

Pratt & Whitney®

**TAPE-O-MATIC®
NUMERICAL CONTROL SYSTEM**

MACHINE TOOLS / CUTTING TOOLS & GAGES / MEASURING SYSTEMS



bulletin A83

Introduction

Any manufacturing process can be divided into two basic operations: doing the work and moving the piece from station to station. Although numerical control cannot do the actual work any quicker than more conventional methods, it can move the workpiece from point-to-point with greater speed, dependability, and accuracy; thereby accomplishing the total task faster than ever before.

Unlike a general purpose computer system which has the ability to handle a large variety of diversified problems, Pratt & Whitney's TAPE-O-MATIC® Numerical Control System performs only a single function or a given group of functions. Because of its specialized nature and relatively simple principle of operation, this system can now bring into your manufacturing operation a degree of speed and accuracy which has until recently been common only to sophisticated computers and other electronic devices which carry out the numerous office functions fundamental in today's business. P&W's system is priced to make installation practical for even a small one-man operation.

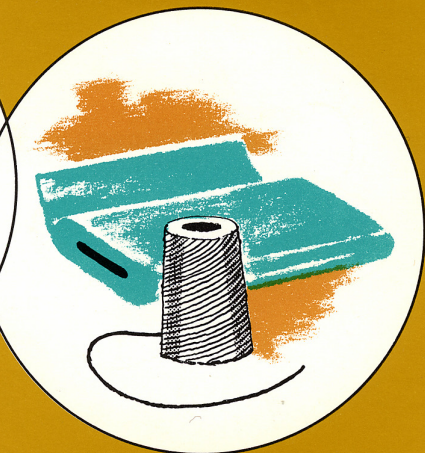
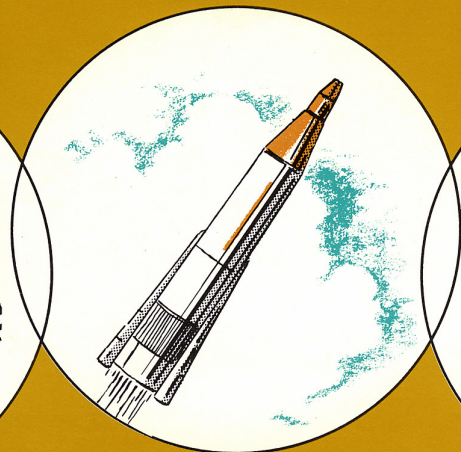
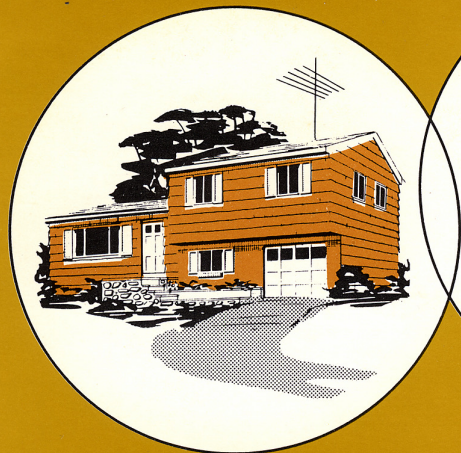
Numerical control, often referred to as N/C, is without question the most dynamic manufacturing technique to come into existence during this century. Its eventual impact may well be beyond the present concept of its usefulness and limited only by man's ability to discover new applications.

Today, numerical controls are being employed in a variety of applications. The ability to position any tool, machine, mechanism, instrument, or device in a precise relationship to the workpiece has given numerical control systems command over virtually any manufacturing step—be it driving a nail, sewing a button, drilling a hole, soldering a connection, or finding a piece of stored equipment on a warehouse shelf. Now, this flexibility is becoming increasingly more important since production lines carry a large assortment of shapes and sizes. Manufacturing companies in increasing numbers are finding themselves forced to pay a penalty in profits for retaining inflexible methods which were excellent only ten years ago. Although numerical control was developed in the metalworking field, its performance, efficiency, and versatility soon attracted the attention of other industries. Even the skeptics were quick to discover that contrary to some thinking, N/C is not difficult to use.

