Control), as a reasonable economic use of the microprocessor. Minicomputer reliability and then not ideal.

Early microprocessor speed and functionality while still not high enough, but can be adopted to solve the multi-processor architecture. As microprocessor core is a general computer components, it is still known as the CNC.

By 1990, PC machines (personal computers, domestic habits that computer) performance has been developed to a high stage, as a CNC system to meet the requirements of the core components. NC system based on PC has now entered the stage.

In short, CNC has also experienced a stage three generations. That is, in 1970's fourth generation - small computer; 1974 of the fifth generation - microprocessors and the sixth-generation 1990 - Based on the PC (called PC-BASED abroad).

Also pointed out that, although the foreign computer has been renamed NC (CNC), but China still customary said Numerical Control (NC). Therefore, we stress the day-to-day "NC", in essence, is that "computer numerically controlled."

1.3, the trend of future development of NC

1.3.1 continue to open, the sixth generation of PC-based development Based on the PC with the open, low-cost, high reliability, rich in resources such as hardware and software features, and more CNC system manufacturers will embark on this path. At least it used PC as a front-end machine, to deal with the human-machine interface, programming, networking and communications problems, the former NC Some systems have the mandate. PC machine with the friendly interface, will be universal to all CNC system. Remote communications, remote diagnostics and maintenance will be more widespread.

1.3.2 high-speed and high-precision Development

This is to adapt to high-speed and high-precision machine tools to the needs of the development direction.

1.3.3 intelligent direction to the development of

With artificial intelligence in the computer field infiltration and the continuing development of the intelligent numerical control system will be continuously improved.

（1）adaptive control technology

CNC system can detect some important information in the process, and automatically adjust system parameters to improve the system running state purposes.

（2）the introduction of expert guidance processing system

Will be the experience of skilled workers and experts, processing and the general rules of law of special deposit system, the process parameters to the database as the foundation, and establish artificial intelligence expert system.

（3）introduction of Fault Diagnosis Expert System

（4）intelligent digital servo drives

Automatic Identification can load, and automatically adjust parameters to get the best drive system operation.

Second, CNC of the need for transformation

2.1, microscopic view of the necessity of

From the micro perspective, CNC machine tools than traditional machines have the following prominent superiority, and these advantages are from the NC system includes computer power.

2.1.1 can be processed by conventional machining is not the curve, surface and other complex parts.

Because computers are superb computing power can be accurately calculated instantaneous each coordinate axis movement exercise should be instantaneous, it can compound into complex curves and surfaces.

2.1.2 automated processing can be achieved, but also flexible automation to increase machine efficiency than traditional 3 to 7 times.

Because computers are memory and storage capacity, can be imported and stored procedures remember down, and then click procedural requirements to implement the order automatically to achieve automation. CNC machine tool as a replacement procedures, we can achieve another workpiece machining automation, so that single pieces and small batch production can be automated, it has been called "flexible automation."

2.1.3 high precision machining parts, the size dispersion of small, easy to assemble, no longer needed "repair."

2.1.4 processes can be realized more focused, in part to reduce the frequent removal machine.

2.1.5 have automatic alarm, automatic control, automatic compensation, and other self-regulatory functions, thus achieving long unattended processing.

2.1.6 derived from the benefits of more than five.

Such as: reducing the labor intensity of the workers, save the labour force (one can look after more than one machine), a decrease of tooling, shorten Trial Production of a new product cycle and the production cycle, the market demand for quick response, and so on.

These advantages are our predecessors did not expect, is a very major breakthrough. In addition, CNC machine tools or the FMC (Flexible Manufacturing Cell), FMS (flexible manufacturing system) and CIMS (Computer Integrated Manufacturing System), and other enterprises, the basis of information transformation. NC manufacturing automation technology has become the core technology and basic technology.

2.2, the macro view of the necessity of

From a macro perspective, the military industrial developed countries, the machinery industry, in the late 1970s, early 1980s, has begun a large-scale application of CNC machine tools. Its essence is the use of information technology on the traditional industries (including the military, the Machinery Industry) for technological transformation. In addition to the manufacturing process used in CNC machine tools, FMC, FMS, but also included in the product development in the implementation of CAD, CAE, CAM, virtual manufacturing and production management in the implementation of the MIS (Management Information System), CIMS, and so on. And the products that they produce an increase in information technology, including artificial intelligence and other content. As the use of information technology to foreign forces, the depth of Machinery Industry (referred to as information technology), and ultimately makes their products in the international military and civilian products on the market competitiveness of much stronger. And we in the information technology to transform traditional industries than about 20 years behind developed countries. Such as possession of machine tools in China, the

proportion of CNC machine tools (CNC rate) in 1995 to only 1.9 percent, while Japan in 1994 reached 20.8 percent, every year a large number of imports of mechanical and electrical products. This also explains the macro CNC transformation of the need.

