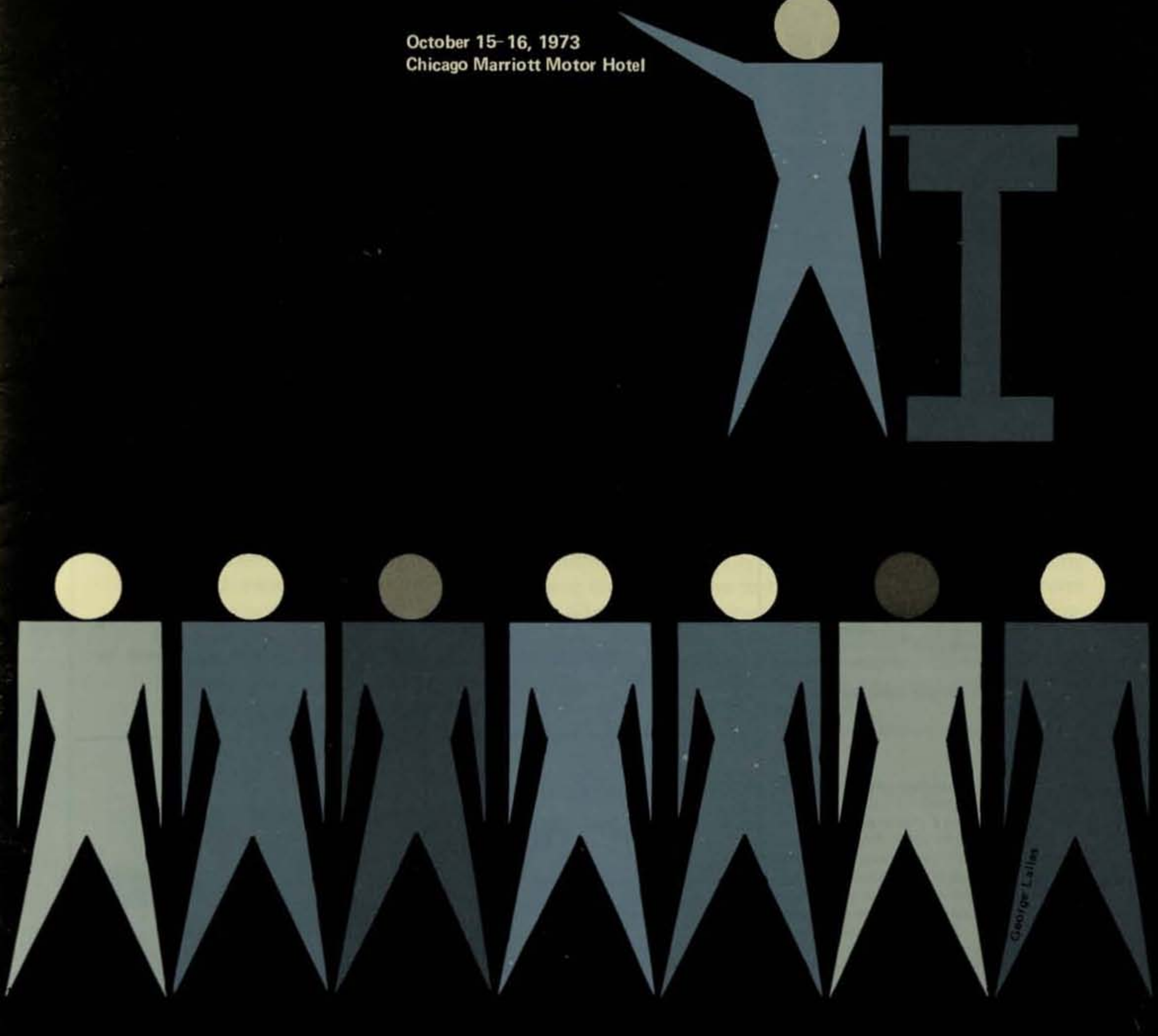
NC SCENE

September 1973

NC JUSTIFICATION SEMINAR FOR THE SMALL SHOP

October 15-16, 1973
Chicago Marriott Motor Hotel



NC SCENE

September 1973

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DIRECTORY

Cover: design and illustration by George Lallas.

