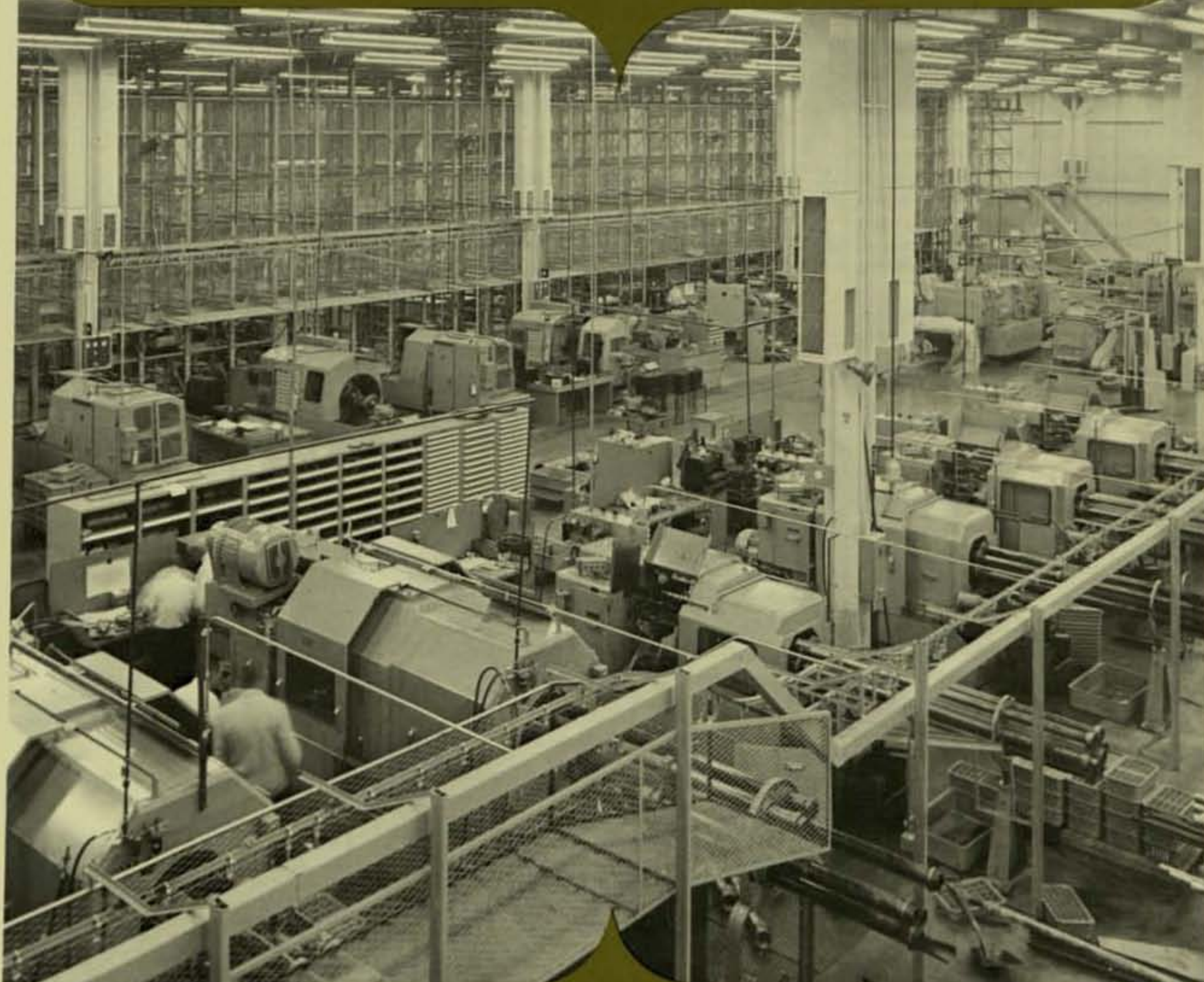
NC SCENE

May 1973

The Perfect Marriage

MACHINING SYSTEMS



AND RANDOM MIX PRODUCTION

NC SCENE

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DIRECTORY

Official Publication of the Numerical Control Society

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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.

NC EDUCATION

WANTED: NC TECHNICIAN FACT OR FANTASY?

J. J. VALIANTE
Guest Editor

Management is not aware of or ignores its true needs when it comes to maintaining, servicing, and troubleshooting NC equipment.

Many prefer to rely on a machine tool builder and his service department. Some assign the responsibility of keeping their NC equipment "up" to the maintenance department. Others send their engineering personnel to NC machine tool manufacturers' schools; these engineers learn all about the equipment that will be coming into the house with the intention of supervising repairs, but they never get involved in the actual equipment in the plant.

All of the above approaches are good in their aims to keep the down time of an NC machine tool *down*, but–can you absorb a loss of profit while you're "waiting on the list" to be serviced? Can your maintenance department handle the repairs on the NC equipment, or will they do their best and then dial "HELP"? Can your engineering personnel properly direct a technician or wireman in troubleshooting your NC equipment efficiently, accurately, and with a good cooperative attitude?

The answers to these are NO! You cannot tolerate down time while you are waiting for a machine tool service rep to get to you.

You cannot arbitrarily assign NC equipment responsibility to your maintenance department as "another piece of equipment to maintain."

You cannot satisfactorily have your engineering personnel direct technicians in troubleshooting and use them as another "pair of hands".

What's the answer? An NC technician. What is an NC technician? The actual title could be senior technical assistant–NC specialist, or senior engineering associate–NC specialist, or engineer (nondegree)–NC specialist, or just plain NC specialist. Regardless of the title, one of the things that is obvious is that each should have NC as a part of the classification that sets him apart from the technician category.

An NC technician is a different breed and as such requires as many facets to his background and capabilities as there are peripheral equipments attached to a machine tool. All NC machine tools start with a basic machine and to this are added controls, tape readers, positioning devices, read-outs, print-outs, teletypewriters, and on some an on-line computer facility. As a result, an NC technician needs to be familiar with machine tools and all of the peripheral devices attached to it.

It's not a requirement that he know your specific equipment, although if he does his learning time is reduced to a minimum. What is important is that he have a working

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NC PANORAMA

REFLECTIONS ON A DECADE OF NUMERICAL CONTROL

JAMES J. CHILDS
Contributing Editor

In April the Numerical Control Society held its tenth annual meeting, and it seems appropriate to reflect somewhat upon these past ten years in light of progress and developments in the NC field. For example:

- In 1963 there were less than 3,000 numerically-controlled machines operating in the country. Today there are approximately 25,000.
- In 1963 there were almost 7½ times as many point-to-point machines shipped as continuous-path machines. Today the trend is running almost two to one in favor of *continuous-path* machines, and the dollar value of shipments for continuous-path machines is running almost three times as much as for point-to-point machines.
- In 1963 the total number of lathes shipped was less than 200. This past year over 500 lathes were shipped.
- In 1963 the percentage of machines being programmed via computer assistance was approximately 15 per cent. This figure now averages in the neighborhood of from 40 to 55 per cent.
- In 1963 a "low-cost" milling machine was just about anything under $150,000. Now there are three-axis milling machines that can be purchased for between twenty and thirty thousand dollars.
- In 1963 an on-site computer was required to use computer-assisted parts programming. Today a number of companies offer reliable service via a telecommunications terminal where the only capital investment is a chair for the operator. The user need pay only for the time that he uses the remote computer service. Or the user may now elect to go the route of an in-house minicomputer. In either case he has a good chance for justification based on NC parts programming requirements alone. This was unheard of with the larger computers of ten years ago.
- In 1963 terms such as CNC and DNC had not been coined and it appears that these developments may be the answer to the elusive "automatic factory".
- In 1963 the government and particularly defense contractors were the prominent purchasers of NC equipment, accounting for over 50 per cent of the NC procurement dollar. As best as can be determined, this figure has dropped to a neighborhood of below 20 per cent.