Third, CNC machine tools and production lines of the transformation of the market

3.1, CNC transformation of the market

My current machine total more than 380 million units, of which only the total number of CNC machine tool 113,400 Taiwan, or that China's CNC rate of less than 3 percent. Over the past 10 years, China's annual output of about 0.6 CNC machine tools to 0.8 million units, an annual output value of about 1.8 billion yuan. CNC machine tools annual rate of 6 per cent. China's machine tool easements over age 10 account for more than 60% below the 10 machines, automatic / semi-automatic machine less than 20 per cent, FMC / FMS, such as a handful more automated production line (the United States and Japan automatic and semi-automatic machine, 60 percent above). This shows that we the majority of manufacturing industries and enterprises of the production, processing equipment is the great majority of traditional machine tools, and more than half of military age is over 10 years old machine. Processing equipment used by the prevalence of poor quality products, less variety, low-grade, high cost, supply a long period, in view of the international and domestic markets, lack of competitiveness, and a direct impact on a company's products, markets, efficiency and impact The survival and development of enterprises. Therefore, we must vigorously raise the rate of CNC machine tools.

3.2, import equipment and production lines of the transformation of NC market

Since China's reform and opening up, many foreign enterprises from the introduction of technology, equipment and production lines for technological transformation. According to incomplete statistics, from 1979 to 1988 10, the introduction of technological transformation projects are 18,446, about 16.58 billion US dollars.

These projects, the majority of projects in China's economic construction play a due role. Some, however, the introduction of projects due to various reasons, not equipment or normal operation of the production line, and even paralyzed, and the

effectiveness of enterprises affected by serious enterprise is in trouble. Some of the equipment, production lines introduced from abroad, the digestion and absorption of some bad, spare parts incomplete, improper maintenance, poor operating results; only pay attention to the introduction of some imported the equipment, apparatus, production lines, ignore software, technology, and management, resulting in items integrity, and potential equipment can not play, but some can not even start running, did not play due role, but some production lines to sell the products very well, but not because of equipment failure production standards; because some high energy consumption, low pass rate products incur losses, but some have introduced a longer time, and the need for technological upgrading. Some of the causes of the equipment did not create wealth, but consumption of wealth.

These can not use the equipment, production lines is a burden, but also a number of significant assets in stock, wealth is repaired. As long as identifying the main technical difficulties, and solve key technical problems, we can minimize the investment and make the most of their assets in stock, gain the greatest economic and social benefits. This is a great transformation of the market.

Fourth, NC transformation of the content and gifted missing

4.1, the rise of foreign trade reform

In the United States, Japan and Germany and other developed countries, and their machine transformation as new economic growth sector, the business scene, is in a golden age. The machine, as well as technology continues to progress, is a machine of the "eternal" issue. China's machine tool industry transformation, but also from old industries to enter the CNC technology mainly to the new industries. In the United States, Japan, Germany, with CNC machine tools and technological transformation of production lines vast market, has formed a CNC machine tools and production lines of the new industry. In the United States, transforming machine machine tool industry as renewable (Remanufacturing) industry. Renewable industry in the famous companies: Bertsche engineering company, ayton machine tool company, Devlieg-Bullavd (Bo) services group, US equipment companies. Companies in the United States-run companies in China. In Japan, the machine tool industry transformation as machine modification (Retrofitting) industry. Conversion industry

in the famous companies: Okuma engineering group, Kong 3 Machinery Company, Chiyoda Engineering Company, Nozaki engineering company, Hamada engineering companies, Yamamoto Engineering Company.

4.2, the content of NC

Machine tools and production line NC transformation main contents of the following:

One is the restoration of the original features of the machine tools, production line of the fault diagnosis and recovery; second NC, in the ordinary machine augend significant installations, or additions to NC system, transformed into NC machine tools, CNC machine tools; its Third, renovation, to improve accuracy, efficiency and the degree of automation, mechanical, electrical part of the renovation, re-assembly of mechanical parts processing, restore the original accuracy of their production requirements are not satisfied with the latest CNC CNC system update; Fourth, the technology updates or technical innovation, to enhance performance or grades, or for the use of new technology, new technologies, based on the original technology for large-scale update or technological innovation, and more significantly raise the level, and grades of upgrading.