Official Publication of the Numerical Control Society

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.

PARADOXES IN AN NC WORLD

JAMES J. CHILDS
Contributing Editor

In the world of numerical control, as with almost any other commercial field, there are certain developments that to all outward appearances will become a success; yet they fall flat. One might wonder whether the reasons for an unsuspecting demise are based on sound technical grounds or rather on conservatism and psychology.

Take the case of *digital magnetic tape* as an input medium, for example. Most computer-oriented persons would think that this is a natural. Far more data can be stored on a reel of magnetic tape than on a reel of punched tape. Data blocks can be fed to the control system at greater speeds via magnetic tape. There is no need to make the electro-mechanical coversion from magnetic to punched tape as required with most large computer systems. The magnetic tape can also be reused. And with inexpensive cassette-type cartridges, there is little chance of damage or contamination. There appears, therefore, to be nothing technically deficient about magnetic tape. Indeed, a form of analog magnetic tape was being used with numerical control machine tools even before the development of the punched tape medium.

Of course, the standard answer in favor of punched tape over magnetic tape is that one can read the hole patterns and, therefore, interpret the message. But, except for perhaps the end-of-block character, how many people read the hole patterns on tapes? There *is* one significant advantage with punched tape–that it can be prepared on relatively inexpensive equipment. But why do companies that use computers, which have magnetic tape producing capabilities, still use punched tape? One plausible answer is that the people that have to use the numberical control equipment, that is, the manufacturing personnel, are psychologically more *mechanically* than *electronically* inclined, and you can *see* the holes on a punched tape which is something you cannot do with magnetic tape.

Then there's the case of the *straight binary format* vs. the binary coded decimal format. The straight binary format is often easier to handle in the computer and the electronics within the control system is less complex. Technically, therefore, it seems to make more sense. Yet, the first system builder to offer it almost twenty years ago dropped it about nineteen years ago, and another system builder attempted it approximately ten years ago only to find that he was unable to sell a single unit. The entire argument of input media is probably somewhat academic, however, since there is a fair chance that CNC and/or DNC may solve the dilemma in many cases.

Another NC paradox is *retrofit.* While the retrofitting of low-cost controls to low-cost machines has proved to be reasonably popular, especially with low-cost point-to-point equipment, relatively large machine tool retrofits have not faired nearly as well, although in many cases, savings of from 40 to 50 per cent when compared with new equipment acquisitions can be realized. The argument against retrofit seems to be an aversion on many people's part to attach a new control system to an old machine, in spite of the fact the the *old* machine, in most instances, can be brought up to new machine accuracies. Admittedly, as time passes, the *old* machines become increasingly obsolete due to the advancements in the numerical control machine tools themselves.

Playback is another example of a seemingly justifiable concept; yet, for certain cases it has never really caught on (See *NC Scene,* April 1971.) A number of unsuccessful marketing attempts have been made; the first one before NC, in approximately 1948. Outside of the automotive industry there doesn't appear to be too much excitement about this one either, although in theory it would seem to have reasonable merit.

Then there's the case for *subcontract parts programming.* While there are a few companies that have made a go of this, they have succeeded by almost super-human and exceptional service. Many more companies have withdrawn from the field. One of the more obvious problems seems to be an exceptional requirement for extreme versatility. The subcontractor must be familiar with the equipment and tooling practices of a variety of customers. This is no mean task even for those associated with one plant. Another problem with this type of business is that most potential customers are not truly aware of their total programming and tooling costs and may feel that contract prices are inflated. Obviously, this is not the case since so many companies have decided to drop this activity. Only the exceptional ones have survived. There also appears to be that psychological tendency towards the NIH* factor, in addition to the fact that subcontract costs are more obvious than in-house costs.

And last, but not least, how about *adaptive control?* At one time it appeared that the programmer and machinist would be able to throw away feed and speed tables (if he ever used them at all.) Under laboratory and in-plant manufacturing tests, adaptive control has proven itself, both technically and economically–however, not in the order book. There may be two reasons for this; one is that the cost has been relatively high when compared with the cost of the control system, and another is that some people foresee that CNC (or DNC) may be able to handle adaptive control better than hard-wire offerings. Only time can answer this one. It should be pointed out that one company, which began offering a retrofit adaptive control unit a relatively short time ago, appears to be doing reasonably well. In this case, the cost of the unit is approximately one half to one third that of previous units and the retrofit requirements are palatable.