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The Perfect Marriage

MACHINING SYSTEMS AND RANDOM MIX PRODUCTION

By C. R. Reynolds
and Mark Porter

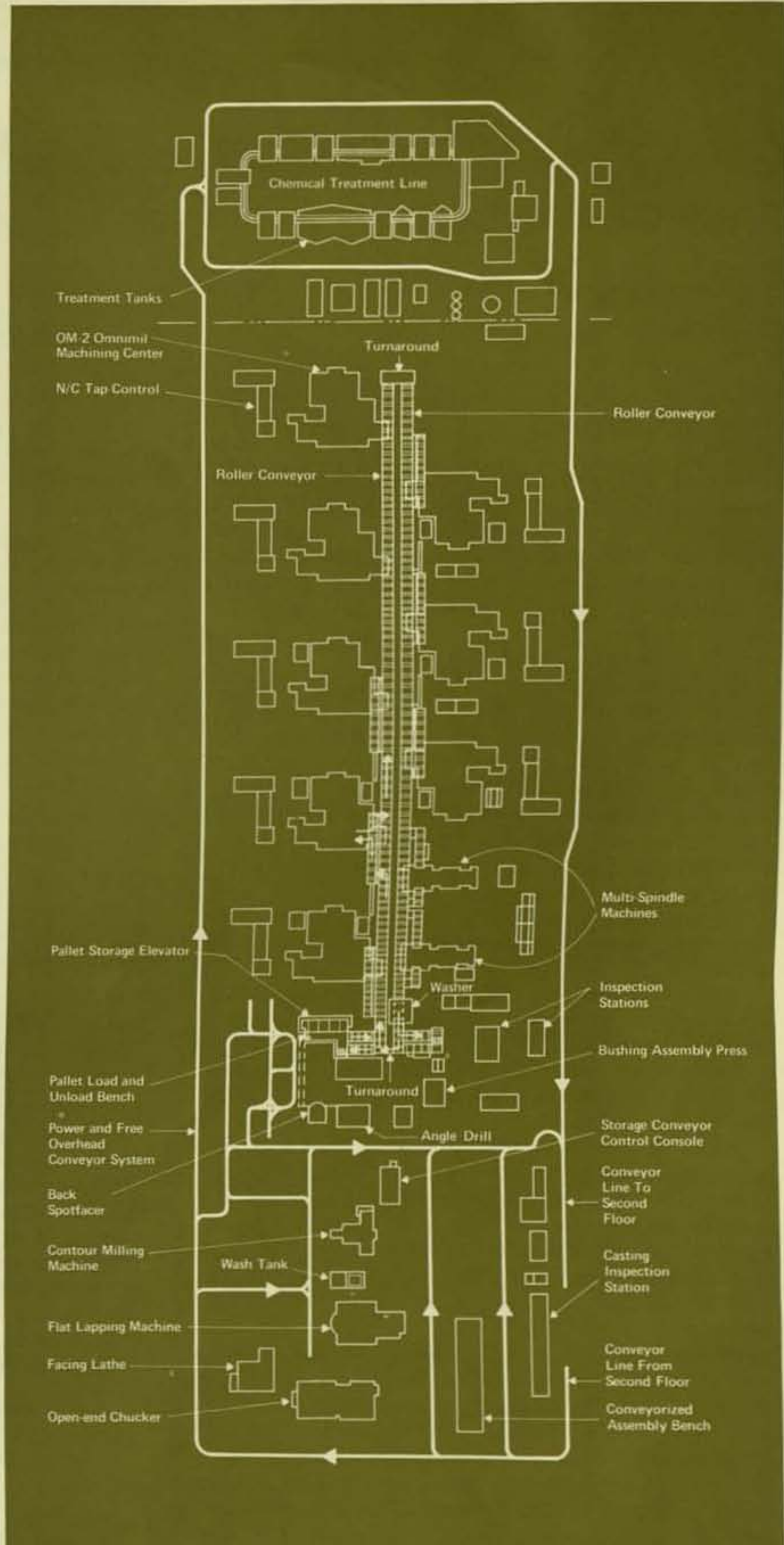

Figure 1. Programmed machining system integrates all machining fluorescent penetrant inspection, corrosion resistance treatment, and parts storage in three different areas. Areas are connected by a power-and-free overhead monorail conveyor.

Today many companies are investigating the application of computers to manufacturing operations. This investigation frequently prompts a look at over-all operations and, in some cases, results in the development of plans for a complete manufacturing facility under direct computer control. More often, however, these investigations result in what has become known as a manufacturing system program.

A manufacturing system is a series of machines, generally NC or DNC, with automatic parts delivery to the machine, and usually with automatic loading and unloading provisions at the individual machines; peripheral operations such as parts washing and inspection are often included so that a fully integrated and complete manufacturing cycle is possible. These systems often treat a large mix of parts numbers having similar processing and with a certain size range.

Examples of Systems

Four manufacturing systems are described here because each exhibits some unique variation in relation to the application of a control system and the parts mix that is produced. Of the four manufacturing systems, two are similar in concept and consist of a group of NC machines connected by a power roller conveyor. The other two are significantly different; one of these is a group of NC machines connected

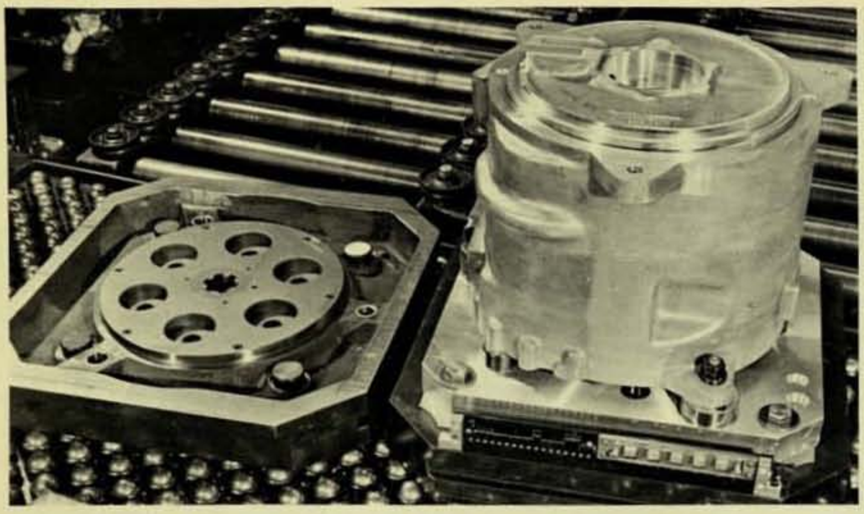

Figure 2. Pallet code can be seen along the bottom of the loaded pallet.

