NC SCENE

October 1973

The NCS Journal of Numerical Control

NC SCENE

October 1973

CONTENTS

DIRECTORY

Cover design and illustration by George Lallas.

Official Publication of the Numerical Control Society

TECHNICAL ADVISORY BOARD
Stephen C. Clark, Chairman

NCS BOARD OF DIRECTORS
Edward E. Miller, president; O. Jack Anderson, administrative vice president; Arthur H. Rice, technical vice president; Michael D. Sestric, Jr., secretary; Stokes F. Burtis, treasurer; Leon B. Musser, George Putnam, Howard S. Abbott, directors; and Richard A. Thomas, past president

EXECUTIVE DIRECTOR
William H. White

EDITOR AND PUBLISHER
Mary A. De Vries

CONTRIBUTING EDITORS
James J. Childs
William M. Rynack

CHAPTER REPORTER
Carl Natoni

ART DIRECTOR
George Lallas

NCS Headquarters Office:
P.O. Box 138
Spring Lake, New Jersey 07762
201-449-1400

Editorial and Advertising Office:
P. O. Box 26
Concord, New Hampshire 03301
603-225-2631

The NC SCENE is published monthly by the NUMERICAL CONTROL SOCIETY. Art direction and editorial production by EDITORIAL SERVICES. Printed by THE VILLAGE PRESS. Statements of facts and opinions are those of the authors alone and do not necessarily reflect the views of the NCS executive staff, officers and directors, or membership.

Subscription rates for non-members are $12 a year U.S. and Canada and $15 a year overseas seamail. Overseas airmail is $10 additional.

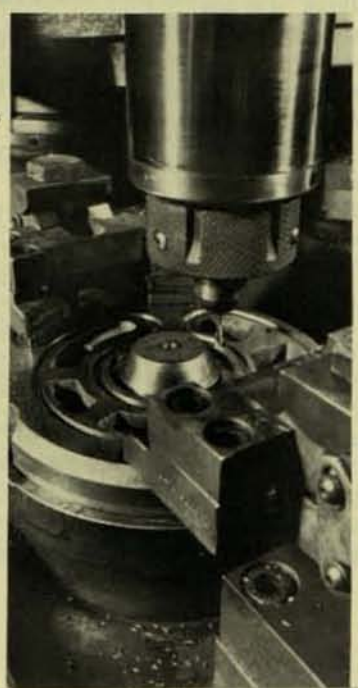
Tom Spenner, Manufacturing Engineer who developed this concept, discusses the operation with Jim Andersen, N/C operator.

Bridgeport® N/C cuts part cost by 41%

Rexnord Mfg. Corporation's Racine Hydraulic Division got this terrific savings when they switched to Bridgeport Series II N/C millers to produce hydraulic pump port plates. Previously produced on a manual machine, this part required 3 separate cuts. Scrap rate ran 25-30%.

Here's how the Bridgeport Series II N/C miller saves $11,316 a year for this one part:

- Reduces cycle time from 7½ to only 2 minutes.
- Produces 2 parts simultaneously using T-ram with two 2J milling heads, plus 4-position hydraulic fixture.



- Maintains tighter tolerances at precisely repeatable uniform feed rates.
- Negligible scrap loss.
- Reduces tool breakage; permits use of less expensive cobalt tools.
- Provides management control of production processes.

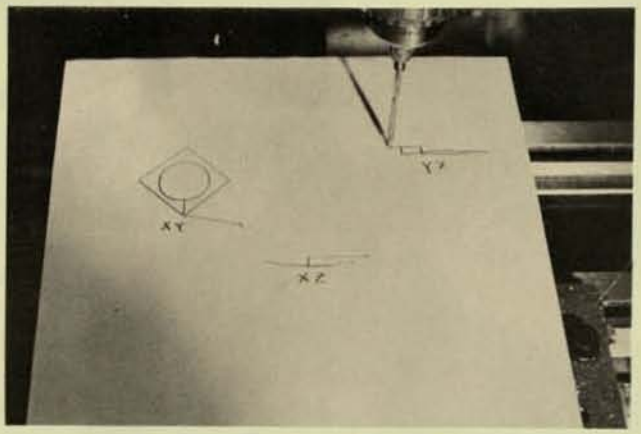
For details about our N/C millers, see your Bridgeport dealer. Or write for our N/C catalogs. Bridgeport Machines, Bridgeport, Connecticut 06606. a textron company

Better Buy Bridgeport®

NC PANORAMA

CHECK THAT TAPE

JAMES J. CHILDS
Contributing Editor



Courtesy of American Edelstaal, Inc.

Plots are shown for the XY, XZ, and YZ planes. In this instance, movements in the XZ and YZ planes can be simulated via switches on the control console.

If a parts program passes through the computer without any diagnostics, and a tape is prepared, chances are that the program is correct and that the tape will produce a true and accurate part. Right? WRONG! The odds are about two or three to one that the tape is *not* correct; the exact odds will depend on the complexity of the part. For the very simple parts, there is a good chance of obtaining a correct tape the first time; however, for a part with any sort of complexity, chances are that corrections to the original parts program will be required. Even where a parts program does pass, there are usually modifications that can be made to optimize the cutting cycle.

How then does a parts programmer go about determining whether a parts program and the resulting tape are correct? The most direct and obvious way is to fix a piece of metal to a work table or into a chuck, and apply cutting tools to it. In the final analysis, this is the only true test. It is also the most expensive way to check out a parts program, both in material and equipment utilization. An alternative, which is considerably less costly, is to try and *approach* the machine tool with as accurate a tape as possible. The tape may not be one hundred per cent correct; however, if a good share of the errors can be corrected before running the tape on the machine tool, considerable savings will result. A machine tool, which may be valued at several hundred thousand dollars, is simply a horribly expensive means of checking out a tape, even if no material is used and the machine is cutting in the air.

The most common route to off-site tape verification is to *plot* the path of the center of the cutting tool. There are a number of plotters on the market that can handle this requirement. Oscilloscopes, in conjunction with suitable computer software, can offer up a display of the cutter path. And even remote typewriter terminals can be programmed to display a pattern of "x's" that resemble the path of the cutting tool. Although not very accurate, this type of assist can go a long way towards eliminating a portion of the errors.

One simple means of checking a program is shown in the illustration below. All that is required, in addition to the machine tool, is a ball point pen and a pad of paper. The pen may be inserted into the spindle, and the path that the cutting tool will take is traced, via the tape instructions. This means of checking the tape is not recommended for more expensive machines; however, it is a reasonable alternative to the plotter or other special verifying machines when lower cost milling machines or machining centers are involved.

