NUMERICAL CONTROL

(The Control of Manufacturing Equipment by Numbers)

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Numerical control (NC) is the operation of a machine tool by a series of coded instructions consisting of numbers, letters of the alphabet, and symbols that the machine control unit (MCU) can understand. These instructions are changed into electrical pulses of current that the machine's motors and controls follow to carry out manufacturing operations on a workpiece. The numbers, letters, and symbols are coded instructions that refer to specific distances, positions, functions, or motions, that the machine tool can understand as it machines the workpiece.

History

A form of NC was used in the early days of the industrial revolution, as early as 1725, when knitting machines in England used punched cards to form various patterns in cloth. Even earlier than this, rotating drums with prepositioned pins were used to control the chimes in European cathedrals and some American churches. In 1863, the first player piano was patented; it used punched paper rolls, through which air passed to automatically control the order in which the keys were played.

The principle of mass production (interchangeable manufacture), developed by Eli Whitney, transferred many operations and functions originally performed by skilled artisans to the machine tool. As better and more precise machine tools were developed, the system of interchangeable manufacture was quickly adopted by industry in order to produce large quantities of identical parts. In the second half of the nineteenth century, a wide range of machine tools were developed for the basic metal-cutting operations, such as turning, drilling, milling, and grinding. As better hydraulic, pneumatic, and electronic controls were developed, better control over the movement of machine slides became possible.

NC Evolves

In 1947, the U.S. Air Force found that the complex designs and shapes of aircraft parts such as helicopter rotor blades and missile components were causing problems for manufacturers, who could not keep up to projected production schedules. At this time, John Parsons, of the Parsons Corporation, of Traverse City, Michigan, began experimenting with the idea of making a machine tool generate a “thru-axis curve" by using numerical data to control the machine tool motions. In 1949, the U.S. Air Material Command awarded Parsons a contract

to develop NC and in turn speed up production methods. Parsons subcontracted this study to the Servomechanism Laboratory of the Massachusetts Institute of Technology (MIT), which in 1952 successfully demonstrated a vertical spindle Cincinnati Hydrotel, which made parts through simultaneous three-axis cutting tool movements. In a very short period of time, almost all machine tool manufacturers were producing machines with NC.

At the 1960 Machine Tool Show in Chicago, over a hundred NC machines were displayed. Most of these machines had relatively simple point-to-point positioning, but the principle of NC was now firmly established. From this point, NC improved rapidly as the electronics industry developed new products. At first, miniature electronic tubes were developed, but the controls were big, bulky, and not very reliable. Then solid-state circuitry and, eventually, modular, or integrated circuits were developed. The control unit became smaller, more reliable, and less expensive. The development of even better machine tools and control units helped spread the use of NC from the machine tool industry to all facets of manufacturing.

Data Processing

NC data processing (with numbers, letters, and symbols) is done in a computer or machine control unit (MCU) by adding, subtracting, multiplying, dividing, and comparing. The computer can be programmed to recognize an A command before a B command, an item 1 before an item 2, or any other elements in their sequential order. It is capable of handling numbers very quickly; the addition of two simple numbers may take only one billionth of a second (a nanosecond).

NC Evolves into CNC

The introduction of software-based controls in the early 1970s replaced the NC hardware design with complete computer logic that had more capacity and could be programmed for a variety of functions at any time. This made it possible to revise, modify, or update CNC programs or parts of programs at any time on a computer. In turn, CNC machines became easier to use with their menu-selected displays, advanced graphics, and ease of programming.

Cartesian Coordinate System

Primitive people used their 10 fingers and 10 toes to count numbers and from this evolved our present decimal, or Arabic system where "base ten," or the power of 10, is used to signify a numerical value. Computers and MCUs, in contrast, use the binary or base 2 system to recognize numerical values. Knowledge of the binary system is not essential for the programmer

or operator since both the computer and the MCU can recognize standard decimal system and convert it to binary data.

Almost everything that can be produced on a conventional machine tool can be produced on a computer numerical control machine tool, with its many advantages. The machine tool movements used in producing a product are of two basic types: point-to-point (straight-line movements) and continuous path (contouring movements).

The mathematician and philosopher Rene Descartes invented the Cartesian or rectangular coordinate system. With this system, any point can be located in mathematical terms from any other point along three perpendicular axes. CNC systems use rectangular coordinates because the programmer can locate every point on a job precisely and independently from each other.