Introduction of the TAPE-O-MATIC Numerically Controlled Drilling Machine by Pratt & Whitney represented a major breakthrough for industry because it was the first practical tape machine to be priced within reach of those who could use it most. Four out of five machines have gone to smaller sized plants as first applications. Pratt & Whitney, as a designer and builder of automatic controls and fine machine tools, is in a unique position to bring a better understanding of the problems involved in successfully mating machine and controls. Experience assures you of dependability, performance, and long life from P&W's TAPE-O-MATIC Numerical Control Systems.



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N/C Applications

WOODWORKING

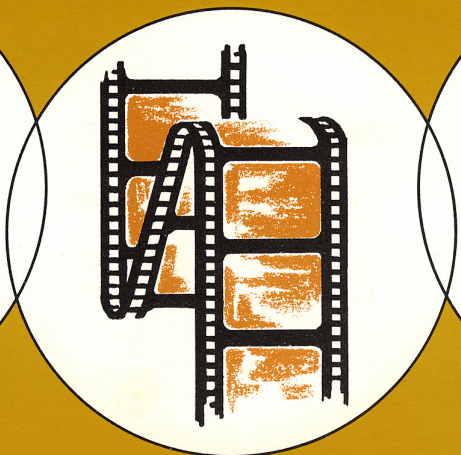
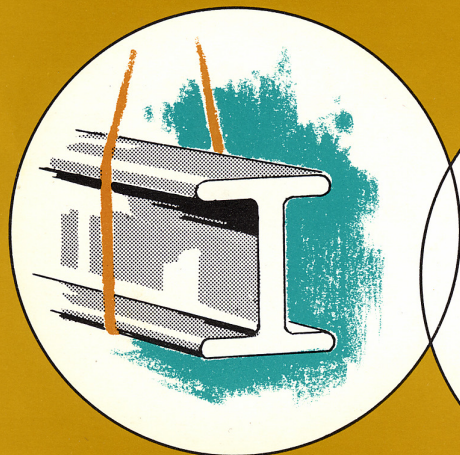
Many of the woodworking requirements for building a house, yacht, bookcase or door frame can be automatically handled by a TAPE-O-MATIC Numerical Control System. It can bring the advantages of speed and flexibility to a furniture factory, cabinet shop, or board mill by automatically performing many sawing, turning, drilling, routing, gluing, and assembly operations.

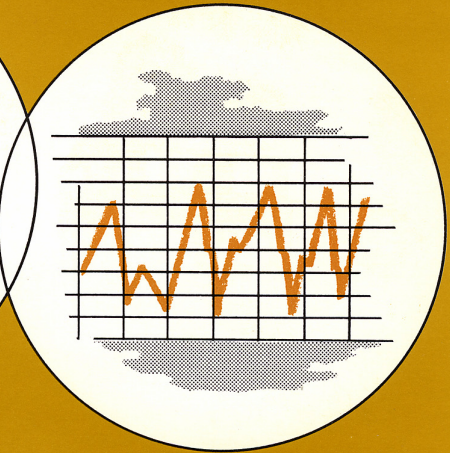
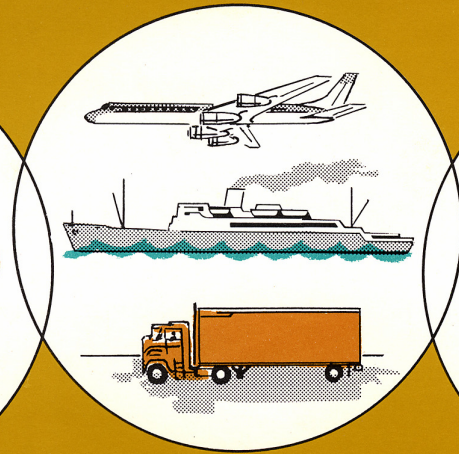
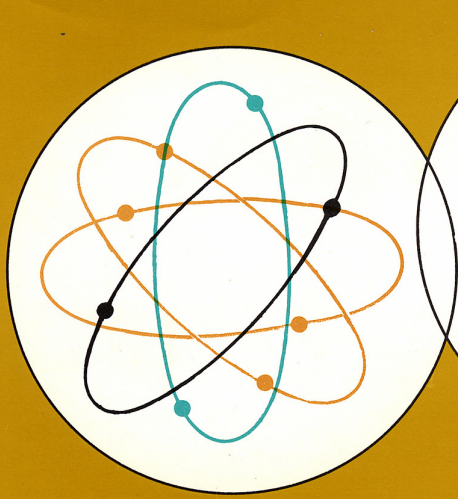
METALWORKING