From NC history alone it is apparent that some things sell and others do not. Even in retrospect the answers to *why* are not always obvious. You can probably be sure of one thing, however. There will be some company in the future that will introduce a "new" playback system, or invest heavily in the market of large-scale retrofits, or develop a "special" magnetic tape system, or propose and invest in a grossly nonstandard tape format. It may look good on paper, but if experience teaches anything–it probably won't sell.□

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*Not Invented Here.

Coordinate Measuring Machines

Applications at Solar

By Carl Natoni

Thirteen pieces of point-to-point NC equipment in constant use are 13 very valid reasons for coordinate measuring machines (CMMs.) Waiting 8 to 12 hours for the completion of a first part layout is a dim and unpleasant memory, according to Gerald H. Fox, NC programmer at Solar–Division of International Harvester in San Diego, California.

Solar now has four Sheffield Cordax CMMs: three small Model 300 machines plus a Model 7000 devoted primarily to the production inspection and first part layouts for Solar's numerical control efforts. Since the Model 7000 has computer assistance, Fox naturally spent more time on it. However, the three smaller machines are performing yeoman service: one in receiving inspection at the Rose Canyon gas turbine packaging facility and two in the conventional machining areas.

Programming from actual production paper, Fox determines inspection sequences and provides nominal coordinate locations and the necessary mathematical routines. Upon arrival of the part and check tape at the CMM, it's a simple matter to dog the part lightly to the table since the CMM's automatic alignment compensation feature does away with the need for tediously zeroing in the part. The inspector then inserts the check tape, inputs significant hole and/or surface references and under program manuscript direction positions probes to the proper X-Y-Z location for each dimension to be checked. Unfortunately, Solar's installation lacks the automatic checking feature which allows the entire operation to be under computer numerical control. Accepting each reading, the computer checks it against the recorded nominal, compares tolerances, produces a print-out of actual dimensions plus any out of tolerance condition.

In answer to a question, Fox admitted that probe insertion was a manual function. "We have 70 different styles of probes that are used in over 150 tape programs in our library."

Working toward the use of FOCAL 8 and CMAP 8 in conjunction with the purchase of a Digital Equipment Corporation dual tape deck, Fox is planning to couple the languages with an additional 4K and OS-8 operating system. This will add 500K storage to the system plus allow loading memory in 3 seconds versus the present 35 minutes.

FOCAL 8 (Formula Calculator), a math-oriented language is already being used to some degree by Fox. With information derived from the Cordax, he can easily average the results of a series of readings; any geometric formula can be resolved directly e.g., the X and Y coordinates of any number of holes on any bolt circle. In an effort to expand his programming options further he is adapting the use of CMAP 8 (Coordinate Measuring Analysis Program), a recent development by Sheffield Cordax of a standard program allowing even greater information storage and retrieval capability.

The shop tour through the NC machining area and tool preset room culminated in a visit to the temperature-controlled room where the Sheffield Cordax Model 7000 was viewed in action. With a measuring range of 72" in X, 30" in Y, and 24" in the Z axis the machine can accommodate a full work height of 36". A full 2,000 pounds can be handled under static conditions while the motor elevating table can manage 1,000 pounds.

Interfaced with an ASR 33 Teletypewriter, the system can read or punch 1" eight channel tape in ASCII or Binary Code and either ASCII or EIA input is acceptable. The basic computer assist is accomplished through a Digital Equipment Corporation PDP-8E with a 4K core and an 8K overlay. (Note: This will be soon expanded to 12K plus the installation of the DEC tape deck.)

When questioned about accuracy, Fox replied: "We're guaranteed plus or minus .001 over the entire measuring range at a plane 8" below the Y axis carriage–and furthermore, the repeatability is plus or minus .0002." Due to the heavy use of the Cordax 7000 system, Solar is investigating the possibility of retrofitting one or more of the Model 300 units to Cordax 3000 specifications with an 8K computer assist.