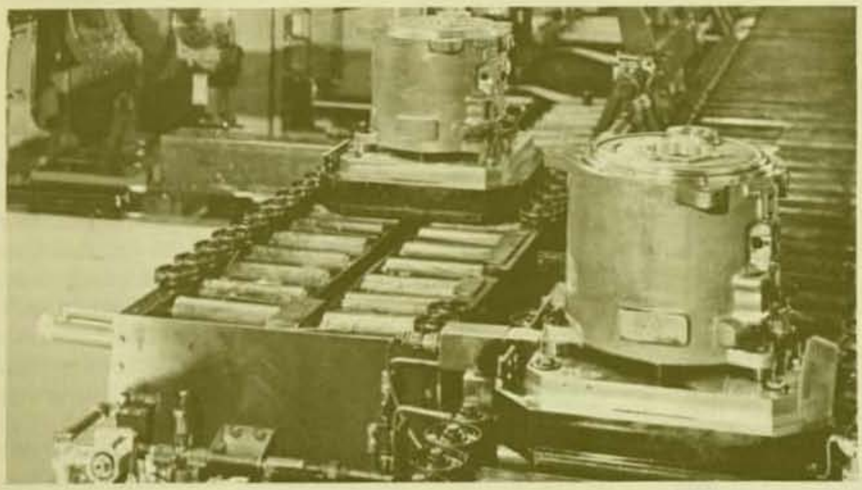

Figure 3. Part and pallet, moving along conveyor, are checked by photoelectric reader at each machine's banking and loading station. When machine and pallet codes agree, pallet is shifted onto machine's holding conveyor, unless it is filled.

by a shuttle car which transports parts to and from and loads and unloads the individual machines in a central loading area. The fourth system is a facility consisting of 70 machines, mostly conventional, with stacker cranes used to hold and deliver batches of in-process parts to the individual machines or work stations.

System No. 1

One of the powered roller conveyor installations is a subsystem of a complete manufacturing system (except for castings) for aircraft component housings. This complete manufacturing system provides for in-process storage and automatic delivery of the stored parts to the work centers, and for all machining operations, chemical treatment, chip handling, part cleaning, inspection, and subassembly. Figure 1 shows a plan view of the installation. The system was designed to produce 70 different P/Ns and 24,000 parts per year. The system also handles an almost continuous introduction of new design parts and has caused a lead-time reduction of from one year to four months over the old methods of manufacture.

The first operations (preping) are accomplished on conventional machines with the machine operators handling the parts in and out of the machines. The overhead monorail conveyor system delivers the parts to these machines' areas, and when these preping operations are completed the same conveyor moves the parts to a loading point at the head of the main machining line.

The main machining line consists of eight Sundstrand OM-2 NC five-axis machining centers and two multi-spindle drilling and tapping machines. The eight OM-2 machining centers are standard tape NC operated. (This system was installed before the advent of direct computer control.) At this main machining line the parts are fastened to a 24" square pallet which is conveyed by powered roller conveyor to deliver the parts to the machines. Each machine has an automatic loading device which loads the pallet onto the machine. When a part has finished the operation on a particular machine, the pallet loading device removes the pallet from the machine and returns it to the powered conveyor.

The pallets are coded to identify the part (figure 2). Photoelectric readers (figure 3) are located along the power conveyor at each machine. The readers read the code of each pallet as it is moved along the conveyor, and are instructed as to which part to accept by the NC program tape which is in the machine control. When the pallet reaches the machine intended,

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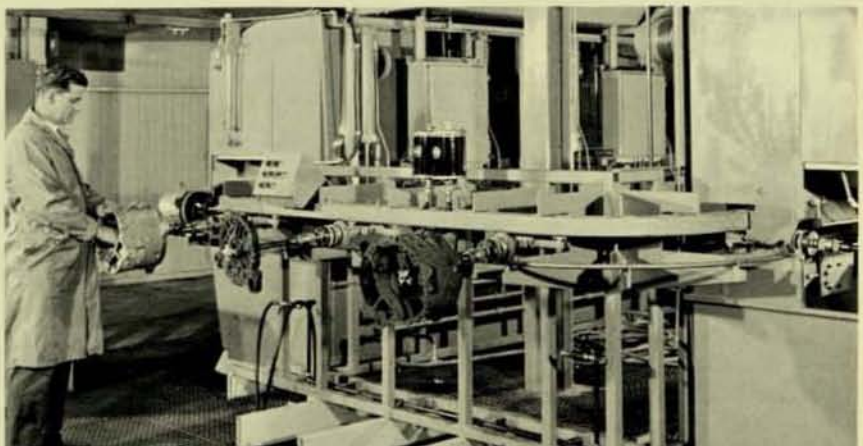

Figure 4. Chemical treatment line.

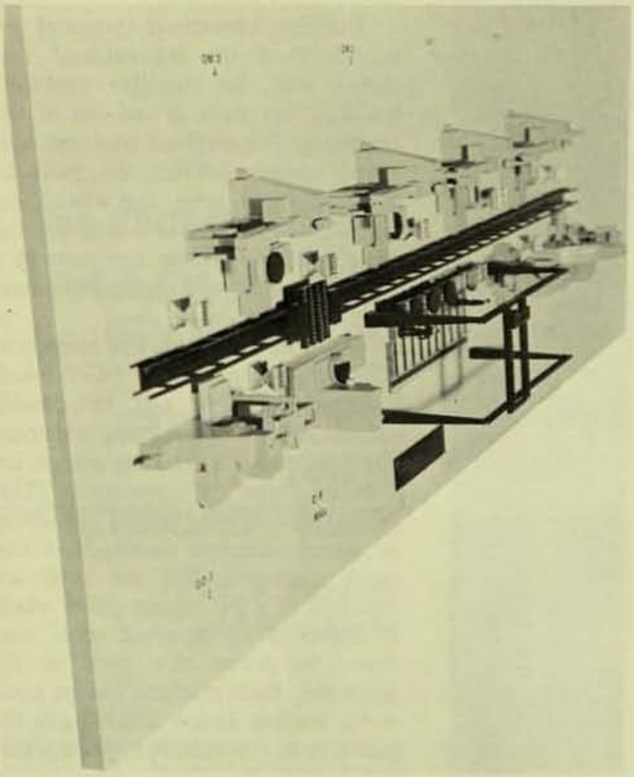

Figure 5. Shuttle car system.