The TAPE-O-MATIC Numerical Control System was first designed for boring and drilling operations in the metalworking field. In recent years it has been applied in many fastening and forming operations, especially where the quantity of parts being produced is small, pieces complex, design changes frequent, inspection critical, or lead time is short. Under any one of these circumstances, numerical control is the most economic answer to production problems.

ELECTRONICS

Hand operations involving the connection, routing, and termination of wires — in this age of multi-level spaghetti-like circuitry — have all but become prohibitive. Numerical control is well suited to locate, route, and connect wires from point-to-point. Other operations





include inserting components and checking continuity. Higher output, greater accuracy, and lower operating costs are yours with the introduction of N/C to meet your assembly and inspection needs.

MATERIAL HANDLING

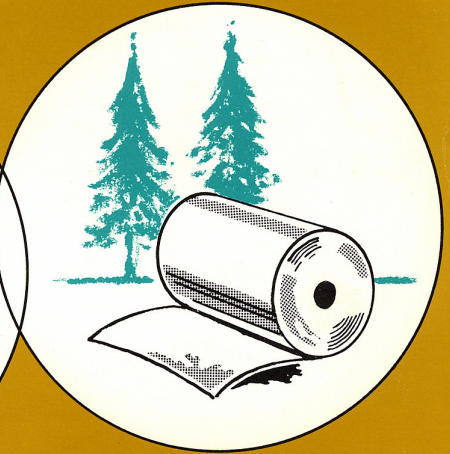
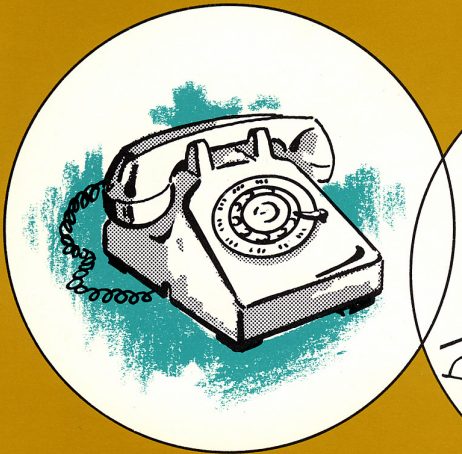
The point-to-point precision of numerical control can also be adapted to a wide variety of warehousing and shipping operations. Storing and retrieving packages, parts, and pieces can be done with surprising speed and accuracy. A typical dry cleaning establishment, for example, would have to account for about 2,500 customer orders. A TAPE-O-MATIC Numerical Control system can do this. In fact, it could be relied upon to account for more than 2.5 billion different customer orders and locate any garment in a matter of seconds. N/C can also be adapted to do many stapling, wrapping, and packaging operations.

TEXTILES

Automation is an economic essence to the textile industry. Since the early 1700's, when the card-controlled knitting machine was invented, better and faster means of working cloth have been sought. Now, point-to-point numerical control systems are able to automatically perform a great number of different sewing, stitching, punching, weaving, cutting, and inserting operations with speed and precision, yet, still retain flexibility.

GRAPHIC ARTS

Architects, draftsmen, artists, photographers, and other artistically and technically oriented people can also benefit from numerical control. The TAPE-O-MATIC Numerical Control System can be set to operate a camera, projector, pen, or pencil to position, photograph, and draw according to plan.



