

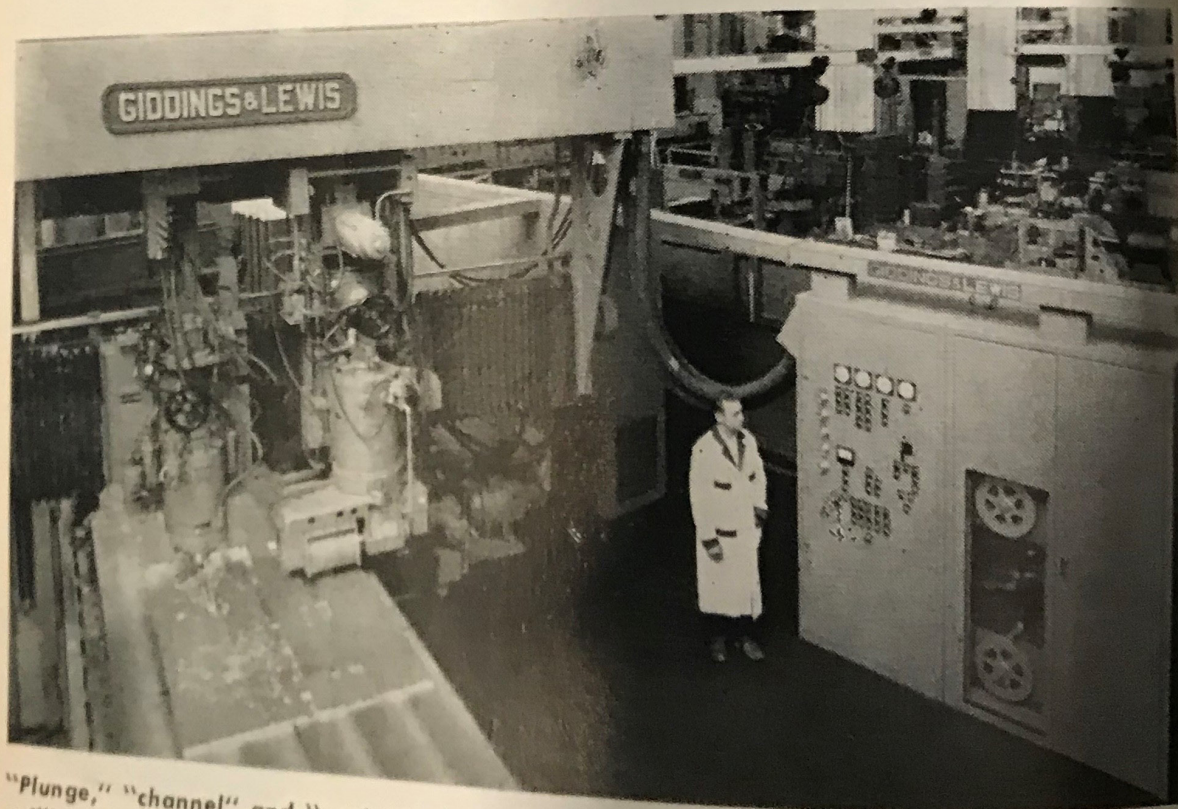
Tape-Automated Machining

This article describes the new Giddings & Lewis Numericord system which automates machine tools for production of precision parts from numerical data.

Milling intricately-contoured, low-tolerance workpieces on multi-axis machines completely controlled by magnetic tape—on which entire work cycles have been programmed solely from numerical data—was proved a present-day production reality by the Giddings & Lew-

is Machine Tool Company in a recent demonstration of its revolutionary Numericord control system operating a skin milling machine at the company's Fond du Lac, Wisconsin, plants.

With this system, machining cycles involving as many as five



"Plunge," "channel" and "pocket" milling cuts are performed by means of this spar and skin milling machine under complete control of a numerically-prepared magnetic program tape.

machine axes and 22 auxiliary machine functions are completely planned and engineered by mathematical computation. Pre-calculated data, in normal decimal numerical form, are processed by the system's exclusive "electronic brain" computing director into continuous phase-modulated command signals, automatically recorded on magnetic tape. This "magnetic memory" tape is electronically read in the machine control unit to operate minute-current-response, wide range amplidyne servo mechanisms which perform all feed and traverse functions automatically—repeating tirelessly and accurately the entire machining program for producing identical parts in any quantity, to tolerances limited only by the machine tool — ordinarily ranging plus or minus 0.001 inch to 0.002 inch.