4.3, NC transformation of the gifted missing

4.3.1 reduce the amount of investment, shorter delivery time

Compared with the purchase of new machine, the general can save 60% to 80% of the costs and transforming low-cost. Especially for large, special machine tools particularly obvious. General transformation of large-scale machine, spent only the cost of the new machine purchase 1 / 3, short delivery time. But some special circumstances, such as high-speed spindle, automatic tray switching systems and the production of the installation costs too costly and often raise the cost of 2 to 3 times compared with the purchase of new machine, only about 50 percent of savings investment.

4.3.2 stable and reliable mechanical properties, structure limited By the use of bed, column, and other basic items are heavy and solid casting components, rather than kind of welding components of the machine after the high-performance, quality, and can continue to use the new equipment for many years. But by the mechanical

structure of the original restrictions, it is not appropriate to the transformation of a breakthrough. 4.3.3 become familiar with the equipment, ease of operation and maintenance The purchase of new equipment, new equipment do not know whether to meet the processing requirements. Transformation is not, can be used to calculate the machine processing capacity; In addition, since the use of many years, the operator of the machine has long been understood that in the operation, use and maintenance of the training time is short, quick. Transformation of the machine tools installed, we can achieve full load operation.

4.3.4 can take full advantage of the existing conditions

Take full advantage of the existing foundation, not like buying new equipment as necessary to build a foundation.

4.3.5 can be used as control technology

According to the development speed of technological innovation and in a timely manner increased level of automation in production equipment and efficiency, improve the quality of equipment and grades, and the old machine will be replaced by the current level of machine.

5, the choice of NC System

NC system are the three major types of transformation, in accordance with specific circumstances Choose.

5.1, stepper motor drive the open-loop system

The servo drive system is stepper motor, stepper motor power, such as electro-hydraulic pulse motor. NC system by sending commands to the progress of pulse, the drive control and power amplifier circuit, the stepper motor rotate through the gears with ball screw drive of the implementation of parts. As long as control commands the number of pulses, frequency and electricity sequence can control the implementation of parts of the displacement movement, speed and direction of movement. Such a system does not require the test will be the actual position and velocity feedback to the input, so called open-loop system, the system accuracy of the displacement in the major decisions of the stepper motor angular displacement accuracy, transmission gear and other components of the leadscrew pitch accuracy, the accuracy of the lower displacement.

The system is simple, convenient debugging maintenance, reliable, low cost, easy modification success.

5.2, or asynchronous motor DC Motor Drive, grating feedback loop measurement NC system

And the open-loop system is the difference between a system: from the grating, such as position sensors for simultaneous detection device measured the actual position feedback signals, at any time and to compare the value will be the difference between the two enlarge and change, driven implementing agencies , given the speed of elimination of bias towards the direction of movement, until a given position feedback and the actual location of the margin of zero. Feed the closed-loop system in the structure than to the open-loop system into the complex, high-cost, strict requirements on the environment at room temperature. Design and debugging difficult than open-loop system. However, can be compared to the open-loop system into higher accuracy, faster speed, greater power drive characteristic indicators. Under the technological requirements and decide whether or not to adopt this system.

5.3, AC / DC servo motor drive, the semi-encoder feedback loop NC system

Semi-closed-loop system detection devices installed in the middle of transmission, the implementation of indirect measurement components position. It can only be part of the internal loop compensation system components of the error and, therefore, it compared the accuracy of the closed-loop system of low accuracy, but its structure and debug than simple closed-loop system. Will be in the angular displacement detection devices and speed detection devices and make a servo motor when there was no need to consider the overall position of the installation of detection devices. NC system for the current production companies more manufacturers, such as the famous German company SIEMENS, Japan FANUC companies; Everest domestic companies such as China, Beijing Aerospace CNC System Corporation, Shenyang and the central high-grade companies NC NC National Engineering Research Center.

NC selection system is based mainly CNC machine modified to achieve the various precision, motor-driven power and user requirements.

Sixth, the transformation of NC modification of the main mechanical components

A new CNC machine tools in the design to achieve: a high static and dynamic stiffness of movement of the friction coefficient between small, transmission without clearance; big power; easy operation and maintenance. CNC transformation should be possible to achieve the above requirements. NC devices that can not be connected together with the general machine tools to reach the requirements of the NC machine tool, should also be major components corresponding to the transformation of up to a certain design requirements can be anticipated adaptation.

6.1, sliding Guideway

On the NC lathe, in addition to a general guide lathes and precision of sexual orientation, but also a good Naimaca, wear characteristics, and reduce the frictional resistance to the death zone. At the same time there must be enough stiffness to reduce rail deformation on the impact of machining accuracy, a reasonable guide protection and lubrication.