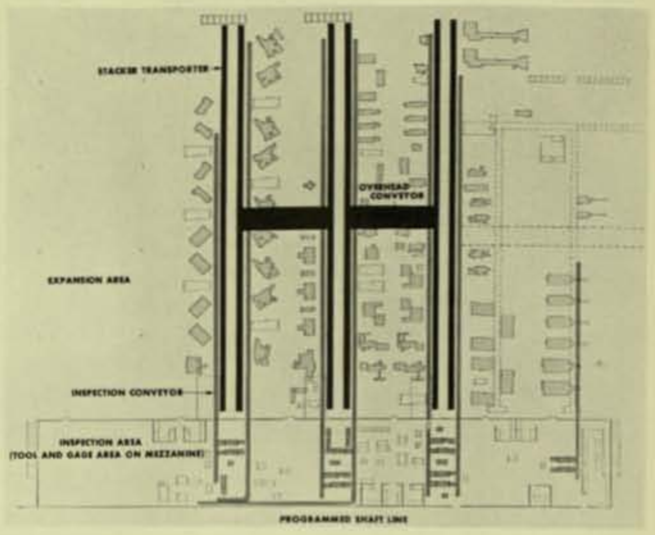

Figure 6. Floor plan of stacker system.

the reader signals the conveyor controls and the pallet is transferred into a holding position from which it is then moved into the machine loading device when the machine is available to receive it. Upon leaving the machine, the pallet code is reset by an automatic device. In this way the part can be dispatched to any other machines or operation as may be desired.

Wash stations are incorporated directly on the line so that the part and pallet are washed just before entering the inspection stations or unload station.

Parts are inspected with coordinate axes measuring machines while still mounted on the work-holding pallets. Balancers are employed to assist operators in picking up part and pallet and placing them on the inspection machines.

The problems of control for the total manufacturing system for this facility would have been greatly simplified and would have provided much greater flexibility had the direct computer controls been available for this system. Not having direct computer control limits the mix of parts that can be run on the NC machine at any one time. Also, special designs all using different equipment had to be developed for each of the three different conveyors in the over-all system. Therefore, the costs ran more and the maintenance is more difficult with a mixture of controls as compared with direct computer control.

The chemical treatment line receives parts after all machining is completed (figure 4). The overhead conveyor delivers a production lot to the input point of the chemical treatment line. The chemical treatment line feeds the parts through 28 stations for the processing required for fluorescent penetrant inspection, deburring, cleaning and anticorrosion coating. A stepper drum control is used to control the entire line. Again, much more flexibility and lower cost would have been obtained had direct computer control been available for this treatment line.

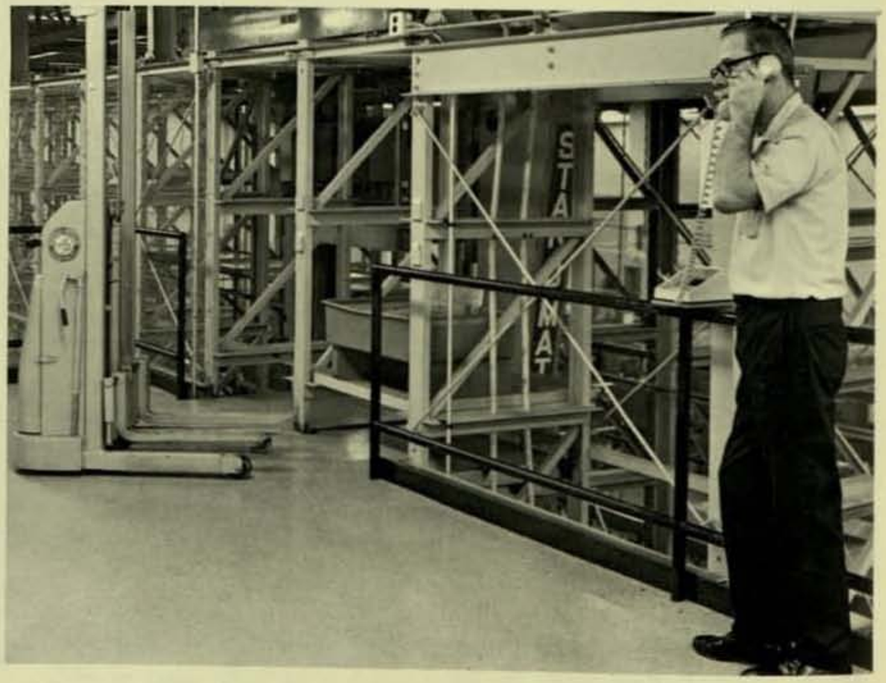

Figure 7. Stacker input from mezzanine.

System No. 2

The second system, also a powered roller conveyor system, is very similar to the one just described above as the main machining system except that the pallets are 40" diameter and the machines are, of course, larger than the OM-2. This system is a complete DNC installation. A very high mix of parts are run on the machines at one time without set-up changes, which results in high machine utilization. The only set-up change which interferes with the machine operation is the tool changing. When a new part configuration is sent into the line which requires tools that are not available in the tool drums, then the operator is instructed by the computer to load the required tools into specific machines.

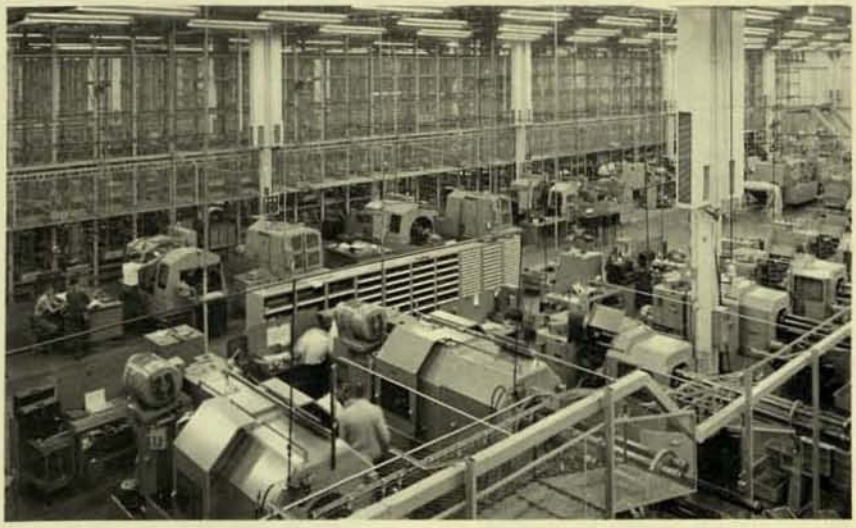

Figure 8. Bar machine and chucker area.

System No. 3

The third system is called the shuttle car transporter system, wherein the machines are supplied parts on pallets as in the other systems. However, the pallets are moved to and from the machines and loaded in and out of the machines by a shuttle car transporter. The transporter moves on a set of rails with the machine located along the tracks (figure 5). The shuttle car has provision for holding two pallets, so that when a machine is to have a fresh part loaded, the shuttle car is directed to that machine after it has picked up the new part and pallet from a load station. At the machine, the empty pallet position of the shuttle car is aligned to remove the part and pallet from the machine. As soon as the finished pallet is removed, the shuttle car moves to align the fresh part and pallet and then loads them onto the machine. As soon as this new part and pallet are loaded, the machine is ready to begin cutting. The shuttle car will then transport the complete part to another machine or inspection station if further operations are required, or it will return and deposit the pallet at a loading area where an operator will remove the part and load in another. This system is also controlled by a DNC unit which coordinates parts programs and parts movement while also directing the loading and unloading of machines from the shuttle car.