Unfortunately, Fox was unable to quote actual time value comparisons between surface plate checks and the present CMM techniques. However, the understanding at Solar is that one hour of Cordax time is equivalent to 10 hours on the surface plate. Suffice it to say that an inspector would take it as a personal affront to be asked to make a surface plate check in areas served by the CMMs.□

From a San Diego Chapter meeting report, presentation by Gerald H. Fox, Solar–IH.

MANAGEMENT GUIDE TO NC

No one concerned with any aspect of management should be without this book. In fact, no one who holds any position concerned with NC can possibly afford to miss the wealth of information contained in this valuable, hard-hitting guide. Here are the facts about not only the advantages but the unexpected pitfalls in justifying, organizing for, and using NC—profitably.

Ten leading authorities candidly discuss Principal Problems Facing the User; NC is a Business Tool; Economics of NC Machine Tools; Computer-Aided Manufacturing for the Seventies; NC—What's it all About? Computer Services for Management; Affect on the Work Force—Union Problems; Management and Design Aspects of Small Batch Production; Introduction of a New NC Unit; and Data Retrieval for NC Management.

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NC JUSTIFICATION SEMINAR FOR THE SMALL SHOP

October 15-16, 1973
Chicago Marriott Motor Hotel

Co-sponsored by NCS and Machine and Tool Bluebook

Monday, October 15

8:30 GENERAL SESSION: Presentation by William Hack, Harper College. *Definition and history of NC; types of NC; typical applications; management implications; point-to-point systems; contouring systems; programming systems; advantages and disadvantages; associated tooling.*

1:30 WORKSHOPS: Presentations by moderators, followed by questions and answers and interchange of information.

1:30 A. Justification of NC: Eric Sund, Ideal Tool and Manufacturing, and Joe Nikoden, Armour Metal Products, moderators. *What are the areas of savings? Should I purchase new tools, used tools, or retrofit existing tools? How can savings be estimated?*

3:30 B. Training: Atols, Atols Tool & Mould, and Jim Heisler, Harper College, moderators. *Local schools; programmed courses of instruction; special seminars; tailor-made programs; how much do they cost? Who should be trained? Ho much training should be given?*

Tuesday, October 16

8:30 WORKSHOPS (continued)

8:30 C. Maintenance: Daniel Caskey, Auto Cut Machine Co., and Don Andrews, Cincinnati Milacron, moderators. *The supplier; the owner; special maintenance companies cost considerations; availability; how much electronics is involved? How difficult is it?*

10:30 D. Tape Preparation: Lee Posterick, Mueller Engineering and Manufacturing Co., and Ken Stephens, MDSI, moderators. *Do I make my own tapes? Can I hire this expertise? What material should I use for the tape under specific conditions? Can a computer help? Will it be expensive? How difficult is programming?*

1:30 E. Organization: Bob Parrott, Hills-McCanna, and Bill Hack, Harper College, moderators. *Who gets involved in NC? To what extent? Many specialists or a few generalists? Will I need to redo the organization completely to accommodate NC?*

3:30 PANEL SESSION: Don Andrews, moderator, with Lee Posterick, Bob Atols, Joe Nikoden, and Dave Conville. *A summary of workshop activities, with reactions; questions and answers.*

Registration: $65; fee includes coffee breaks, lunches, and dinner, plus a copy of the book *Management Guide to NC.* Mail your registrations direct to Machine and Tool Bluebook, Hitchcock Publishing Company, Geneva Road, Wheaton, Illinois 60187, attn. Ron Kegerris (312-665-1000).

Hotel: Make your reservations directly with the Chicago Marriott Motor Hotel, 8535 West Higgins Road, Chicago, Illinois 60631 (312-693-4444).

QUALITY ASSURANCE

QA meets today's NC challenge through innovation

by Kenneth R. Wulf

Although inspection will never be eliminated, it plays a lessor role in today's QA function than it did in the past.

A quality assurance department associated with the world of numerical control can no longer be thought of as the area in the plant where piece part inspection is the primary objective. Although inspection will never be eliminated, it does play a lesser role in today's quality assurance function than it did in the past. For example, the tight tolerance requirements of parts machined on today's machine tools must be measured to determine if the critical ten-thousandths of an inch are being maintained, but first it must be determined if the machine is capable of providing this accuracy before actual chip cutting.