6.2, deputy Gear

General Machine concentrated in the main gear box and gearbox in the spindle. In order to ensure transmission accuracy, the use of CNC machine tool accuracy of gear higher grades than the general machine tools. In the structure must be able to achieve seamless transmission, thus transforming, machine main gear must meet the requirements of CNC machine tools, in order to ensure accuracy machining.

6.3, and the ball screw sliding leadscrew

Screw-drive directly related to the transmission chain accuracy. Screw selection depends largely on the accuracy of the processing of requests and drag torque requirements. Accuracy is the main requirement of processing may be sliding Screw, but should check the leadscrew wear, such as pitch and pitch error accumulated error and match Nut Gap. Sliding leadscrew general should not be less than six, the nut is too large gap replacement nut. The use of a sliding leadscrew relatively lower prices of ball screw, but it is difficult to meet the high precision machining.

Ball screw friction losses small, high efficiency, the transmission efficiency of more than 90% of high accuracy, long life; starting torque and the torque of close

campaigns, starting torque motor can be reduced. So to meet high precision machining requirements.

6.4, security

Efficiency must be security as the prerequisite. Machine transformation in the light of the actual situation, we should take corresponding measures must not be ignored. Ball screw is sophisticated components, work to prevent dust particular chip and hard sand into the raceway. Screw in the vertical can also increase overall plate shields. And the extension units at both ends of the sliding contact surface Guide to seal well, absolutely rigid Coarse prevent the entry of foreign matter sliding surface damage Guide.

7, the main steps of CNC machine tools

7.1, for the determination of transformation

Through analysis of the feasibility of transforming the future, we can against a Taiwan or a few machines determine the current status of reform programmes, which are generally include:

7.1.1 mechanical and electrical repair of combining

Generally speaking, the need for a transformation of the electrical machine, are subject to mechanical repairs. Repairs to determine the requirements, scope, content must be decided by electrical machinery required to transform the structure of the request; transformation to determine electrical and mechanical repair, alteration between the staggered time requirements. The mechanical properties of intact electrical transform the basis of success.

7.1.2 easy first, and to the overall situation after the first local The removal of the original system must control the original drawings, carefully, to make drawings in a timely manner marked to prevent the demolition or omission (of local circumstances). In the process of demolition will discover some new system design in the gaps, and that should be promptly added, removed and parts of the system should be disaggregated, safekeeping, in case of failure or partial failure reinstated. There is a definite value, and can be used for spare parts for other machines. Must not extravagantly used and misplaced.

7.2 reasonable arrangements for a new location and routing system

Under the new system design drawings and reasonable new system configurations, including fixed box, panel installation, alignments, and the fixed position adjustment components, sealing and necessary, such as decoration. Connection must be a clear division of work, it was reviewed inspection to ensure connectivity of norms, diameter appropriate, accurate, reliable handsome.

7.3 Debugging

Commissioning must be identified in advance by the steps and requirements. Debugging should be cool-headed, keep records, in order to identify and solve problems. Commissioning of the first test sensitivity security protection systems to prevent physical, equipment accidents. Debugging the scene must be cleaned, no superfluous items; coordinates extension units in the campaign centre of the whole trip; empty can test, first empty after loading; can simulate the test, after the first real dynamic simulation; can manually the upper hand After moving automatically.

7.4, acceptance and post-work

Acceptance of the work to employ the staff to join, has been developed in accordance with the acceptance criteria. The transformation of the late work is also very important, it is conducive to enhancing the level of technical projects and equipment as soon as possible so that production. Acceptance and post include:

7.4.1 machine mechanical properties acceptance

After mechanical repairs and maintenance as well as a full transformation, the mechanical properties of the machine tools should meet the requirement, in the geometric accuracy should be within the limits prescribed.

7.4.2 electrical control function and control accuracy acceptance

Electrical control the various functions of action must be normal, sensitive and reliable. Application control accuracy of the system itself functions (such as stepping dimensions, etc.) and standard measurement apparatus (such as laser interferometer, coordinate measurement machines) inspection, the scope of accuracy achieved. At the same time also and the transformation of the former machine tool accuracy of the various functions and to contrast, poor access to quantifiable indicators.

7.4.3 specimen cutting Acceptance

Can refer to the CNC machine tool cutting at home and abroad specimen standards, qualified operatives, with the programming staff to test cutting. Acceptance specimen cutting machine stiffness can be cutting, noise, trajectory, and other related actions, the general should not be used for product components specimen use.