Simplified Operation

A blueprint, pattern, layout, or dimensional description of the piece to be worked is first studied to determine the work to be performed and the sequence to be followed. With a Numerical Control System, all work is done in relationship to a starting point. On a P&W TAPE-O-MATIC Numerical Control System this starting point, or setup as it is called, is free floating. This means you can use any position on or near the workpiece as the reference point. After studying the job, a specially designed processing sheet is filled in with the necessary information. This way management gains a more direct control over the time and material expended on each job. The processing sheet, which can be filled-in by engineering personnel or a shop foreman, ensures the most expedient execution of each function. Important figuring and calculations are done in accommodating surroundings and not at a shop bench in the midst of production noises.

Using a special tape punching machine or an office flexowriter, one of your secretaries (or a man in the shop) takes the information from the processing sheet and transfers it to the tape. This step is no more complicated than using a typewriter or adding machine. The strip of eight-track punched paper tape containing the numerical instructions is run through the machine a second time to verify accuracy and eliminate errors. The tape is then taken into the plant to start producing.

When ready to begin work, the machine operator places the tape in the reader, positions the workpiece, pushes the "zero" button on the control panel to bring the work in step with the punched tape instructions, and minutes later is producing error-free pieces. Electronic controls translate the dimensional data from the tape into precise commands which govern the movement of the workpiece within thousands of an inch. Even after a job has been started, revisions and modifications can be made by merely punching a new tape and inserting the desired corrections. Numerical control offers consistency from workpiece to workpiece, yet still retains the all-important quality of flexibility.



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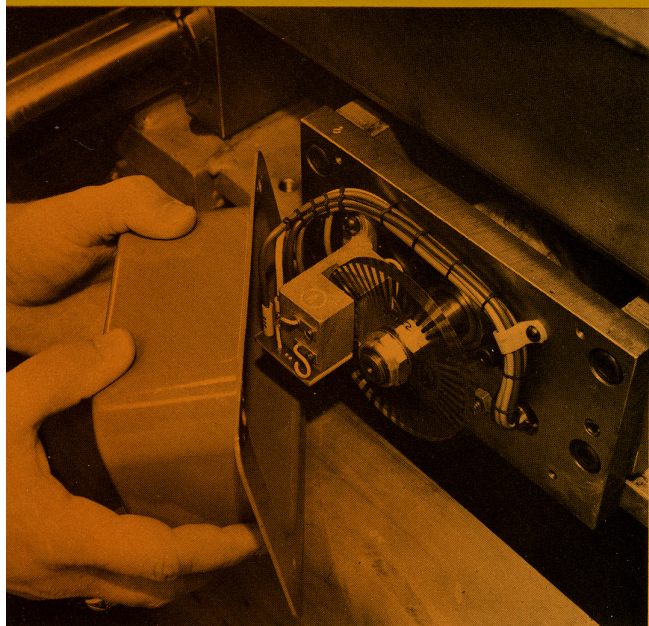
N/C Advantages

EFFICIENCY

With N/C, design and lead time is reduced because there is no need for elaborate blueprints or detailed drawings — all the control system needs to know is what you want done, where, and how many times. A greater number of operations can be carried out with a single setup. Automatic positioning also eliminates human error and reduces scrap.

ECONOMY

Expensive templates, jigs, and fixtures can be replaced by simple, standard work-holding devices. Higher outputs per-machine per-hour also create additional space for profit-making activities. Toolroom costs go down too. What could be done with the space you now use for setup jigs and fixtures?



Tape-O-Matic Features

CLOSED LOOP DIGITAL SYSTEM

P&W's quantizer feedback system works on a simple principle which always ensures positive positioning. A revolving plastic disc with alternate opaque and transparent segments is mechanically synchronized with the movement of the workpiece. As the disc rotates, the dark segments interrupt a beam of light thereby generating digital impulses of current which are fed back to the control system and compared to the punched tape instructions. When the number of feedback pulses equal the numerical input, the machine is at the "set point" — movement stops. The piece is ready to be worked.

FULLY TRANSISTORIZED CONTROL SYSTEM

In the TAPE-O-MATIC Numerical Control System there are no relays or stepping switches to worry about. The use of NOR universal printed circuits lends uniformity and reliability to the system and simplifies maintenance and repair. Control accuracy is unaffected by line voltage fluctuations or frequency variations. Time-tested, solid-state modular construction makes Pratt & Whitney numerical controls resistant to many conditions which would ordinarily impair performance and dependability. The entire system will operate in temperatures up to 120°F without special cooling apparatus.