Whatever the means employed, it is becoming apparent that some sort of plot verification is expedient, at least until such time when the parts programmer becomes a unique and perfect human being, incapable of error.□

is your... NUMERICAL CONTROL production running at a snail's pace?

The reason may be that the "heart" of your numerical control system, tape preparation, is holding up production. Tape not ready when you are; tapes that have to be reworked to properly conform to blueprints. Now *you* can cut costs with CMT's self-contained TAPE CENTER. No time sharing, terminals, special hookups or costly retraining that can cut into your competitive edge.

To find out more about how *you* can control the cost and time of your Numerical Control processing, write today for the TAPE CENTER Brochure or call Mr. Steve Moss, 201-748-7002 collect.

You can not afford not to!

cmt

Computer Machining Technology
5 Lawrence Street Dept. B-2
Bloomfield, New Jersey 07003

☐ Send me your N/C TAPE CENTER BROCHURE.

☐ Send the N/C MASTER PLAN.

Name _____ Title _____

Company _____

Address _____

City _____ State _____ Zip _____

NC SHIPMENTS: 1972 SUMMARY

from Series: MQ-35W(72)-5, Current Industrial Reports, Metalworking Machinery, U. S. Department of Commerce.

During 1972, the value of shipments of numerically controlled metalworking machine tools totaled $170 million. Numerically controlled machine tools accounted for 14 percent of the value of industrial type metalworking machine tool shipments during 1972.

Over 90 percent of the value of all numerically controlled machine tool shipments during 1972 was for cutting type machine tools predominatly represented by machining centers, 27 percent; lathes, 39 percent; boring machines, 12 percent; milling machines, 9 percent; and drilling machines, 5 percent.

Table 4.--TOTAL SHIPMENTS AND UNFILLED ORDERS (INCLUDING EXPORTS) OF NUMERICALLY CONTROLLED AND AUTOMATIC MECHANICAL METALWORKING MACHINERY, BY TYPE OF CONTROL AND TYPE OF MACHINE: 1972

1972 product class code	Item	Shipments			Unfilled orders (December 31)		
		Quantity (number of machines)	Value ($1,000)		Quantity (number of machines)	Value ($1,000)	
			Machines and controls	Controls only		Machines and controls	Controls only
	METALWORKING MACHINERY, TOTAL	1,630	170,115	42,314	1,334	182,054	50,565
	By type of numerical control:						
	Point-to-point positioning	605	49,494	10,400	337	50,763	15,697
	Continuous path activated by tape or punchcard	989	117,352	31,292	977	128,310	34,438
	Dial or plugboard type of prerecorded motion program control	36	3,269	622	20	2,981	430
	By type of machines:						
35411	Boring machines, total	84	20,973	4,083	126	30,020	12,222
	Point-to-point positioning	56	12,710	3,083	107	25,396	11,404
	Continuous path activated by type or punchcard; Dial or plugboard type of prerecorded motion program control	28	8,263	1,000	19	4,624	818
35412	Drilling machines	118	8,427	1,606	25	4,332	681
35415	Lathes, total	570	67,056	19,650	578	66,287	20,941
	Point-to-point positioning	36	2,976	459	18	1,982	168
	Dial or plugboard type of prerecorded motion program control; Continuous path activated by tape or punchcard	534	64,080	19,191	560	64,305	20,773
35416	Milling machines	229	15,750	3,265	83	11,047	1,743
35418pt.	Machining centers	475	45,344	11,446	434	61,836	13,275
354**	All other metal cutting and metal forming type machine tools	154	12,565	2,264	88	8,532	1,703

**Represents a combination of product class codes.

NC TAPE VERIFIER AND EDITOR

By Carl Natoni

Increased productivity, a tantalizing goal of the 70s, seems so close, and yet so many nonproductive spindles are seen on the most sophisticated facilities. A significant possibility for increasing productivity is to deliver a technically correct tape to an NC facility. The track record on this score certainly bears improving. When management accepts an average of three tape reworks, and programmers (honest ones) admit to five tries to get a good working tape, a vast amount of idle machine spindle time is indicated. And, of course, the greater the NC investment, the more critical is the need to keep work spindles productively buried in a piece part.

Designed specifically for NC tape verification and ease of editing, the Tektronix Verifier and Editor, as described and demonstrated by John Toftemark, provides some impressive gains in useful spindle time. "It matters not so much how many NC facilities are on the floor," declared Toftemark, "but, rather, how many tapes are created."

"And how is each tape really checked?" he asked. By eyeball matching of holes: By comparing tape print-out with manuscript? By plotting the cutter path on a drafting machine or a plotter using CL data?"

In each case, pointed out Toftemark, the check is either cursory, illusory, inadequate, or concentrates on only a portion of the final tape. "It still takes a trial run, with all the attendant risks, to actually prove out the tape." Whether cutting styrofoam, wood, aluminum, or simply making a dry run–no piece part has been produced. It goes without saying that an NC facility is much too expensive for tape try out purposes. While plotters and NC drafting machines do have the ability to check cutter paths accurately, they usually work from computer CL data. Subsequently, speeds, feeds, and machine functions must be inserted into the final tape with all inherent chances for error.

It has only been during the last year that a technically error-free tape could be placed into a machine control unit with all debugging and cutter path optimization being done at the programmer's desk. The first Tektronix installation was made at Teledyne Ryan Aeronautical Company in San Diego, California over a year ago, reported Toftemark. Since then over 100 units are in use throughout the country.

Working from a final tape, the Tektronix system provides both a visual record of cutter path plus a check of all tape functions as designated alpha-numerically. This checking can be done at high speed or one block at a time. Errors show up readily and can be easily corrected from a keyboard entry on the editor. Corrections are viewed as made on a cathode ray tube (CRT) presentation; when satisfactory, they are punched onto a new tape at 66 characters per second. A final verification of the corrected tape can then be scanned via reader and CRT at 500 characters per second.

While the approximately 6 inch by 9 inch CRT seems relatively small, it packs a powerful potential: plots can be scaled up or down, zooming in on any point in question and enlarging for closer examination. Measurement of an actual dimension against a superimpose grid is a simple matter. Any two axes at a time may be viewed. plus there is the option of an oblique mode for an over-all picture of the cutter path or total part. At any time in the checking procedure, alpha-numeric information may be simultaneously viewed one block at a time.