While the shuttle car system is in general similar to the loop conveyor line, it is more applicable to large parts with long cycle times, which reduces the number of shuttle moves required in a given period.

System No. 4

The fourth system is of a completely different configuration and can be used to run about any mix of cylindrical parts such as shafts, bearings, or gears, even though the parts may have a wide range of cycle times. This system more closely approximates a total factory in that its input is rough stock and parts are completely machined within the installation.

The installation consists of approximately 70 machines of many different types which, when used in various routing combinations, are capable of performing all machining operations

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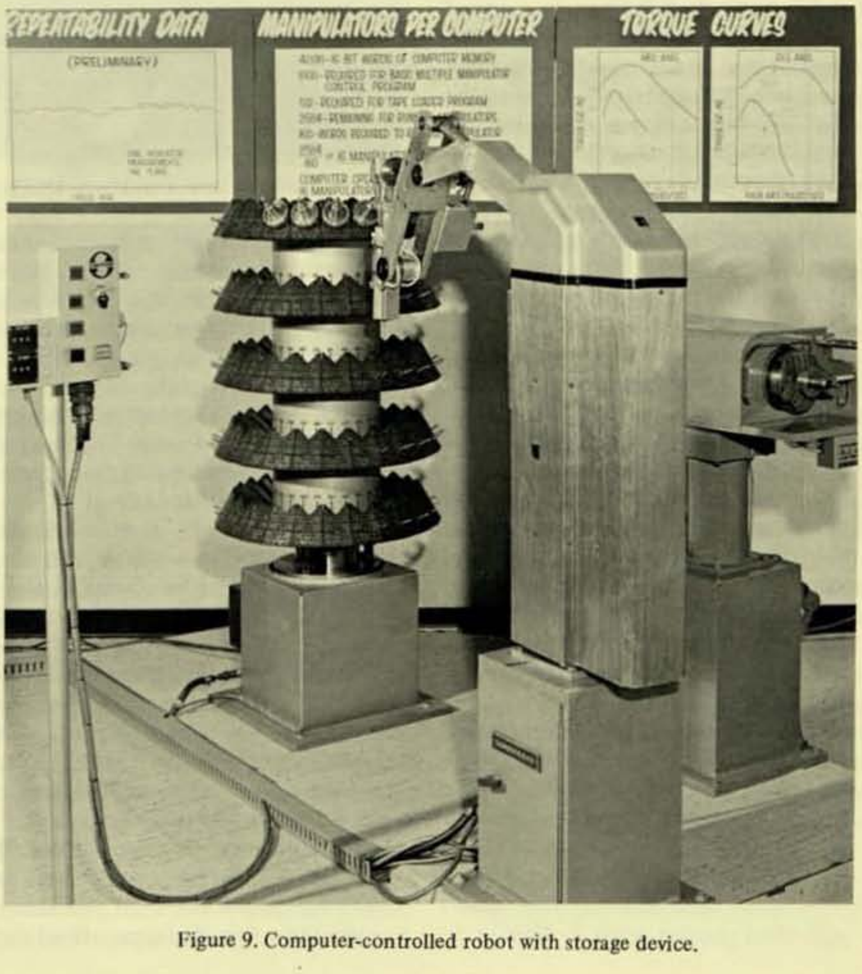

Figure 9. Computer-controlled robot with storage device.

required. The machines are located along both sides of three parallel stacker transporter units which are interconnected by overhead roller conveyors (figure 6). With this method of handling, pallet loads of parts can be transferred to and from any machine in the system by stacker crane and conveyor. Tooling, gages, and most fixtures are stored on a second floor mezzanine which is accessible to the upper bins on one end of each of the three stacker units (figure 7). These items, which are checked and preset here, if applicable, can also be moved to and from the machines as necessary by the stacker cranes. In addition to providing the transport function, the stackers are used for in-process storage from which machines can be fed.

Sampling inspection is done in the first floor area beneath the mezzanine. Parts for inspection are carried back and forth from the machines by fast-moving overhead conveyors located along the length of each stacker unit.

There are four general machining areas arranged among the stackers. One such area includes automatic bar machines of 2½" and 3½" capacity and is located at the extreme side of the installation adjacent to the raw steel storage area (figure 8). Near these machines and next to one side of the first stacker unit are six automatic chuckers and four precision lathes. Two vibratory deburring machines are also included in the area. With this arrangement, raw stock is fed to the bar machines and then on to the chuckers and lathes to complete the first operations. After completion in this area, parts are washed, deburred if necessary, and placed in trays. The trays are subsequently loaded on pallets in the bins located on the side of the first stacker unit, making it possible to transfer them near any of the other machines in the system. Some of the fixtures for the larger machines in this area are stored at the machines, but most fixtures, gages, and tooling for these machines are moved to and from the second floor area by the stacker transporter.

The second machine area is between the first and second stacker units and consists primarily of gear grinding and shaping equipment. Hand and rotary deburring equipment is also located in this area.

A third area between the second and third stacker units is devoted to four numerically-controlled machines—a Sundstrand OM-2 three Brown and Sharpe Hydrotapes, a jig grinder, and a hone; also in this area are nine Norton O.D. grinders.

Figure 10. CRT unit at machine.

On the other side of the third stacker unit is a group of machines devoted to bearing races. The machine complement consists of a disc grinder, chucking grinders, and I.D. grinders.

With this variety of machines and handling capability available, it is obvious that parts can be routed in about any way necessary to achieve the desired objectives. With the added feature of in-process storage, parts can be kept under complete inventory control as long as they are in the system, regardless of whether they are continually moving through their routing or not.

Since the stacker does not directly load or unload parts to a machine, other equipment has been provided to accomplish this function. One such device is a robot, operating under computer control, in conjunction with an intermediate part storage device (figure 9). This arrangement requires only that an operator load a quantity of parts onto the storage device from trays in the stacker, start the system, and allow it to cycle unattended. The computer-robot combination transfers parts between the machine and storage device and cycles the machine. The capacity of the storage device is large enough to allow the unit to run for several hours, even with parts with relatively small cycle times. This device is used with the precision lathes in the system being discussed.

Another device has also been developed to achieve automatic loading and unloading between a stacker unit and a machining tool. In general, the mechanism consists of roller conveyors located in the stacker bins which allow a pallet of parts to be fed directly to a special machine loader which services the machine. Finished parts are returned to the stacker, also via rollers to be picked up by the stacker crane.

Part flow in a system of this type is directed by a production coordinator or process control computer using a scheduling queue based on delivery dates as a guide for operations. All stacker moves and machine assignments are coordinated through the control function, which also notifies the tool mezzanine several hours ahead of time so that tools and fixtures can be prepared and entered into the stacker before the time they are needed on the floor. In this manner lots are cycled through the system with some parts placed in controlled storage from time to time to be fed to machines as they become available.