Precision Measurement

To accomplish this, certain geometric characteristics must be controlled and measured by the manufacturer of machine tools during erection of the machine. Just as the foundation of a complex building must be rigid and solid, so must the foundations of a machine tool. The steelways that serve X, Y, and Z linear motions must be erected flat, straight, and parallel to control the allowed tilt, deviation from straightness of motion, and axis squareness relations in the work zone above the table top. The steelway characteristics are established by the aid of exotic metrology equipment and optics such as electronic levels, and autocollimators. These instruments, accompanied by technology and the expertise of the user, will provide a basis for measurement to the nearest ten-millionths of an inch when calculated and when the way profile is analyzed graphically.

The same precision measurements must also be made for rotary motions such as for the table and head axis and this is accomplished by means of indexing equipment or polygons and the automatic autocollimator. Precision measurement also applies to lead accuracy for the linear motions which are measured using the laser interferometer. The lead measurements for linear motion represents linear displacement as opposed to angular displacement measurements made for rotary motions. To control the lead accuracy of a machine also means measuring tilt and straightness of motion using electronic levels and calibrated straightness in conjunction with an electronic indicator.

As a manufacturer of numerically-controlled machine tools with a high degree of accuracy, the previously mentioned measurements are most im-

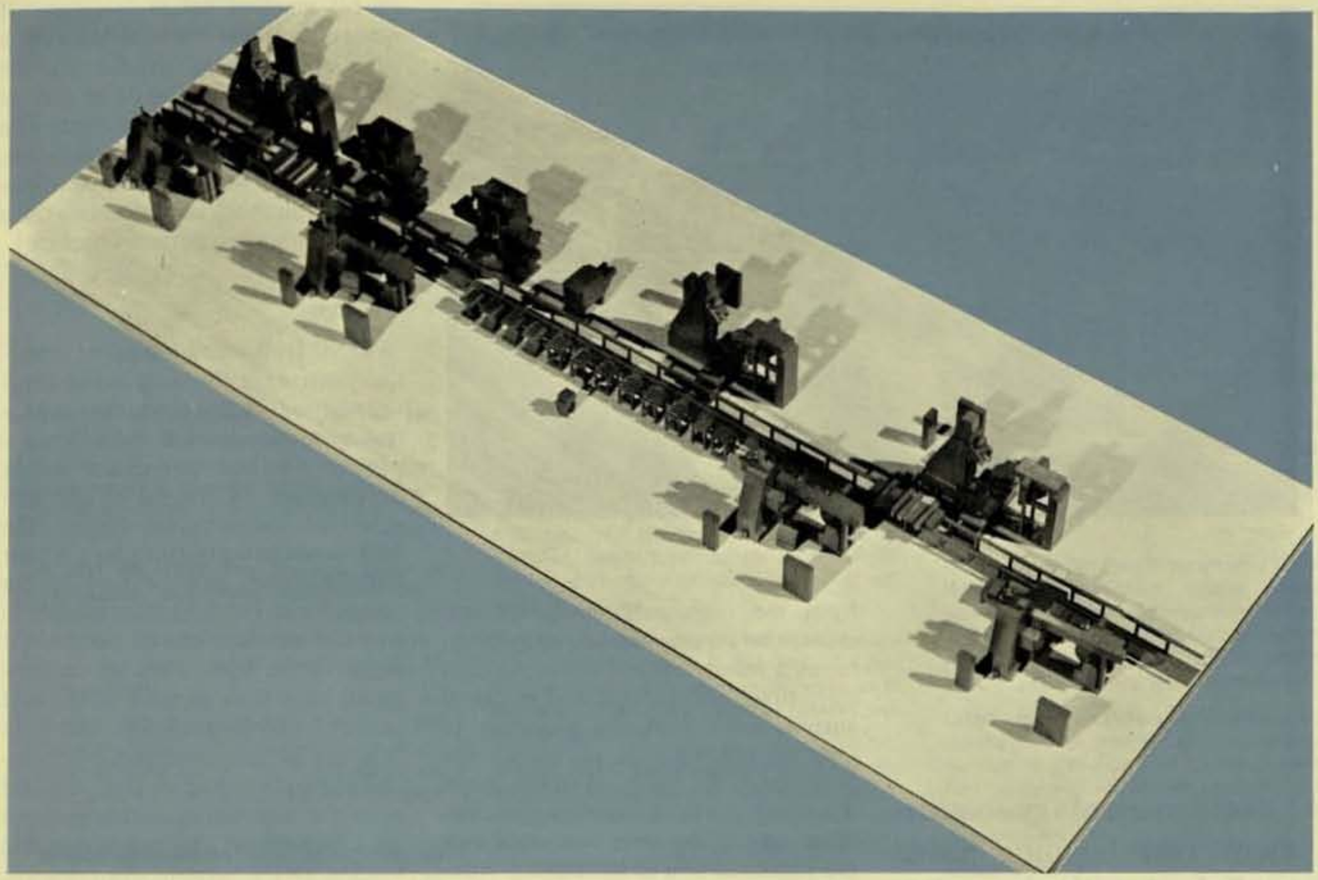

Figure 1. Model of third machining system.

portant. But because these characteristics are complex and controlled only through maintenance, they must be measured from time to time during the life of the machine and ideally are considered during preventative maintenance of any machine tool whether numerically controlled or conventional. The products Sundstrand builds are based on the same principles and concepts of alignment that is carried over into the maintenance program, which is additional responsibility for the quality assurance technicians.

