SALES BULLETIN NO. 42 NC-1

1968 - THE YEAR OF NUMERICAL CONTROL

Information Systems

Time-Sharing Service

1-17-68

WHAT IS NC

Numerical Control is formally defined as "the direct control of a mechanism from prerecorded information in symbolic form." In simple language, NC is the control of a machine tool such as a drill, lathe, milling machine, punch press, etc. by an electronic controller instead of an operator. The electronic controller interprets digital instructions fed to it on punched tape and causes the machine tool to perform the actions required to produce a part. Preparation of the punched control tape requires a large number of calculations and is generally referred to as part programming.

WHY YOU SHOULD BE INTERESTED IN NC

There were 12,000 NC tools installed by year end 1967, and 4,500 more to come in 1968. Market research indicates an average of 130 control tapes prepared per year for each machine. Considering the multiple computer tests required to produce a debugged NC tape, we are looking at a parts programming market in excess of FOUR million computer shots per year.

A large portion of the parts programming is presently done by hand . . . . very slowly and with many errors. The remaining portion is done by computer . . . . batch computer, with parts programmers waiting in batch queues like engineers were before time-sharing. This is indeed a market ideally suited to General Electric Time-Sharing Service.

To help you capitalize on this prime market opportunity, a series of new products is being developed. These products are specifically designed to help you get a large segment of the numerical control parts programming market. The products are being developed for the GE-265 and the Mark II Time-Sharing Service.

You will receive the Users Guide and a sales promotion sheet on the first of these products this month.

PURPOSE OF NC BULLETINS

This NC Bulletin (#1 of a long series) provides you with a general outline of our NC plans and will introduce you to some of the basic terminology you will need for selling these products. Future NC Bulletins will include:

A. NC fundamentals - general workflow - reference sources.

B. Description of the features, benefits, and targeted market segment for each NC product as it is released.

C. User success stories for reference selling.

D. Results of our contacts with machine tool builders, distributors, and national trade associations.

SEQUENCE OF EVENTS

(Check the new terminology list on the last page if you find unfamiliar words)

1. The Users Guide and sales promotion sheet you receive this month will explain a series of three NC programs for the GE-265. These programs will prepare control tapes for two-dimensional, point-to-point NC tools. These programs have had excellent customer acceptance for the NC jobs which are normally manually programmed.

2. Later in the first quarter a more sophisticated program for point-to-point work will be released. Input to this GE-265 program will be a point coordinate file generated by the NCPTS program (part of the January release) and English-like statements of the actions the NC machine tool is to perform. Output is an EIA coded control tape which includes auxiliary tool commands. The program is flexible enough to permit the user to enter his own tool specification file into the post processor.

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3. The next product is the big one — the REMAPT parts programming language. This is an expanded, conversational version of the ADAPT language. Manufacturing Services has estimated that the REMAPT language can be used to prepare control tapes for 90% of the installed NC tools. REMAPT is for Mark II Service.

   Initially, REMAPT will include the GELATH generalized postprocessor for lathes. Postprocessors for milling machines and point-to-point tools will be added later in the summer. REMAPT will output a clean EIA tape which will run on an NC tool without modification.

4. One high point of our NC promotion will be the presentation of a paper on the REMAPT language to the Fifth Annual Meeting and Technical Conference of the Numerical Control Society in Philadelphia on April 4, 1968. As specific promotion plans are firmed up for each new product they will be communicated to you through the appropriate NC Bulletins.

WHAT NOW

This is the time to begin.
As you can see from this bulletin, there is a new set of "jargon" or "buzz words" for you to learn. The attached list of NC terminology will get you started speaking the NC language. The next NC bulletin will describe the general workflow in an NC shop and list some good references where you can gain a greater understanding of the NC business, and thus converse knowledgeably with your prospects.

Now is the time for you to establish contact with the Numerical Control Society chapter in your area. Learn which companies are members of the society. They represent first-class prospects for time-sharing service in 1968.