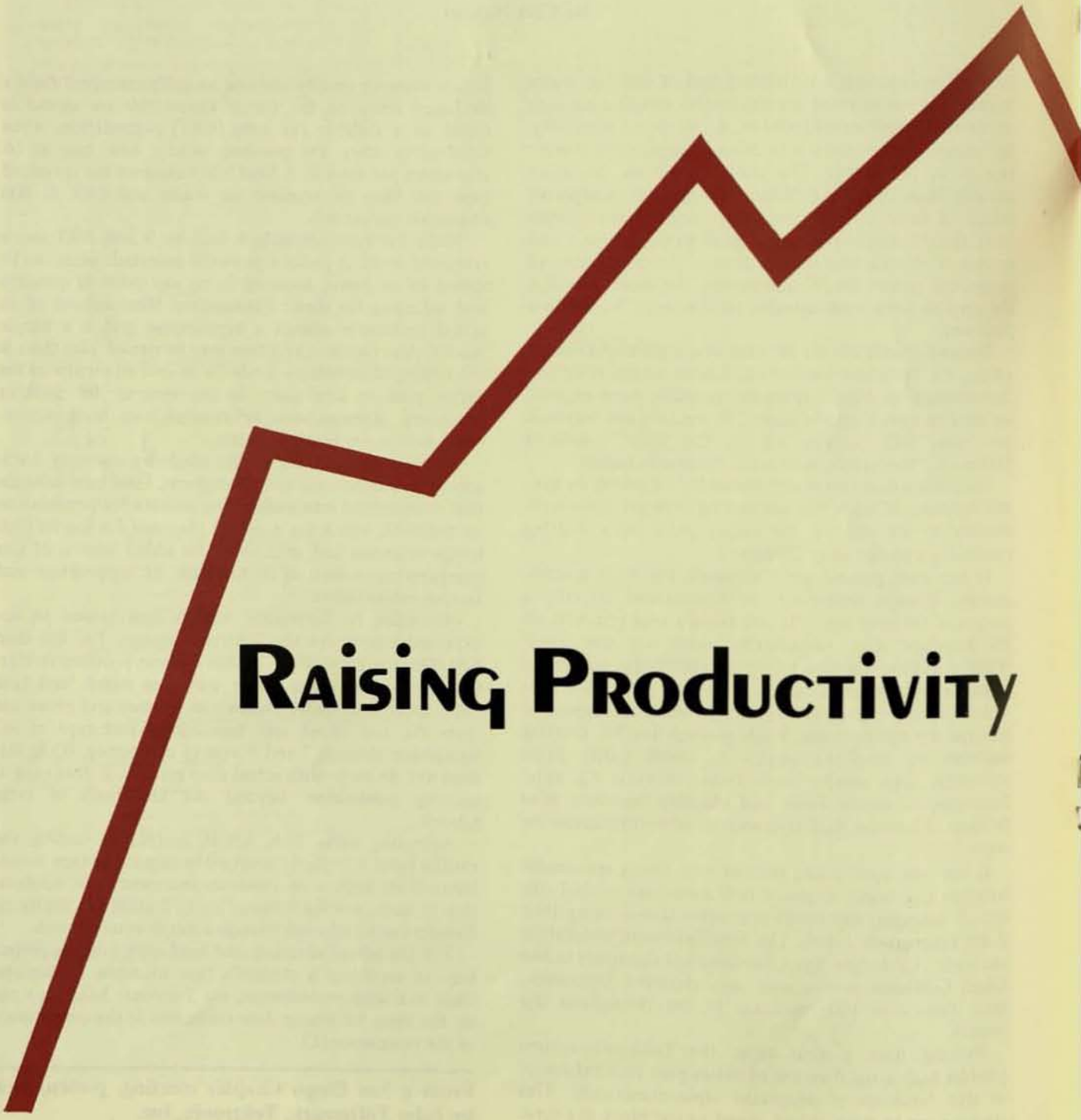
In order to keep the system attractive cost-wise, hard-wired components are used throughout. Final tape information is converted into analog data suitable for presentation on the CRT, which has a special phosphor coating for high image retention and sensitivity. An added benefit of this computerless system is its tolerance of temperature and factory environment.

According to Toftemark, schools have proved an unexpected market for the Tektronix system. For less than $20,000, the stand-alone, mobile console provides verifier, CRT plotter, program editor with tape punch, and hard copy unit. This allows students to produce and prove out tapes for just about any tape format and type of NC equipment through 2 and 3 axes of contouring. While this does not do away with actual shop practice, it does expand training possibilities beyond the limitations of most schools.

Accepting either EIA, ASCII, or ISO bit coding, the verifier panel is logically arranged to respond to tape format instructions written in absolute, incremental, or combination of both; word address or up to 8 other tab sequential formats can be selected through a simple rotary switch.

For the school situation, the hard copy unit is a perfect way of recording a student's tape triumphs or trip-ups. Used in a shop environment, the Tektronix hard copy can be the basis for source data correction at the convenience of the programmer.□

From a San Diego Chapter meeting, presentation by John Toftemark, Tektronix, Inc.