While applicable to virtually any machine tool, the new Numericord system was demonstrated at Giddings & Lewis in control of one of the company's aircraft-type spar and skin milling machines performing all "plunge," "channel," "pocket" and contouring cuts necessary to mill complete jet plane skin and wing panels from solid 75 ST aluminum plate.

One of the outstanding advantages of the system is its ability to "store" skills. Master tapes covering all parts of prototype planes or other military items can be stored in safe locations waiting an emergency order for all-out production. Even more important, such vital production can be transferred from one plant to another, in a matter of hours, by this method of "storing" skills on magnetic tape.

A novel, yet nonetheless practical, advantage of this system is the ease with which audio signals can be included in the magnetic tape. These can be used to alert the machine attendant to up-coming tool changes and "planned stop" machine inspection periods.

The new system provides another unique advantage in its complete physical separation of numerical-tape-preparation and machine-control components. Thus, tapes can be prepared on a continuous production basis for all machines and jobs in the shop. Files of magnetic tapes can be maintained ready for changing any machine's production from one part to another without loss of time. Even part design modifications can be processed on tape ready for later production change-over.

Four major components make up

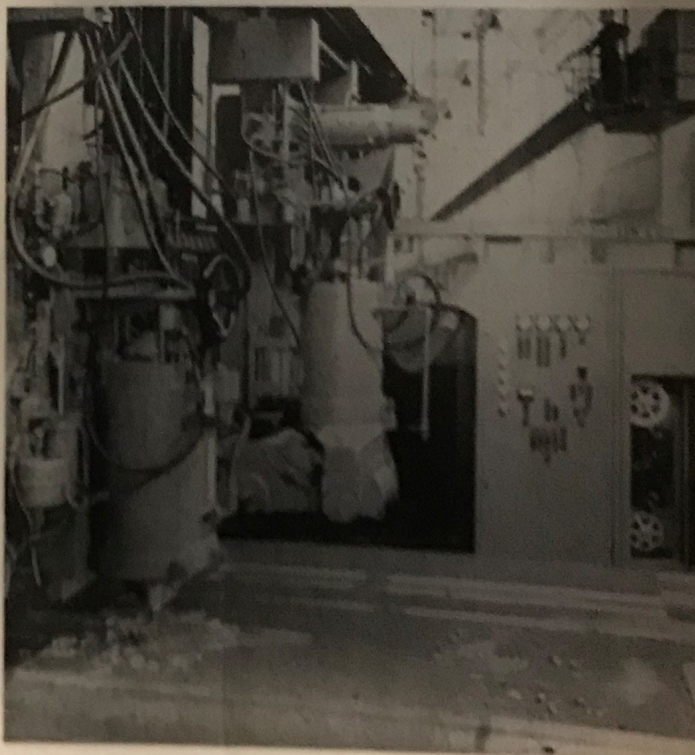


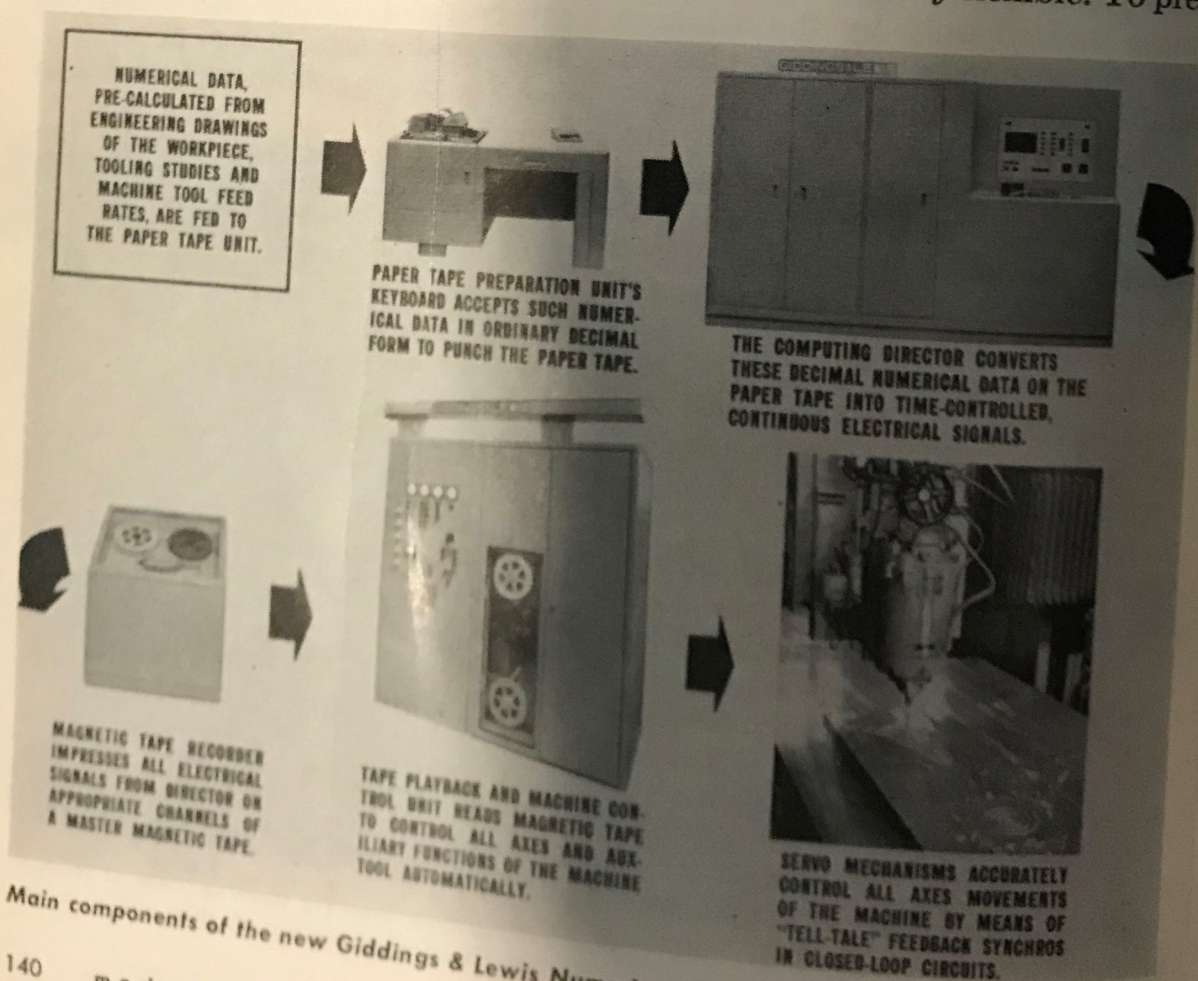
Illustration showing close-up view of Numeri-cord-controlled spar and skin miller in use.

"... the Numericord system is simple, practically foolproof and extremely flexible."