Prepare now — get in on the ground floor — The marriage of Time-sharing and Numerical Control will be big news in 1968.

Your contact at Headquarters, Marketing is Len Hendricks. Dial Comm 8*273-4473.

NUMERICAL CONTROL TERMINOLOGY

Numerical Control
Control of a machine tool such as a drill, lathe, milling machine or punch press by an electronic controller instead of an operator. Input to the electronic controller is usually punched tape which may be prepared manually or by a computer.

Control Tape
The punched tape containing the numerically coded instructions which will be interpreted by the controller and cause the NC tool to perform the actions required to produce a part.

Part Programming
The process of writing the symbolic instructions which describe the geometry and the sequential machine steps required to produce a part.

Point to Point
This describes one category of NC tools. These tools are two dimensional and normally move a workpiece in either of two directions, perform some operation, then repeat the cycle. Normally, there is no cutting while the workpiece is in motion. Drills are an example of point to point NC tools.

Contouring
The ability of a NC machine tool to move on two or more axes simultaneously. Cutting may be performed while the workpiece is in motion. Lathes and milling machine are examples of contouring machine tools.

Two Axis
Three Axis
Describe the number of axes along which the machine tool is capable of numerically controlled motion. Two axis tools usually move the workpiece side to side (the X axis) and forward and backward (the Y axis). Three axis tools include the ability to control up and down (the Z axis) motion.

Multi-axis
This term is commonly used when referring to large machine tools having 4 or 5 axes of motion. In addition to the normal X, Y and Z motions, these tools have a rotating table and can adjust the cutting head to different angles.

APT
A sophisticated computer program which accepts English-like statements defining workpiece geometry and machining operations; calculates required cutter locations and punches a NC tool control tape. These input statements are known as a parts program. APT is available only on large scale computers and handles the complete spectrum of machine tools.

ADAPT
A subset of APT for use on medium scale computers. It has complete two axis capability, limited three axis capability, and covers the majority of NC machine tools in use today. It is upward compatible with APT.

CL File or Point Coordinate File
Cutter location file. This is the output of the calculation phase of APT or ADAPT. It defines series of points which represent the location of the cutter at all times during the machining operation.

Postprocessor
A section of APT or ADAPT which converts the cutter location file into the specific commands required by a particular NC machine tool.

Generalized Postprocessor
A postprocessor designed to handle a broad class of related machine tools. In order to provide for differences between machine tools in a given class, it is necessary only to provide the generalized postprocessor with the parameters unique to the NC tool involved.

GECENT
A generalized postprocessor developed by General Electric for use with the APT language.

GELATH
A generalized postprocessor developed by General Electric for use with ADAPT. It covers a wide variety of lathes. & AND REMAPT

GEMILL - A GE MILLING-MACHINE P. PROC. FOR USE WITH REMAPT - ADAPT

GPOINT
A generalized postprocessor developed by General Electric for use with ADAPT. It covers a wide variety of drills.

GEPOINT SAME AS ABOVE, BUT FOR REMAPT.

EIA Code
Electronic Industries Association. This is the standard punched tape code recognized by most machine tool controllers.

IITRI
Illinois Institute of Technology Research Institute. This is the group responsible for maintenance and further development of APT.

Mark Century
The trade mark used by General Electric Specialty Control Department for a series of machine tool controls.

SALES BULLETIN NO. 42 NC-2

Information Systems

Time-Sharing Service

1968....
THE YEAR OF NUMERICAL CONTROL

DYNAMIC DUO

Numerical Control is frequently referred to as the one overwhelming metalworking development of this century. Now, that capability can be stretched even farther... by linking it with Time-Sharing. NC and Time-Sharing Service make a great team for hitting the manufacturing market.

Our first NC sales bulletin merely broke the ice by announcing our strong sales thrust planned for this big market in 1968. This bulletin (#2 in the series) explains the fundamentals of the NC process. As new NC programs are released, additional bulletins will discuss each of them specifically.