Control Systems Planning

When planning a control system for a manufacturing installation, the functions to be provided must be considered. Since a large installation usually means a large investment, the need for high levels of production and machine use is apparent. To meet these requirements, a high degree of system control, planning, and operator assistance is necessary. With a random mix operation, the number of parts programs required and their frequency of use dictate a controller that provides a practical means of loading, updating, and distributing such programs to the equipment. In addition to parts program handling, the controller or its associated equipment must monitor and control the movement of parts throughout the system. To do this the parts routing and degree of completion of each active part must be processed by the control equipment to provide the desired parts flow. The planned control system must be organized then with enough flexibility to meet the needs for a wide range of parts types and routings.

Because of the many variations possible in this type of installation, the amount of information required as an input to the controller can be quite large and require a significant part of an operator's time to monitor and enter. This can increase an operator's work load to a prohibitive level, or require a highly skilled person and, in some cases, even increase the staffing requirements of the installation. Therefore, when planning a system, consideration must be given to the equipment and methods which an operator will use to enter system parameters. To reduce this requirement on the operators, the control arrangement being considered should generate information which will keep him aware of current system status and, in some cases, instruct him as to what he should do next. If the controller is to complement the over-all installation completely, it should be able to direct the loading of parts and monitor machine loading and tooling requirements.

When planning a system control unit, maintenance should also be considered. Besides the obvious requirements of equipment reliability, ease of repair, and training provided, it is also possible to provide a controller which can assist an operator or maintenance personnel during troubleshooting and repair periods. Regardless of what degree of assistance is provided, the controller must have features to allow initialization and restart after interruptions.

In addition to controlling equipment either directly or by operator instructions, a complete control configuration should provide accounting data which can be used to analyze the total system operation over varying periods. From this data, production rates, machine use, down-time hours, etc., can be used to determine future scheduling, costing information, and inventory needs.

When reviewing possible control configurations for a machining system, the aforementioned features must be considered in addition to the usual items, such as degree of control, cost, and delivery, that are considered when specifying conventional equipment. It also should be noted that in an installation as large as the ones being discussed, the cost of controls is usually a small portion of the over-all investment, and the completeness of control and ease of operation contribute significantly toward achieving desired objectives.

Types of Controllers

There are several different types of control configurations that have been considered for large machining systems, but most of them cannot provide all the functions normally required to operate a total machining installation effectively, especially when a random input is desired. As a result, most systems are controlled with DNC or modified NC equipment.

In the applications using NC, additional sequential or manually-programmed stand-alone controllers are used for operating transfer and loading devices. In such an arrangement, the continuity between control modules is difficult to achieve and has caused the user to customize equipment himself to maintain an effective over-all system operation. Also, an NC system requires additional manual data recording and reporting to evaluate system status, as well as a large amount of effort in areas of tape handling and maintenance and parts program changes. As a result, there are very few large random-mix machining systems operating under NC controllers.

With the advent and optimization of DNC and minicomputers in the last few years, total system control and monitoring is possible and practical. Now that this equipment is available, manufacturing systems of the type being discussed are gaining wide acceptance in the metalcutting industry. In a DNC system, all areas of material handling, parts programming, machine control, management information, and operator instructions are coordinated by a computer. All pertinent information and operator instructions are displayed on a CRT (cathode ray tube) unit (figure 10) or printed-out for future reference. CRTs are located at the system input area and near the machine tools. Parts programs, routing, and tooling requirements are entered initially and used to maintain machine loading and part flow.

DNC is a definite asset in those systems using automated material handling equipment to deliver parts directly to the machines. It simplifies the problem of coordinating parts programs with the parts as they move through the system, which is important when several different parts are routed over the same machine. In many applications, machines are unattended with the control directing the loading and unloading of parts, assigning the parts programs, and starting the machines as soon as a part is loaded.

Systems of this type also require a certain degree of tooling coordination which is best handled by a computer. In most installations, parts programs are written to run on two or more machines with the part assignment governed by the tool complement on the machines. As a result, the computer must keep track of the tooling on

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MACHINING SYSTEMS continued

each machine and is used to assist the operators when tools are to be loaded or unloaded from a machine. This is done by having the operator list the tool numbers that are to be loaded on a CRT. The computer then selects the changer or drum position to be used and issues an instruction via the CRT, directing the operator to load a certain tool into a particular changer position. Tool removal is handled in the same manner.

Some systems using DNC incorporate input scheduling routines and do direct the operators through an input sequence that has been calculated to maintain production rates and machine use. This is done by displaying instructions on a CRT with a screen that is sequenced as each piece enters the system. Also, when a computer is directing the input, it can determine the lot that is to be entered next and print a list of tooling and fixtures that should be set up ahead of time. Set-up time will then be internal to system operation and will not affect use.

In those systems which do not directly load or unload machines, the DNC unit is used to coordinate parts movement to assure that enough of the right parts are delivered to a particular machine at the right time. When stackers are used to support production machines, the computer directs the crane movements, monitors in-process storage, alerts the operators when tooling, fixtures, or parts are needed, and controls the machines in the standard DNC mode. The same functions are also provided when other types of equipment such as robots, inspection machines, wash and chemical treatment equipment are automated.

The built-in monitoring systems that are usually included with a DNC system are also important in systems for management information reporting. Real-time data on cutting time, production rates, machine use, etc. are made available for analysis by production managers and are important in achieving the desired objectives.

All of these features are just further examples of how DNC complements a manufacturing system and does join in a perfect marriage with random-mix production.□

Authors Reynolds and Porter, Sunstrand Machine Tool, first presented this paper on April 19, 1972 at the NCS 9th Annual Conference in Chicago, Illinois.

NC EDUCATION
continued from page 1

knowledge of these devices, with the capability and desire to learn the specific equipment involved.

The fact that he has taken an interest in the NC field and taken the necessary courses in the numerous schools throughout the U. S. to learn NC (all phases) shows that he is someone with imagination, is self-sufficient, capable, and not afraid to take on the challenging field of NC.

What can an NC technician give you that you don't have or is readily available? He can give you the minimum amount of down time on your NC equipment. And, as you well know, down time costs money, delays, customers, and good will.

The NC technician will know your machine tool (he's on your payroll); he will be thoroughly familiar with all phases of it–from the machine itself on through to the computer. He will be able to troubleshoot and pinpoint any malfunctions that may occur in the NC machine tool.

This does not mean that he will never require help from the NC machine tool service rep. But what you gain is a knowledgeable person at machine-side who will know when to call for help and who will be able to understand troubleshooting assistance which can usually be supplied by a machine tool service rep over the telephone.

There have been many instances in the NC field when a machine tool could have been put back on line if the customer's technician had been capable of diagnosing a problem accurately and had been able to follow a troubleshooting excursion through a set of schematics with suggested remedies.

In some cases, when a service trip was necessary to a customer, it was found that improper troubleshooting techniques by the customer's maintenance department resulted in modules being replaced in wrong slots, modules not properly seated, fuses blown in power supplies, damaged wires, bridged connections, and missing signals due to component failure.

There are many, many more reasons for a service call–the majority of which could have been handled at the machine site either by an NC technician alone or with some assistance from the service rep.

Again, this does not mean you'll never need a service rep, but it will keep your down time to a minimum.