the Numericord system: (1) a paper tape preparation unit, which punches a master numerical tape with previously-calculated decimal information from part drawings, tooling data and machine feed rates; (2) an electronic computing director, which converts digital information on the paper tape into phase-modulated, time-coordinated command signals recorded on proper parallel channels of a magnetic tape; (3) electronic play-back circuitry, which reads commands off the magnetic tape and sends appropriate

electrical control signals to the machine; (4) electro-mechanical, machine-control units which operate in closed-loop-feedback, phase-shift, synchro-servo systems to position machine axes in accordance with taped command signals. Machine auxiliary functions and non-feed controls are operated automatically through relay circuits from simultaneous command impulses on other parallel tape channels.

Operation of the Numericord system is simple, practically foolproof and extremely flexible. To pre-



Main components of the new Giddings & Lewis Numericord System of Machine Tool Automation.

"'Stop' codes . . . provide intervals for tool examination . . ."

pare a master paper tape, the operator merely enters previously-calculated decimal increments of desired machine axes motions and time intervals on the paper tape unit's keyboard. No conversion into usual bi-

nary code form is necessary as the unit accepts ordinary decimal digital information. Special commands are entered on the tape in the same fashion by using six auxiliary symbols supplied. Checking circuits in the unit operate automatically to determine such command errors as exceeding feed rates or time intervals chosen, missing "plus" or "minus" signs, wrong number of digits in any

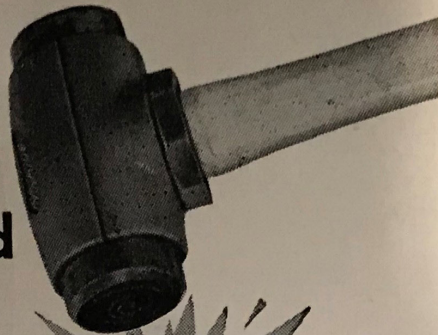
command and improper least significant digit. Other supervisory circuits examine all data fed into the unit, perforating additional holes in the paper tape for logical control of the system's electronic director unit.