MAXIMUM SETUP FLEXIBILITY

Full floating zero with an independent set up point is an exclusive standard feature on all TAPE-O-MATIC Numerical Control Systems. In the electronic component insertion situation, shown here, this means you can choose any point for setup that you wish. You're never compelled to work a job any other way than the most efficient. Accuracy of work is often further enhanced by using several different reference locations on the same part during a single setup. Full floating setup reference points enable you to establish the starting point anywhere within the working capability of the machine.

FLEXIBILITY

Engineering changes, design modifications, improvements and alterations in the manufacturing process are easily made when you use numerically controlled equipment—just punch a new tape. There is no time loss. Optimum production runs become easily arranged. Experimental and one-time piecework is oftentimes easier and quicker on N/C equipped machines.

SIMPLICITY

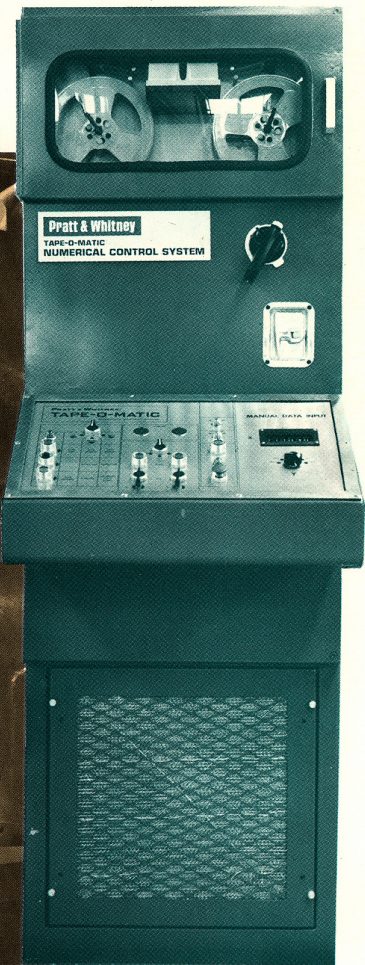
Once punched and tested, the tape takes the worry out of working. The most complex instructions are quickly and accurately carried out.

CONSISTENCY

Parts and pieces are no longer similar; they are identical. To a numerical control system, it matters not whether the shift has just started or is almost at an end. Performance is unaffected by the fact that the machine may be performing the 1st or the 49th in a fifty-step operation. Each movement is always executed with the highest degree of self confidence and in the same time, with the same accuracy.

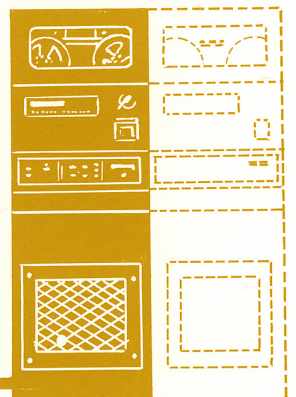
DEPENDABILITY

Solid state electronics and a comparatively simple principle of operation using a high volume of "like" components assures long hours of profitable operation from your TAPE-O-MATIC Numerical Control System.



Specifications

YOUR
EQUIPMENT



Mode of Operation:

- (a) Point-to-Point Positioning
Shortest distance between points by predetermined cycle
- (b) Parallel to any axis
Continuous movement, 1 axis at a time

Controlled Axes:

1 or more. Any combination of rotary or linear motions

Input Tape:

Standard EIA, 1 inch, 8 track, BCD, plus or minus absolute coordinates

Tab Sequential or Word Address Format

Resolution:

.0001" or .0002"
.001" or .002" } or metric equivalent
.01" or .02"

others available

Programmable Capacity:

± 32,767
± 65,535
± 131,071 } counts of resolution
± 262,143
± 524,287

others available

e.g., with a resolution of .001" and a programmable capacity of ±65,535—travels of plus or minus 65.535 inches from chosen zero reference are possible.