Raising Productivity

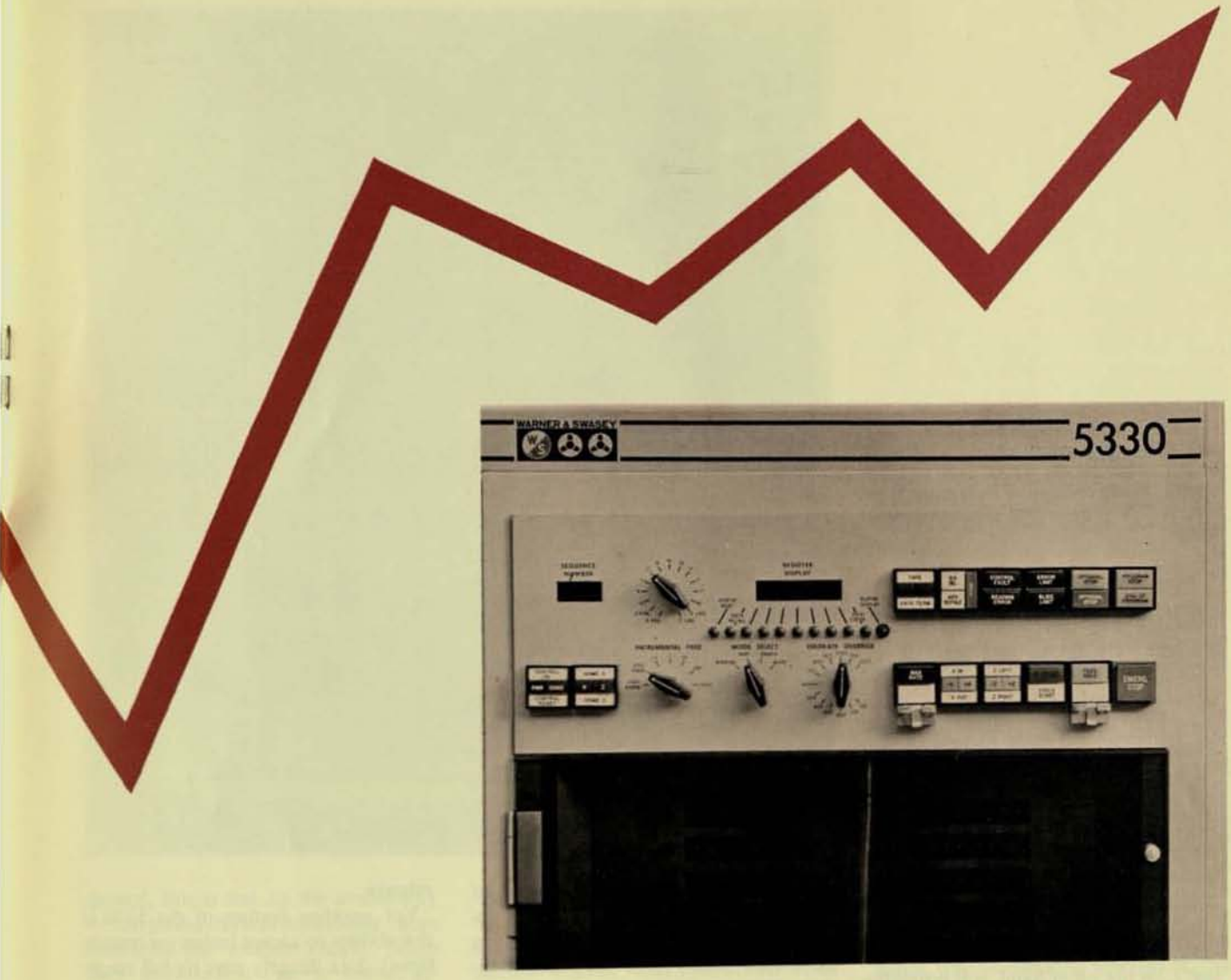


Figure 1. Simple layout and a carefully selected number of operator controls speed up cycle times and enhance operator acceptance of the 5330 control.

with modern controls and on-line tape editing equipment

By Steven C. Kish and Norman R. Traffis

The over-all productivity of an NC machine tool is a function of two major factors: management techniques and operational characteristics of the *total* NC system, i.e., the control and the machine tool. Thus, once maximum machine use has been achieved through the application of modern management techniques, there is only one way to make further productivity gains–keep the machine tool busy cutting metal, i.e., increase the work-to-idle time ratio, as well as ensure that such cutting is done at the maximum machine tool capability.

Factors Influencing NC Machine Productivity

In general, NC machine productivity is affected by a variety of factors that contribute to a machine's idle time or to a decrease in machine efficiency; these can be either direct or indirect. Among the major indirect factors is programming methods. Some of the major direct factors influencing productivity of an NC machine are:

(1) System reliability and serviceability.

(2) Parts program tape editing.

(3) Operator's control panel complexity.

The difference between direct and indirect factors is as follows: In the case of programming, for instance, programming complexity (quite often due to the control-logic design short-

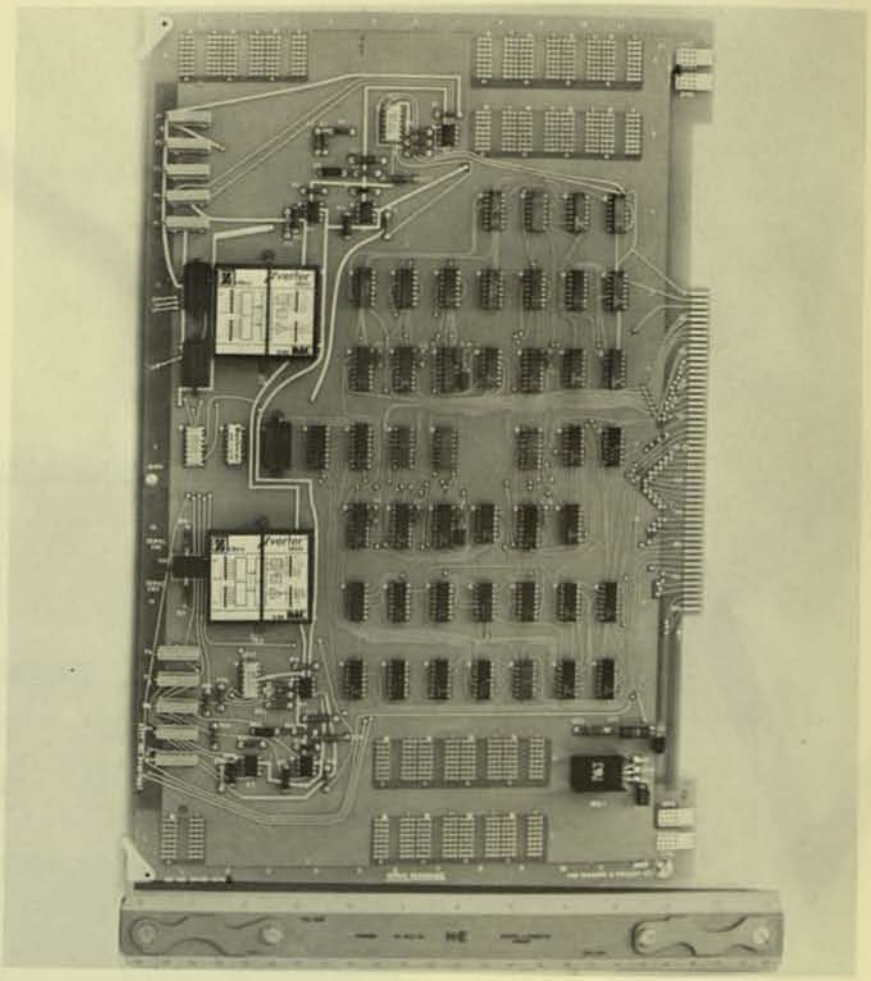


Figure 2. Greatly reduced back-plane wiring cuts cost and increases reliability. This is made possible by the use of only 13 large printed circuit boards of four-layer type that, in turn, permits total byfunction packaging.

comings) may not contribute to the machine idle time, because it is an "off-line" function i.e., it is done while the machine is producing other parts. Of course, productivity decreases will result in the case of "sloppy" programming that will put the machine tool through unnecessary steps, increasing the cycle time. Programming that does not use the full capability of the machine tool also limits productivity.

Parts program editing (synonymous with "tape proving" or "tape editing"), on the other hand, will generally tie up the machine tool in question for the duration of the editing process. Tape editing, in fact, is perhaps the single largest factor contributing to machine idle time.

Control Features Simplify Programming

Control sophistication refers here to *internal logic* sophistication that results in operational simplification. This internal sophistication–with actual increase in control reliability and serviceability–is made possible by the recent advances in solid-state technology, as well as by the associated design and packaging techniques. Thus, today, by packing more functions into a given circuit module, the number of circuits and wired connections is reduced. The real impact of these developments, from the point of view of a typical machine tool user, has become apparent only in the last two to three years.