NC IS A HOT MARKET

The growth of NC has been very rapid. The number of NC tools installed is doubling every year, as the table below shows.

YEAR	TOTAL NC TOOLS INSTALLED
1960	629
1962	1,891
1964	4,236
1966	8,762
1968	16,700*
1970	28,600*
1972	47,000*

* Figures based upon forcast of shipments from the National Machine Tool Builders Association

To help you get up to speed in this key market area, read the article "Crank the Handwheel Eight Times." This is partially a pickup from American Machinist. It focuses clearly upon the general idea of NC. The second article called "Elements of the NC Process," is a more detailed discussion of NC. It will give you a good understanding of the NC process, the sequence of events, the work of the parts programmer, and the like. A list of references is included.

CRANK THE HANDWHEEL EIGHT TURNS

"Crank the handwheel eight turns, and thump the carriage once to make sure."

When a man does it, that's manual control. When a circuit triggers the action, that's numerical control.

That's how simple the NC concept really is.

In one instance, a man carries the numerical data in his head, and counts the turns as he transfers the data to the machine by hand.

In the other, the very same information is carried by holes in a tape. A controller does the counting, and the instructions are transmitted to the machine by a non-human agent.

Perhaps this is an oversimplification of NC, but it does make a valid point: There is nothing complicated about the idea of controlling metalcutting machines (and a great variety of other equipment) by feeding them numbers.

Numerical control is a method of automating machine tools while retaining the ability to switch to different jobs. It is accomplished by feeding a previously prepared tape, or other medium, with all commands in numerical form to a control system which directs the machine.

POINT TO POINT? CONTOURING?

Basically, there are two different degrees of control that can be handled numerically on machine tools: point-to-point and contouring.

In the simplest point-to-point control, as implied by its name, the tool and the workpiece are placed in the desired relationship, and then the tool is advanced. Drilling a pattern of holes would be a typical example: the NC table positions the work under the spindle, and then the drill is advanced. Tool advance might be under either manual or automatic control.

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The distinguishing feature of this type of control is that it is immaterial what route is taken to place tool and workpiece in the desired relationship. It might travel in a straight line, or it might zig and zag.

In contouring, on the other hand, the path of the tool must be controlled continuously, as in a profile milling job. This requires constant syncronization of the tool's motion in more than one spatial axis. Contouring is also referred to as continuous-path, while point-to-point is generally synonymous with positioning.

Note that the basic definitions of positioning and contouring apply whether the system operates in two dimensions or three. If you're just getting into numerical control, you've probably seen the terms "two-axis" and "three-axis" control. But you may not have encountered the term "multi-axis." This term is commonly used to refer to large machine tools having four or five axes of motion. In addition to the normal X, Y, and Z motions, these tools have a rotating table and can adjust the cutting head to different angles.

Other NC terminology that is commonly used is listed in the attachment to NC Bulletin Number 1. Make these "in words" a familiar part of your NC vocabulary before talking to your prospects.

FOR ADDITIONAL INFORMATION, HERE IS A LIST OF PUBLICATIONS OFFERING GREATER DETAIL ON NUMERICAL CONTROL.

NUMERICALLY CONTROLLED MACHINE TOOLS, *GE Computer Equipment Dept., No. CPB 343 A*

GE 400 SERIES ADAPT PART PROGRAMMING, *GE Computer Equipment Dept., No. CPB 1155*

PRINCIPLES OF NUMERICAL CONTROL, *James Childs – Industrial Press*

APT PART PROGRAMMING, *McGraw Hill Book Co.*

THE LANGUAGES OF TAPE, *Special Report No. 545 from American Machinist Magazine (The article originally appeared in the January 6, 1964, issue.)*

APT – ADAPT, *Special Report No. 554 from American Machinist Magazine (The article originally appeared in the June 22, 1964, issue.)*

NC TODAY, *Special Report No. 579 from American Machinist Magazine (The article originally appeared in the November 22, 1965, issue.)*