In the past it has not been uncommon to see two, three, or more similar machines operating in a given plant, but all independent of each other, the only similarity being the same manufacturer brand name or machining the same or similar parts. But today is the initiation of a new era of high-volume machining systems—a number of machines of different capabilities interfaced by a material handling system that begins with a raw casting and follows through all machining operations until the part is also inspected in this system before being sent to stock.

Figure I, for example, shows a model of the third machining system which is currently being assembled in Sundstrand's plant. It consists of four five-axis contouring machining centers, three drilling and tapping centers, two vertical turret lathes, a wash station, a coordinate measuring machine, sixteen load-unload stations, and the complete system will be operated by two men and the support of the Sundstrand Omniline computerized direct numerical control system. The computer operates the two railroad cars that transport the castings (secured in fixtures that are mounted to the pallets from the load stations) to each of the various machine tools for processing as required, until the finished product is accepted and returned to the unload station for removal from the fixture and finally sent to stock.

Minicomputer Interface

Because of this concept and other added responsibilities for additional measurements, the quality assurance department has also had to become an innovator to meet the demand for greater accuracy in measurement, in a more efficient manner to save time, and yet reduce the probability of any error. When similar requests for efficiency and flexibility were required

The QA department has to become an innovator to meet the demand for greater accuracy in measurement, faster, with less probability of error.

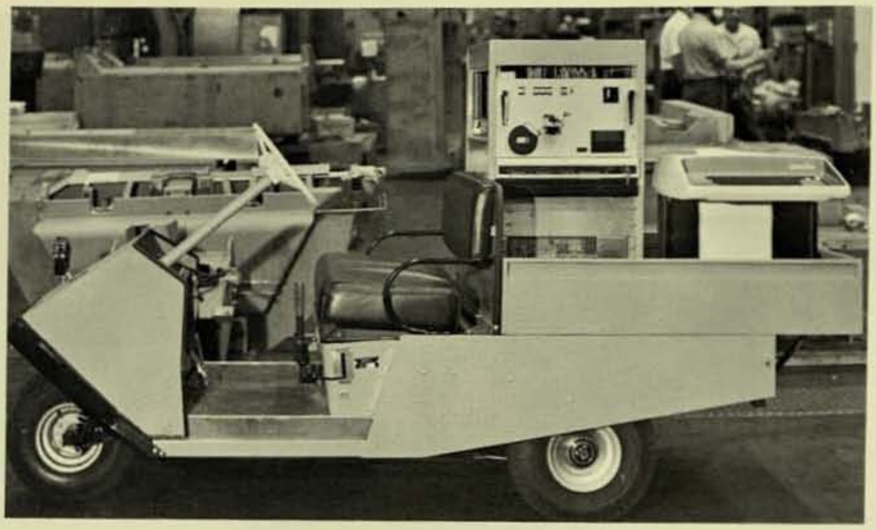

Figure 2. Electric cast.