With this in mind, consider some of the ways control sophistication reduces programming complexity. It can be stated boldly that the ideal situation for a parts programmer is when various physical parameters can be programmed directly, rather than with the use of such aids as "feedrate number" and others commonly used in NC controls. For instance, in the Warner & Swansey 5330 control, the slide velocity, as a function of spindle speed usually given in inches or millimeters per revolution (ipr or mmpr), is programmed directly in ipr or mmpr as a single word over the total operational range.

Another feature in the 5330 that simplifies programming is the so-called "constant surface feet per minute." That is, when a part to be turned on a lathe is programmed, the programmer simply indicates the desired constant surface feet per minute. The 5330 control uses this information to adjust the spindle speed automatically (within the spindle-speed range), i.e., it increases the spindle speed as the part diameter decreases to maintain the specified constant surface feet per minute.

Yet another feature of the 5330 is the ability to accept inches per minute (ipm) data directly over its full range. Thus, programming the "F word" in ipm, or millimeters per minute (mmpm), is all that is required; there are no additional words to program.

These are just a few examples of how control functional sophistication can simplify programming. Obviously, longer programs resulting from the programming limitations of an NC control increase the possibility of more parts program errors. It should also be obvious that the features mentioned above and other features provided in a modern NC unit are in addition to the features generally found in most NC controls. Operator's panel simplicity, for instance, is one such a feature (figure 1).

Servicing Sophisticated Controls is Simpler

It is a paradox that more powerful controls are actually simpler to service and maintain than their seemingly "straight forward" predecessors. In

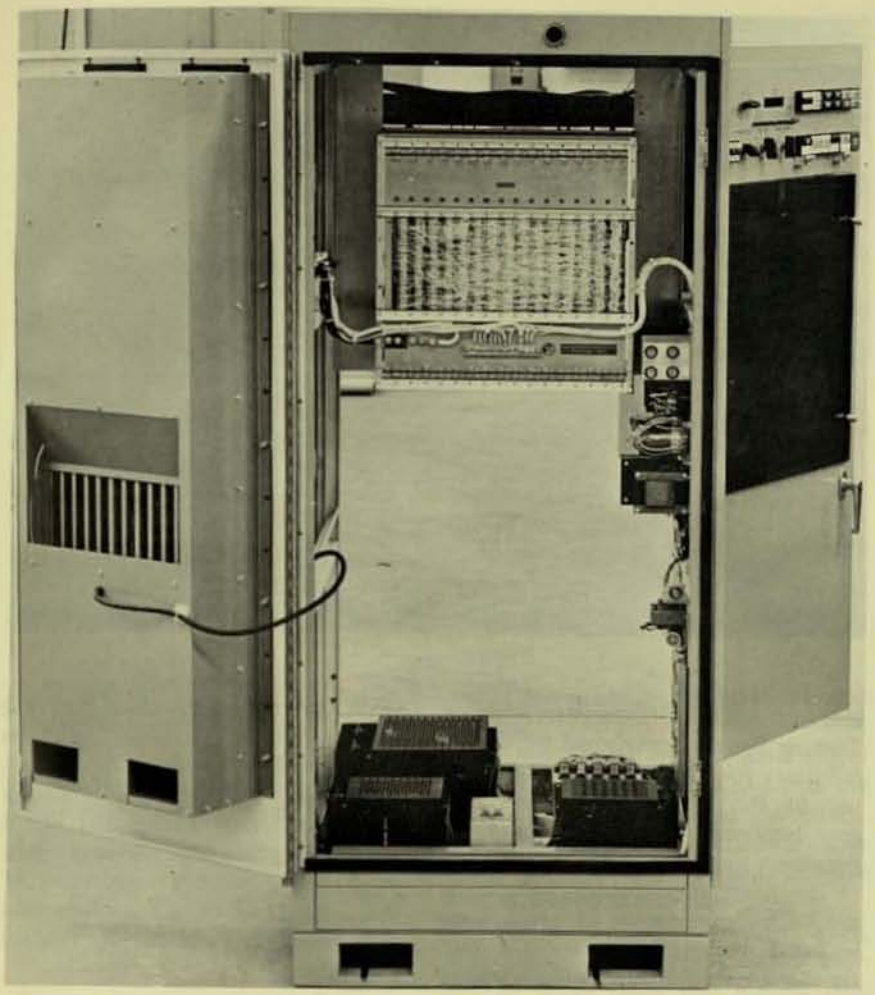


Figure 3. Ease of servicing is ensured through totally modular packaging and providing ample space within the control cabinet.

general, this is due to the availability of integrated circuits containing more functions per module (MSI). Since their per/function cost is lower, reliable controls at lower cost can now be built.

LED (Light Emitting Diode) displays with the accompanying latching decoder drivers are used in the 5330 control. This permits the use of a data muliplexing scheme to the display which reduces considerably the number of interconnections. The multiplexing scheme, through internal control switches, provides control diagnostics by displaying internal information on the operator's panel while it is being processed.

Servo errors (the difference between the input commanded position and the actual position) in digital form can also be displayed, greatly aiding machine check-outs and set up.

The use of four-layer printed circuit boards, giving each board a power and ground plane, reduces the possible noise problems that frequently plague electronic equipment in a machine-shop environment (figure 2).

A significant reliability improvement has been made by a large reduction in the back-plane wiring. This is due to the large size of the four-layer printed circuit boards that permitted total byfunction packaging of the MSI modules.

The use of complex logic components also ensures an easy access to all parts within the control cabinet, simply because they occupy less space. (The over-all size of the control cabinet remains the same to provide mounting areas for operator displays, tape reader, and pushbuttons (figure 3).

Self-testing features can now be incorporated into the control unit at reasonable cost. One of the most significant self-testing features available in the 5330 is a timing check, programmed on punched tape. One use for this feature is in checking the interpolator. The test is of the "go-no/go" nature, i.e., if timing errors are detected, the control test cycle will be terminated and a control error displayed.

Complementing the various features aimed at servicing simplification are a number of "operator convenience" features. While the term "convenience" is used, these features can actually reduce the machine overhead substantially.

One such convenience feature on the 5330 control helps the operator check out new parts program tapes. Using the position display, he can check whether offsets have been inserted. This is possible because in the 5330 control, actual lead-screw position is displayed. Older controls usually display the accumulated command *less offsets*. Thus, the operator has no quick way of checking whether offsets have been inserted.