Counting Rate:

5,000 counts of resolution per second
10,000 counts per second optional
others available

Tape Reader:

Mechanical, fully reversible, 60 characters per second, integral tape spooling, mounted in control cabinet.

Set-Up:

Full floating (anywhere within capacity of control system). Set-up may be performed and programmed at any coordinate, including zero.

Feedback:

200 count per revolution digital photoelectric quantizer. 400 count optional

Control Cabinet:

Width x depth x height — 22x41x68 Cabinet floor space with doors open — 61"x65"

Control Station:

Available as loose plate for mounting on existing equipment, separate pedestal connected to control cabinet or integral with control cabinet

Weight:

750 lbs

Power Input Requirements:

230/460 3 phase, 60 cycle; other voltages and frequencies optional

Temperature:

Maximum ambient 120°F at 60 cps

Outputs:

Can be provided for any type of drive system, electric, hydraulic, etc

Drives:

Stepping motor approach and 3 phase reversible induction motor rapid traverse
Stepping motors: 25 to 1,000 in oz. torque
Induction motors: ¼ H.P. and up
P&W Solid State controlled variable speed D. C. motors from ⅓ H.P. and up. Tachometer feedback giving 500 to 1 speed range, reversible with controllable acceleration. 1/10% regulation of motor speed

Positioning Tables:

Standard travels 15 x 20 or 26 x 40
See Tape-O-Matic Bulletin

Options:

Miscellaneous and Preparatory function outputs.
Special automatic cycles
Feed, Speed and Tool Coding outputs
Manual Data Input
3 or 4 digit sequence numbers.
Slide position displays.
Axis sign inversion
Tumble Box for tape handling
Spare parts maintenance kit

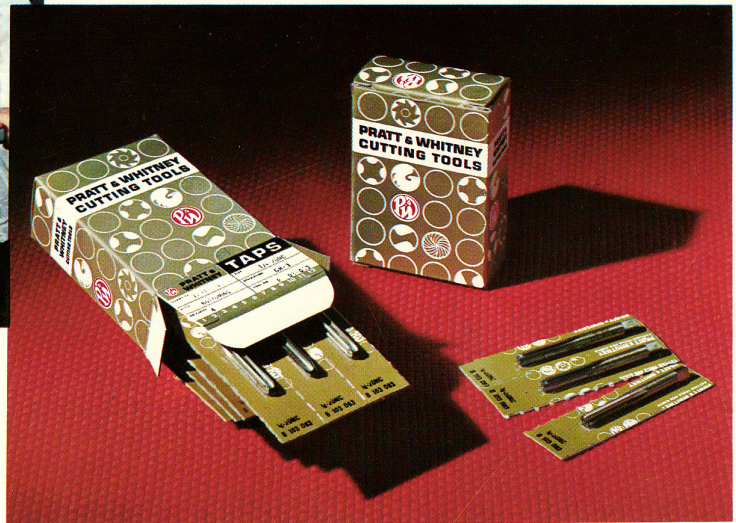
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**PRATT & WHITNEY
PRECISION MACHINE TOOLS**

The tools for Space Age machining.

Jig Borers (Manual, Numeric, and the new PW 1000), Kellers (Tracer and Numeric), Potter & Johnston Automatic Turret Lathes (including the new PJ200, and the PJ400 and PJ600), Tape-O-Matic® Drills (Models A, B and C), N/C Systems, Rotary Tables (Manual and Numeric), Diaform and Sigourney Drills.



**PRATT & WHITNEY
CUTTING TOOLS AND CONVENTIONAL GAGES**

Recognized the world over for superior quality and dependability.

All P&W Cutting Tools and Conventional Gages are available through selected Industrial Distributors in your area. Cutting Tools include: Taps & Dies, End Mills, Milling Cutters, Reamers, Burs, Drills and Solid Carbide Tools. Conventional Gages include: Gage Blocks, Thread Gages, Cylindrical Gages, R. R. Gages, Pipe Gages and Oil Country Gages.



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Gages to meet every gaging and measurement problem.

Basic Measuring Equipment, Standard Comparators, Continuous Gages, "Exotic Measuring Machines", Design and Build Fixtures, Continuing Gages.



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