An NC technician is a specialist in a growing and complex field. As such, he should be in a technical category of his own; he should be in a higher salary range than the regular technician; he should be given responsibility commensurate with his ability and salary. He has either gone to school to learn NC or he is someone with experience in the field that has grown up with NC.

Schools such as NYC Community College are producing NC-oriented graduates with a two-year associate degree who are capable of learning your NC equipment from beginning to end, from the chip color to the programming of a part tape.

Also, don't overlook talented people on your own staff that have the capabilities but are overshadowed by your general job descriptions.

In 1955, logic and control were achieved through the use of relays, timing circuits, sequences, temporary storage in relay banks, permanent storage in paper tape, and, of course, in the machine tools. Finding electro-mechanical technicians to work in this field was impossible. However, with a personal interview it was possible to take an applicant who was a TV serviceman and train him in machine tools and relay logic, and at the other end, take a tool and die maker, with practically no experience in electricity, and train him in machine tool and relay logic. These people had one thing in common–they were systematic and analytical and they were not afraid of the challenge.

Today, the builder and user of NC equipment is more fortunate–there are schools producing the caliber of people required in this NC field of computer-controlled, programmed machine tools from point-to-point two-axis to continuous contouring on five-axis machine tools.□

APT-BP APT-IC APT-AC

The New IBM Family of NC PROCESSORS

By Carl Natoni

From a San Diego Chapter meeting, presentation by Gordon Smith, IBM.

Recognized as a leader in data processing and computer languages, IBM is now spearheading the standardization of machine language formats to APT. Newest of their powerful broad spectrum APT compatible languages are: APT-BP for basic positioning work; APT-IC for intermediate contouring; and APT-AC for advanced contouring needs. Serving the requirements of the smallest shop to the most complex needs of the megabuck installation, the languages have been created with an upward compatibility. According to Gordon Smith, IBM Manufacturing Industry Marketing, Western Region: "This eliminates the burden of changeover as the user's needs expand and grow."

So pronounced are the advantages of the new NC processors that the familiar AUTOSPOT and AD-APT will eventually be phased out. Present users will be happy to learn that compatibility is maintained to the extent that AD-APT can still be run under APT-IC while AUTOSPOT can be accommodated by APT-BP.

This new IBM family of NC Processors is configured for the IBM System 370 on a modular basis with a common language that is upward compatible, covering the full range of industrial usage. Significant among the many new features included are:

- Machinability Section
- Design Aid for Post Processors
- Metric Function Capability
- Debugging Aids
- Systems Library
- Edit Features

A most exciting feature of the new format is the machinability section, a section which APT itself does not as yet possess. EXAPT, an European adaptation of APT; is the only other major format offering a systematic means of coping with machining factors. "What's New at the Cutting Edge," **American Machinist**, March 5, 1973, points to the role of the computer in machinability: both Sandvik and Carboloy provide a computerized data bank or machinability program. The Carboloy system provides answers in minutes via GE time-sharing network through a subscriber's remote terminal.

Based upon empirical data collected at IBM on speeds, feeds, cutting tool, and workpiece parameters, the new processors have easily effected a 20 per cent savings in machine and cycle times through the use of these computer available data. Machinability factors, speeds, and feeds have always been a point of conflict with production people. No matter that a programmer be proficient in creating a technically correct APT program—any lack of cutting tool and work material know-how could severely limit the efficacy of his work. It has always been easier to teach the APT language itself than to promote the proper respect for machining parameters. A programmer, once burned, usually errs on the side of safety; this explains why so many NC programs have so much fat in them.

Initially provided by IBM is a machine file containing basic definitions of machine tools, cutting tools, and parts material specifications. Since this information must be tailored to the user's needs, an edit feature is used. The tool file lists, in a comprehensive manner, tool lengths, diameters, number of flutes, type of cutting material, plus any unique user requirements. The material file takes into account material classification number, machinability coefficient, surface feet per minute, feed per tooth, etc., while the machine tool file lists machine tool limitations, coefficients of behavior, speeds, feeds, and horsepower available.

Post processors—usually the lack of—have always been a problem, especially for the smaller shops and the smaller machine tools. While IBM does not provide post processors as such, they will be much easier to produce in-house "with a great reduction in the headacke factor." Design Aid for Post Processors (DAPP) can be used for lathes, single spindle machines, and mills and drills up to three-axis capability. Using a question and answer format, DAPP routines isolate common features, providing a logical framework for customizing a user's major post processor needs. The few remaining unique features can then be managed with greater ease. Main advantage to the user is the six-to-one time advantage in the creation of a particular post processor.

Since metrication is one of the most relevant subjects in the country today, IBM's Metric Function Capability is a

continued on page 11

NC BULLETINS

Annual Quality Control Conference
May 21-23, Cleveland

The 27th Annual Technical Conference of the American Society for Quality Control is aimed at preparing the quality professional to face the growing challenges for better services, more reliable products, and an improved life in our complex technological world. The meeting will be held May 21-23 at the Sheraton-Cleveland Hotel in Cleveland, Ohio. In addition to 50 technical sessions, a special feature this year is the Wednesday afternoon (May 23) modular consulting sessions at which guests may discuss quality-oriented problems with 18 recognized experts. There will also be a series of tutorial sessions covering fundamental principles and techniques necessary to total quality control. Details and copies of the preliminary program are available from: ASQC, 161 West Wisconsin Avenue, Milwaukee, Wisconsin 53203, telephone 414-272-8575.

AIIE Annual Conference
May 23–25, Chicago

"New and Old Ways" of solving problems, theme of the American Institute of Industrial Engineers' 25th Anniversary Conference, promises a look at the future with an eye on the past. More than 80 technical sessions will be presented at the May 23-25 meeting at the Conrad Hilton Hotel in Chicago, as well as panel discussions, informal symposiums, papers, and exhibits. The program is designed to provide solutions to the current and future problems facing today's and tomorrow's industrial engineer. For details contact: Technical Services, AIIE, 25 Technology Park/Atlanta, Norcross, Georgia 30071 (404-449-0460).

NCS NEWS

Delaware Valley Elects New Officers

Delaware Valley Chapter officers for 1973-74 were installed at a February 9 "ladies' night banquet." Shown above, left to right, are Stephen C. Clark, secretary; William M. McKenzie, chairman; William H. White, NCS executive director; William Rogers, vice-chairman; George Zimnes, program chairman; Louis F. Walton, treasurer.

Tenth Conference

Next month the *NC SCENE* will present a special report on the April 15-18, 1973 Tenth Annual Meeting and Technical Conference. A 406-page illustrated book of the conference proceedings is now available—see order form on page 11. A free copy of the book will be sent to each member in good standing as of April 1, 1973.

NUMERICAL CONTROL SOCIETY

Numerical Control Society (NCS) is a professional organization which provides opportunities to contribute to and learn about the application and technology of numerical control in all industries. NCS is affiliated with American Institute of Industrial Engineers (AIIE); Groupement Pour l'Advancement de la Mecanique Industrielle (GAMI); International Material Management Society (IMMS); and South African Numerical Control Society (SANCS).