This lead-screw position display can also serve as a quick check on the machine tool. For instance, if the machine positions incorrectly, the operator can readily determine whether the feedback circuits, the interpolator, or the program is in error, by comparing the display with the parts program.

Another significant operator-oriented feature in the 5330 control is the so-called "max rate." This feature enables the operator, during a dry run, to speed up various low feedrates thus reducing the tape check-out time.

For maximum functional safety, a list of "legal" characters is stored in the 5330 control read-only memory (ROM). Should a wrong character be read by the tape reader (due to typing an "L" instead of a one, for instance), the parts program cycle will be stopped and the control will display a reading error.

Finally, if data are programmed in a

Figure 4. Just as a fast set up in terms of tooling increases over-all machine tool productivity, so does the ability of this parts program tape editor to edit tapes quickly right at the machine site. The unit's simplicity and low cost stem from the fact that it is a true peripheral for the 5330 two-axis contouring NC unit, i.e., it uses the tape reader, the display, the MDI control mode, and some logic already existing in the 5330 control.

wrong sequence (most likely to occur in the MDI mode), the control cannot be cycled and a reading error will be displayed.

Development of On-Line Parts Program Editor

Regardless of whether an NC tape has been programmed manually or with the assistance of a computer, it will have errors because of material size or hardness, wrong tool selection, improper speeds and feeds, etc. Regardless of their nature, almost every tape must be "edited" to make sure that good parts (rather than expensive scrap) are produced.

All programmers and NC machine tool operators who have been through the conventional tape editing process know what it means–running back and forth between the machine tool and the tape preparation unit, with delays and distractions adding to lost production time, an idle NC machine, and wasted man-hours. These losses can be anywhere from half a day to two days.

In general, there are two approaches to this problem:

(1) The development and use of more sophisticated parts program preparation methods.

(2) The use of an "on-line" parts program tape editor.

Ideally, the first way is best. Specialized NC languages exist today that will help in generating optimized parts programs. A good example of such a language is CUTS (Computer Utilized Turning System) developed by Warner & Swasey for turning applications. The use of this language simplifies programming and results in tapes for running a numerically-controlled lathe at its maximum capability. Until the use of such languages and computers becomes universal, however, the need for on-line tape editing will always be just as acute as it is today.

Yet, the development of a practical on-line tape editor–one that can be plugged into an NC unit and used to punch "good" tapes *right at the machine site*–has been slow in coming. For one, the cost of required electronics and mass storage has been prohibitive. For another, functional differences among machine tools and controls built by different manufacturers have prevented the development of a reasonably priced "universal" tape editor. And third, as the subsequent discussion will indicate, best cost/performance is attained when an on-line parts program tape editor is developed in parallel with the development of the corresponding NC control, rather than as a universal "add-on."

During the last two years a ray of hope shone on this bleak scene: The cost of highly sophisticated electronic packaged circuits (MSI: Medium Scale Integrated Circuits) decreased drastically.

To take advantage of this trend, engineers at the Warner & Swasey Research Center designed and developed an advanced parts program editor (PPE) in conjunction with the 5330 control design. To ensure maximum operational utility at the lowest cost, no attempt has been made to design a "universal" tape editor. The PPE is only campatible with the latest Warner & Swasey two-axis contouring NC unit, the 5330, being manufactured at the company's Electronic Products Division.

How It Works

In operation, a parts program tape that has to be edited is placed on the 5330 tape reader. Its contents are transferred onto the magnetic-tape cassette of the PPE that is plugged into the 5330 control. To provide ample room for corrections and additions, the operator can insert from 0 to 9 empty blocks between each block of data coming from the punched tape.

The runoff of the first part can now begin. Either the punched tape in the 5330 tape reader or the information stored on the cassette can be used, since both modes are available.

In either case, the operator makes the necessary block corrections, deletions or additions, and enters the new block information on the magnetic tape. Once all of the parts program corrections have been made, a good first piece is cut using the corrected magnetic tape. If this test part meets the specifications, the operator can either punch a tape for the 5330 tape reader, or make the desired number of parts directly from the cassette (in the case when only a few parts are involved).

Figure 5. Highly encouraging productivity gains can be realized with this latest Warner & Swasey turret lathe, 1-SC. This is due in part to the total system design concept behind it., i.e., the use of the 5330 control, Warner & Swasey servo drives and interfaces, and the on-line parts program tape editor (figure 4).

Dedicated vs. "Universal" Tape Editors

Among the chief arguments in favor of a dedicated tape editor are:

(1) Low cost.

(2) Ease of operation (designed to be used with a control similar to the programmer-operator).

To appreciate this, it is well to consider the PPE in some detail.

The low cost of the PPE stems from the fact that it is a truly *peripheral* unit for the 5330 control. The PPE makes maximum use of various internal and external devices required for its operation that are already incorporated into every 5330 unit. These include:

(1) Tape reader

(2) Data display

(3) Manual Data Input (MDI)

(4) Electronics for interfacing the above with the PPE.

This is partly illustrated in figure 4. Depicted is the PPE cabinet which contains the required logic, the cassette read/write mechanisms, and a few pushbuttons for the operator's control.

At this time, being offered as a peripheral for the 5330, the PPE can be shared among a number of 5330-controlled machine tools. In a typical situation, the PPE can be literally plugged into a 5330 control with the PPE interface option, do the required tape editing, and be moved to the next machine.

The high degree of functional utility provided by the PPE is also due to the fact that it is "dedicated" in nature. The PPE logic matches various features (both optional and standard) that are available in the 5330 control.

As just one example of its usefulness, take the PPE's tape-preparation ability. In those cases that involve production of "families" of parts, tapes for the "family members" can be prepared with the assistance of the PPE. A good example of such a PPE use is production of gear blanks. For a given gear blank type, parts programs for the gear family will have many similarities. Thus, individual parts programs can be generated (and tapes punched) by "editing" the basic "master" program, making the required additions, deletions, and changes quickly, accurately, and efficiently. Obviously, cassettes with proven parts programs can be stored for future use.