7.4.4 drawings, information acceptance

Machine transformation of the latter should be timely drawings (including schematics, layout plans, wiring diagram, ladder diagram, etc.), information (including various brochures), the transformation of files (including the transformation before and after the various records) summary, collating, transfer to stall. Maintain data integrity, effective, continuous, and that the future stability of the equipment running is very important.

7.4.5 summing up, enhancing

After the end of each should be promptly summed up, helps improve the operational level of technical personnel, but also conducive to the whole enterprise technical progress.

8, several examples of NC

1, use of X53 milling SIEMENS 810M

1998, the company invested 200,000 yuan, with Germany's Siemens 810 M CNC system, 611 A AC servo drive system for the company's X53 as a model of the milling machine for X, Y, Z three-axis NC transformation of the original reservation Spindle and cooling systems; transformation of the three-axis machine used in the roller screw and gear drive mechanism. Transformation of the entire work includes mechanical design, electrical design, PLC and the establishment of procedures for debugging, machine overhaul and, finally, the components are installed and debug. Milling After the transformation, processing effective itinerary X / Y / Z-axis respectively 880/270/280 mm; maximum speed X / Y / Z-axis respectively 5000/1500/800 mm / min; manual speed X / Y / Z-axis respectively 3000/1000/500 mm / min; machining accuracy of ± 0.001mm. Coordinate machine can be linked to complete all kinds of complex curves and surfaces processing.

2, and Step by GSK980T driven system of the C6140 Lathe

1999, the company invested 80,000 yuan, a Guangzhou NC plant production

GSK980T NC system, DY3 hybrid stepping drive unit for the company's C6140 longer a lathe X and Z axes to transform the two retention The main axis of the original system and the cooling system; transformation of the two-axis machine used in the roller screw and belt drive mechanism. Transformation of the entire work includes mechanical design, electrical design, machine overhaul and the components are installed and debug. Lathe After the transformation, processing effective itinerary X / Z-axis respectively 390/1400 mm; maximum speed X / Z-axis respectively 1200/3000 mm / min; manual speed of 400 mm / min; manual for the rapid X / Z-axis respectively for the 1200/3000 mm / min; machine smallest mobile units of 0.001 mm.

3, and GSK980T with AC servo drive system of the C6140 Lathe

2000, NC plant in Guangzhou with production GSK980T NC system, DA98 AC servo unit and 4-position automatic tool carrier of a motor factory lathe C6140-X, Z two-axis NC transformation of the original reservation the spindle and cooling systems; transformation of the two-axis machine used in the roller screw and belt drive mechanism. Transformation of the entire work includes mechanical design, electrical design, machine overhaul and the components are installed and debug. Lathe After the transformation, processing effective itinerary X / Z-axis respectively 390/730 mm; maximum speed X / Z-axis respectively 1200/3000 mm / min; manual speed of 400 mm / min; manual for the rapid X / Z-axis respectively for the 1200/3000 mm / min; machine smallest mobile units of 0.001 mm.

4, use of X53 milling SIEMENS 802S

2000, the company invested 120,000 yuan, with Germany's Siemens 802 S CNC system, stepping drive system for the company's another model of the X53 milling machine for X, Y, Z three-axis NC transformation of the original reservation Spindle and cooling systems; transformation of the three-axis machine used in the roller screw and gear drive mechanism. Transformation of the entire work includes mechanical design, electrical design, machine overhaul and, finally, the components are installed and debugged . Milling After the transformation, processing effective itinerary X / Y / Z-axis respectively 630/240/280mm; maximum speed X / Y / Z-axis respectively

3000/1000/600mm / min; manual feed rate X / Y / Z-axis respectively 2000/800/500mm / min; smallest mobile units of 0.001mm.

9, NC transformation of the issues and recommendations

Through several of CNC machine work, there are also found in many of the issues, as demonstrated by:

First, departments, staff development duties uncertainty, organizational chaos, seriously affecting the progress of reform;

Second, the work of the development process and the development plan are mostly use their experience, not reasonable;

Third, the training of relevant personnel not in place, resulting in improved process machine will be no programming, the operator of the machine operator unskilled, and other issues.

Based on the above issues, a few suggestions:

First, the staff responsible for the transformation of clear responsibilities, reward and punishment clear, and fully mobilize the enthusiasm of the staff;

Second, cultivate a number of high-quality applications and maintenance personnel, selected staff on education and learn advanced technology;

Third, we need to pay attention to users, maintaining CNC system technical training, the establishment of the technical resources at home and abroad NC.