NC PANORAMA continued from page 1

But not everything has changed. Hardware reliability and maintenance were key problems in 1963, and they are still with us. Customer field service could have been improved in 1963, and it still could be. There are still managers and shop operators who claim they do not have the "high-quantity production to justify NC," albeit the percentage of their lot is being reduced. NC machines are still relatively expensive when compared with their conventional counterparts, and the problems of economic justification persist. In 1963 there was a dearth of good parts programmers, and maintenance personnel and there still is. Accurate and sufficient documentation covering machine operation, maintenance, and post processors was a problem in 1963, and things haven't changed too much here, although there has been some improvement.

All things considered, this past decade has shown a respectable improvement in technology, service, and use of NC equipment. May the next decade prove even more interesting!□

NC PROCESSORS continued from page 9

most timely adjunct. Simply by specifying the units, a program can be worked metrically, in inches, or a combinatin of both, as needs dictate.

The Edit Feature is a powerful key for the creation and maintenance of parts programming libraries, machinability files, and the library canonical form files.

Smith noted that APT-BP should be available after August 1973 for $150 per month; APT-IC after October 1973 for $300 per month; while APT-AC (five-axis) should be ready after December 1973 for $500 per month. Said Smith: "Each step upward includes all the capabilities of the prior NC processor." □

NCS ORDER FORM

Books

B-1000. The Expanding World of NC. NCS ninth conference proceedings. 35 papers, 428 pp., ill., softcover. Most up-to-date and best coverage of NC technology available. $9.95 members; $11.95 non-members.

B-1001. NC 1971—The Opening Door to Productivity and Profit. NCS eighth conference proceedings. 33 papers, 486 pp., ill., softcover. Excellent, all-around NC reference and guide. $7.95 members; $9.95 non-members.

B-1002. NC—Management's Key to the Seventies. NCS seventh conference proceedings. 38 papers, 562 pp., ill., softcover. Ideal NC text and reference. $5.95 members; $7.95 non-members.

B-1003. Management Guide to NC. Pub. by NCS. 101 pp., ill., 7 x 9, softcover. Ten papers by leading NC authorities on justifying, organizing for, and using NC—profitably. An absolute must for middle and top management. $6.50 members; $7.50 non-members.

B-1004. Principles of Numerical Control. By James J. Childs. 229 pp., ill., hardbound. Revised, second edition. One of the finest introductions to NC available today. $10.00.

B-1005. NC Guide. By R. Shah. 240 pp., ill., 8¼ x 11 5/8, hardbound. Heavily-illustrated, definitive English-German-French guide to all production aspects of NC. $15.00

B-1006. NC Lexicon. By Y. H. Attiyate. 526 pp., ill., pocket-size, plastic bound. Detailed, well-illustrated English-German-French dictionary of the majority of NC terms. $12.00

B-1007. Programming for NC Machines. By A. D. Roberts and R. C. Prentice. 256 pp., ill., hardbound. An excellent, down-to-earth beginners' text for manual parts programming. $8.55

B-1008. APT Part Programming. By IITRI. 140 pp., ill., hardbound. Helpful and practical introduction to the concepts and language features required for basic APT part programming. $8.50

B-1009. Numerical Control of Machine Tools. By H. E. Horton. 480 pp., ill., 8 x 12, hardbound. A practical and useful English-German-French-Spanish NC dictionary. $30.00

B-1010. Numerical Control. By Nils Olesten. 646 pp., ill., hardbound. Comprehensive coverage of all aspects of NC from a practical viewpoint. **$21.50**

B-1011. NC/CAM—Profits for the Seventies. NCS tenth conference proceedings. 33 papers, illustrated, softcover. Outstanding collection of timely, original, and valuable information—the very latest in NC. $11.95 members; $13.95 non-members.

Courses

C-100. Basic NC Part Programming Course. NCS correspondence course. Specific answers and practical instruction in the art of hand part programming for NC machines. Hardbound, illustrated textbook, plus ten lessons. $45 members; $55 non-members.

C-101. APT Part Programming Course. NCS correspondence course. A thorough introduction to the world of computer-assisted part programming. Hardbound textbook, plus eleven worksheets. $55 members; $65 non-members.

Miscellaneous

M-001. NCS Membership Pin. Handsome, rich gold and deep forest green NCS logo imposed on a globe. $1.95

M-002. NC Scene. Official publication of NCS. Monthly magazine devoted exclusively to NC featuring articles, NC bulletins, Society news, and all items of interest to NC readers. Free subscription to NCS members; $12 US and Canada and $15 overseas for non-members.

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

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N/C NEWSCAST

VOL. 1, NO. 1

N/C TAPE PREPARATION WITH CMT's TAPE CENTER SLASHES COST BY 75% COMPARED WITH TIME SHARING.

CMT's Tape Center, a self-contained, in-plant, modular tape preparation system affords actual dollar savings over time sharing.

For example, an actual cost comparison of a daily taskload of 4 machining center tapes per day with the average tape consisting of 300 blocks of output and requiring 200 lines of input using manual programming; time sharing; and Tape Center preparation methods is shown below:

MANUAL PROGRAMMING	TIME SHARING*	TAPE CENTER**
14 hours (a)	2.2 hours (a)	0.3 hours (a)
x 4 tapes	x 4 tapes	x 4 tapes
56 hours	8.8 hours	1.2 hours
x $5/hr. avg. (b)	x $5/hr. avg. (b)	x $5/hr. avg. (b)
$280 per day	$44 per day	$6 per day
x 200 days/year required	+$160 Tel & connect time (c)	x 200 days/yr. required
$56,000 per year	$204	$1,200/year
	x 200 days/yr. required	+7,143/yr. amortization (d)
	$40,800 per year	$8,343.00 per year

(a) These turnaround times are relaxed by 25% to allow for inefficiencies and other related factors and are based on the time to produce an average tape at 80% efficiency.
The time for manual programming is based on time study of actual personnel and is therefore subject to some variation depending upon the individuals involved. However, the times for Time Sharing and Tape Center are chiefly equipment operating times and are not subject to variation.
Those parts of the programming task common to all three methods, such as writing the original manuscript, preparing a tool part coordinate sheet and typing the input tape or cards are not included in the analysis since they are not affected by the tape processing method.
(b) A flat rate of $5.00 per hour has been applied to all time values which is selected as representing an average for the types of work involved which are typing or keypunching and parts programming.

(c) CRU and computer connect time costs $56.00
Telephone line charges (400-600 mile) $104.00
Total Time Sharing Costs = $160.00

(d) Amortization of computer system and software approximately $50,000.00 over seven years = $7,143.00 per year.

*In addition to the labor involved in Time Sharing, real values for computer connect and CRU costs as well as telephone line time charges have been added to the operating cost.

**For Tape Center the cost of the computing system and software have been amortized over a seven year period which provides qualification for the 7% investment tax credit provision.

Send for more information on how you can realize high dollar savings on your N/C tape preparation using CMT TAPE CENTER. Write CMT, 5 Lawrence Street, Bloomfield, New Jersey 07003 or call (201) 748-7002 and ask for Mr. Steve Moss.

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