1-SC Lathe/5330 Control Machining System

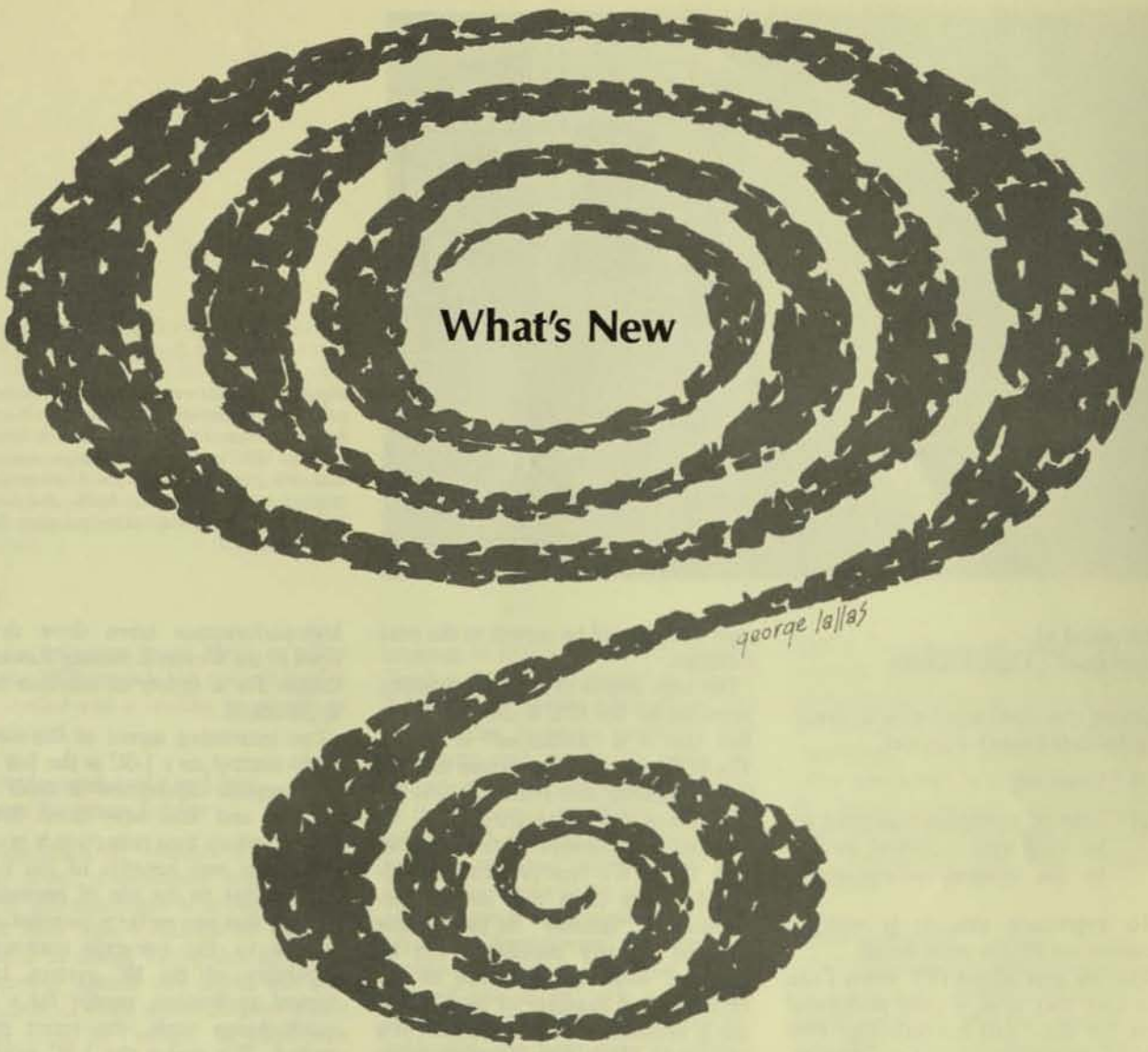
While the 5330 control (with or without the PPE) can be used in many applications requiring two-axis contouring capability, the first 5330 units are being shipped with the latest turret lathe developed by Warner & Swansey (the 1-SC, figure 5). Just as other Warner & Swasey NC lathes, the 1-SC is available with either the 5330 or the General Electric 7542 controls.

axes on the 1-SC are driven by a high-performance servo drive developed at the Warner & Swasey Research Center for a variety of machine tool applications.

One interesting aspect of the use of 5330 control on a 1-SC is the full use of complete capabilities of both the control and this new turret lathe. Drastic set-up time reduction is among the major user benefits of the 1-SC. This is due to the use of permanent tooling that can perform complex cuts thanks to the two-axis contouring capability of the NC system. In a typical application, except for a few quick-change tools, the turret stays tooled. This makes the 1-SC suitable for both small and medium lot production.

It's still too early to draw far-reaching conclusions (the first 1-SCs were shipped in late 1972). Results to date indicate that this combination of machine tool, NC system, and parts program editor have resulted in a total machine tool system with a highly encouraging productivity potential. This machining system was developed in an atmosphere of free exchange of information and cooperation among several divisions of Warner & Swasey, plus valuable feedback from many users.□

Authors Kish and Traffis, from the Warner & Swasey Company, first presented this paper at the NCS Tenth Annual Conference, April 15-18, 1973, New York City.