"Stop" codes placed in the paper tape sequence provide intervals for tool examination and replacement as well as for checking settings of machine verniers. Thus, interruption of a machining program by tool breakage merely requires return to the first previous "stop" signal, retooling and restarting of the machine-

**LESS
REBOUND**
per pound

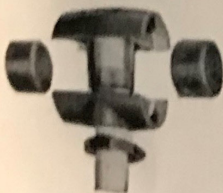
thanks to

"Contact Control"



C/R Jawhead
the best "soft" hammer you can buy!

Special processing controls the rebound for longer striking contact. This means more work with fewer blows, less fatigue. Faces won't mar surfaces, slip, chip, fly off or change with extreme temperatures or use. Cost less, too, and last longer — are safer for work and worker.



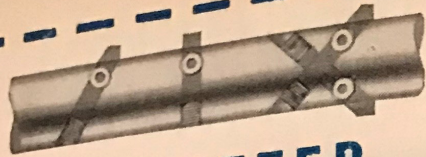
CHANGE FACES IN SECONDS —
Threaded collar locks them in.

• Available from your local industrial supplier.

CHICAGO Rawhide MFG. CO.
1301 Elston Ave., Chicago 22, Ill.
In Canada: Super Oil Seal Mfg. Co., Ltd.,
Hamilton, Ontario

For more data circle 359 on Reader Service Card

142 modern machine shop



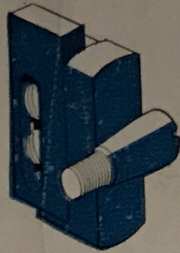
A BETTER BORING BAR

because our method of broaching square holes makes a better fit for the tool bit. This means more rigidity and longer life, especially with tungsten carbide.

Square hole sizes range from $\frac{1}{8}$ " up to and including $\frac{3}{4}$ ".

TYPE "B" & "C" CUTTERS

A strong rigid serrated 2-bladed cutter-located in the bar with a taper pin. Bores holes accurately to close limits. Can be expanded and reground giving long life. Sizes $\frac{7}{8}$ " dia. up to 6".



A simple 2-bladed reaming cutter. Can be expanded and reground. Located in the bar by a hardened V. This V never has to be reground as blades are expanded. Fits other bars with slots

$\frac{3}{8}$ " x $\frac{7}{8}$ "	$\frac{3}{8}$ " x $1\frac{1}{8}$ "
$\frac{1}{2}$ " x 1"	$\frac{3}{8}$ " x $1\frac{1}{2}$ "

THE DETROIT BORING BAR CO.

688 E. FORT ST.

DETROIT 26, MICH.

Established



1927

For more data circle 361 on Reader Service Card

144 modern machine shop

"... director reads punched paper, line for line ..."

control unit. Automatic operation resumes at that stop and continues to the end of the program, unless similarly interrupted.

It is the electronic computing "director" which processes decimal digital information, contained on the paper tape, into the phase-modulated continuous electrical signals for recording on magnetic tape. In operation, the director reads the punched paper tape, line for line, storing information thus serially presented in special magnetic-core memory units until later commands from the director release them to secondary memory units or directly to data-coordinating circuits for final impressing on the magnetic tape, as the program may require.

While the director is processing one group of commands, following groups are being read into it to assure continuous motion of the machine upon playback of the finished magnetic tape. Visual indicators on the director's control panel provide one fine and five coarse data repeaters, which algebraically sum distance commands for each machine axis during a program. The fine indicator can be connected into each of the coarse circuits by push button.

Control of each machine axis is accomplished, in the Giddings & Lewis system of automation, by independent, closed-loop-feedback servo circuits. A movement of but 0.100 inch in a machine axis produces one complete revolution of its "tell-tale" synchro rotor.

August, 1954