The NCS Journal of Numerical Control

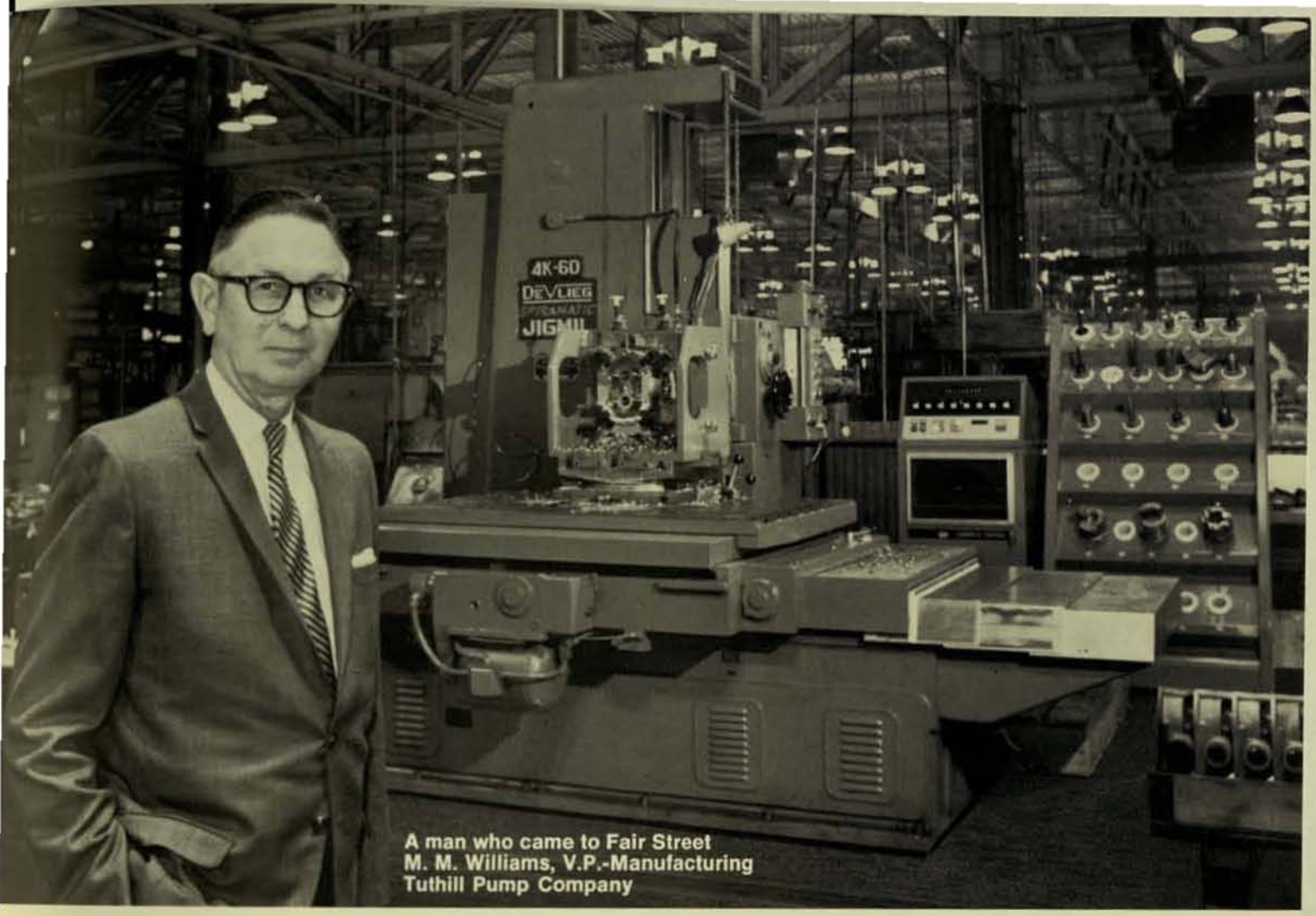
In a recent move to expand its publications, the Numerical Control Society has announced that an all-new, 48-page *JOURNAL OF NUMERICAL CONTROL* will be published quarterly for NCS members and available to nonmembers by subscription. The new journal format will correspond to the Society's popular 6 x 9 annual conference proceedings. Since the new journal will contain numerous articles bound in this convenient book size, readers will be encouraged to save issues and place them on their bookshelves permanently, rather than discard them as so often happens with the larger, trade format.

Recognizing the need also to bring regular news items (NCS news, chapter news, NC bulletins, etc.) to readers, a second publication, a four-page newsletter, will appear eight times a year, in between quarterly journal issues. The combination of these two new publications will replace the present 16-page *NC SCENE* magazine. In essence, the new, expanded publications will bring the same information to readers, but more of it.

The first issue of the new enlarged *JOURNAL OF NUMERICAL CONTROL* is scheduled for release January 1, 1974. Members and nonmembers are invited to submit articles for consideration. Contact Editor Mary A. De Vries, NCS, P. O. Box 26, Concord, N. H. 03301, 603-225-2631, for further information. Advertising will be accepted for the *JOURNAL* and details are also available from the Concord office.

The first issue of the newsletter, which will continue to carry the familiar title, *NC SCENE*, is scheduled for November 1, 1973. Members and nonmembers are invited to submit national and chapter NCS news and NC bulletins. Mail to *NC SCENE*, P. O. Box 26, Concord, N. H. 03301.

NCS members will receive both the new enlarged *JOURNAL OF NUMERICAL CONTROL* and the *NC SCENE* newsletter free of charge. Nonmembers may subscribe to either. Prices for the journal are $16.00 U. S. and Canada and $20.00 overseas seamail. Prices for the newsletter are $6.00 U. S. and Canada and $8.00 overseas seamail.



A man who came to Fair Street
M. M. Williams, V.P.-Manufacturing
Tuthill Pump Company

Tuthill Pump Company had a machining problem . . . It was solved at Fair Street.

"We were producing good pumps—but our machining times were unsatisfactory. We decided to check with DeVlieg and we ended up with not only an answer but what we like to call a turn-key solution.

The men at DeVlieg recommended the right JIGMIL, and we also found we were able to turn to them for proper tooling and fixturing through their Microbore Division as well as receive a complete numerical control program which allowed us to start production immediately after the machine was installed.

As good as DeVlieg's reputation is, we still wanted to be sure the investment was as good as it looked on paper, so we sent six different part pieces, including a stainless-steel impeller housing, cast-iron bearing housing, stainless and cast-iron face plates and a cast-iron gearcase to be machined. The results proved the paper figures—the JIGMIL's efficiency and accuracy did substantially reduce the machining time for roughing and finishing cuts.

Today we not only own a tape-controlled 4K-60 JIGMIL with the proper tooling and fixturing, we also have a Micropoint grinder and Preset machine to further increase our productivity.

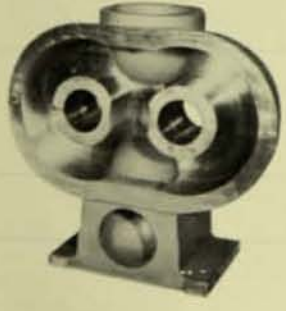
If you have a similar problem, I'd recommend you visit Fair Street soon."

FAIR STREET

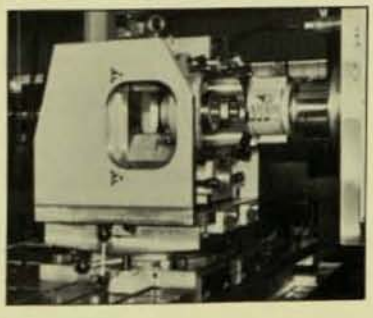
DEVLIEG

DEVLIEG MACHINE COMPANY • FAIR STREET • ROYAL OAK, MICHIGAN 48068

Overall part quality has been improved. Interchangeability of common parts has dramatically decreased assembly time.



As part of the turn-key operation DeVlieg furnished the fixturing, tooling package and tool sheets for each part.



DeVlieg-prepared program tapes enabled Tuthill Pump Company to start production during the period of operator training.

NC SCENE
P. O. Box 26
Concord, N. H. 03301

BULK RATE
U. S. POSTAGE
PAID
CONCORD, N.H.
PERMIT NO. 628

Detach and mail to NCS, P.O. Box 138, Spring Lake, N.J. 07762

INFORMATION REQUEST

Please send information on items checked below to:

Name_____ Company_____

Street_____ City, State, Zip_____

( ) membership ( ) books ( ) correspondence courses ( ) scene subscription
( ) advertising ( ) other_____

Detach and mail to NCS, P.O. Box 138, Spring Lake, N.J. 07762

CHANGE OF ADDRESS

Please change my mailing address from:

Name_____ Company_____

Street_____ City, State, Zip_____

to:

Name_____ Company_____

Street_____ City, State, Zip_____