Exotic metrology equipment can become more proficient with the assistance of a minicomputer interface.

The QA department is on the threshold of a new era of assuring product integrity.

from the coordinate measuring machine, the answer was found by interfacing a minicomputer. Since the data collections, calculations, and graphical analysis are a must, the only way to improve efficiency is to reduce the time spent for each of these steps. Therefore, the exotic metrology equipment can become more proficient with the assistance of a minicomputer interface that will accelerate accurate monitoring of derived data. This innovation will also derive more benefits from existing, and any change in the state of the art for, metrology equipment.

In the past, a quality assurance technician had to record the data, manually calculate, and then graph this information for analysis of qualification. Today, someone performs the manual moves and sets up the equipment, but data collection, calculation, and graphic interpretation of the data can be done by the minicomputer with the assistance of a teletype which will print the calculated data as well as print a graph, both of which are interfaced to the metrology equipment. For added flexibility, a tape reader and tape punch are also a part of the system. All of the software equipment is mounted on an electric cart (figure 2) which provides mobility to the machine and instantaneous analysis of the data. In many applications the required time for data reduction has been reduced three and four fold. This allows immediate correction and remeasurement of the characteristic in question for qualification.

This system will also reduce the time required for a customer to witness leads and rotary capabilities performed on his machine before acceptance if witnessing these measurements is a part of the sales contract. It will virtually eliminate the probability of any human error occurring during data collection, analysis, and interpretation. The system also lends itself to comparing the analysis of the data against predetermined acceptance criteria.

SWINC

SWINC (soft-wired integrated numerical control) is the most recent Sundstrand product line innovation in control systems, and will virtually compensate for lead errors, and can be programmed by the aid of the computerized measurement system. The lead measurements taken by the laser interferometer will be sent to the computer in the time required only to stop the axis long enough for the laser signal to be transmitted to the computer, and then progress to the next reading. The lead error at each position can be calculated and the correction factor punched on tape. Any lead error for a given axis is then gathered on a single tape. This tape is then read by the SWINC system and automatic computerized compensation takes place. (Note: the only human assistance required is to set up the laser and peripheral equipment, and initiate tape feed for the reader.) All compensation is automatically accomplished in a reduced time frame and is superior to anything in the past. Because of the increased efficiency, more than one lead check can be made in various locations of the work zone for the same axis. A complete work zone matrix is feasible with this system.

As experience is gained using the mobile data collection system, eventually other machine alignment characteristics such as tilt, straightness of motion, squareness, etc. will by analyzed with this system. Even spindle modulus, temperature control, and growth, as well as other quality controlled features, will be monitored with this system. It appears as if the quality assurance department is on the threshold of a new era of assuring product integrity.□

Author Wulf, who is manager of QC at Sundstrand Machine Tool, first presented this paper at the NCS Tenth Annual Conference, April 1973, New York City.

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NCS NEWS

Eleventh Conference

Already hard at work on the 1974 conference, the NCS committee reports that the March 31–April 3 Toronto-based meeting will have a strong international flavor.

National meeting coordinator is Ray Gibson, Government of Ontario, 950 Yonge Street, Toronto, Ontario; conference chairman is Alan Mundy, Robert Morse Corporation, Rudic Industrial Division, 270 Evans Avenue, Toronto 18, Ontario; and technical program chairman is Ken Adams, Mechanical Engineering Department, University of Waterloo, Waterloo, Ontario.

Papers are invited for consideration (see page 11, this issue.) Deadline for abstracts is October 1 and for papers, December 1. For further details contact Technical Program Chairman Ken G. Adams, above address.

Who's Who in NC

The 1973 Who's Who in NC, NCS directory of members, is off the press and in the mail. A copy has been sent to each NCS member.

Tenth Proceedings

Extra copies of *NC/CAM–Profits for the 70s* are available from NCS headquarters. Prices are $11.95, members and $13.95, nonmembers. For information on bulk order discounts, write to NCS, P. O. Box 138, Spring Lake, N. J. 07762.

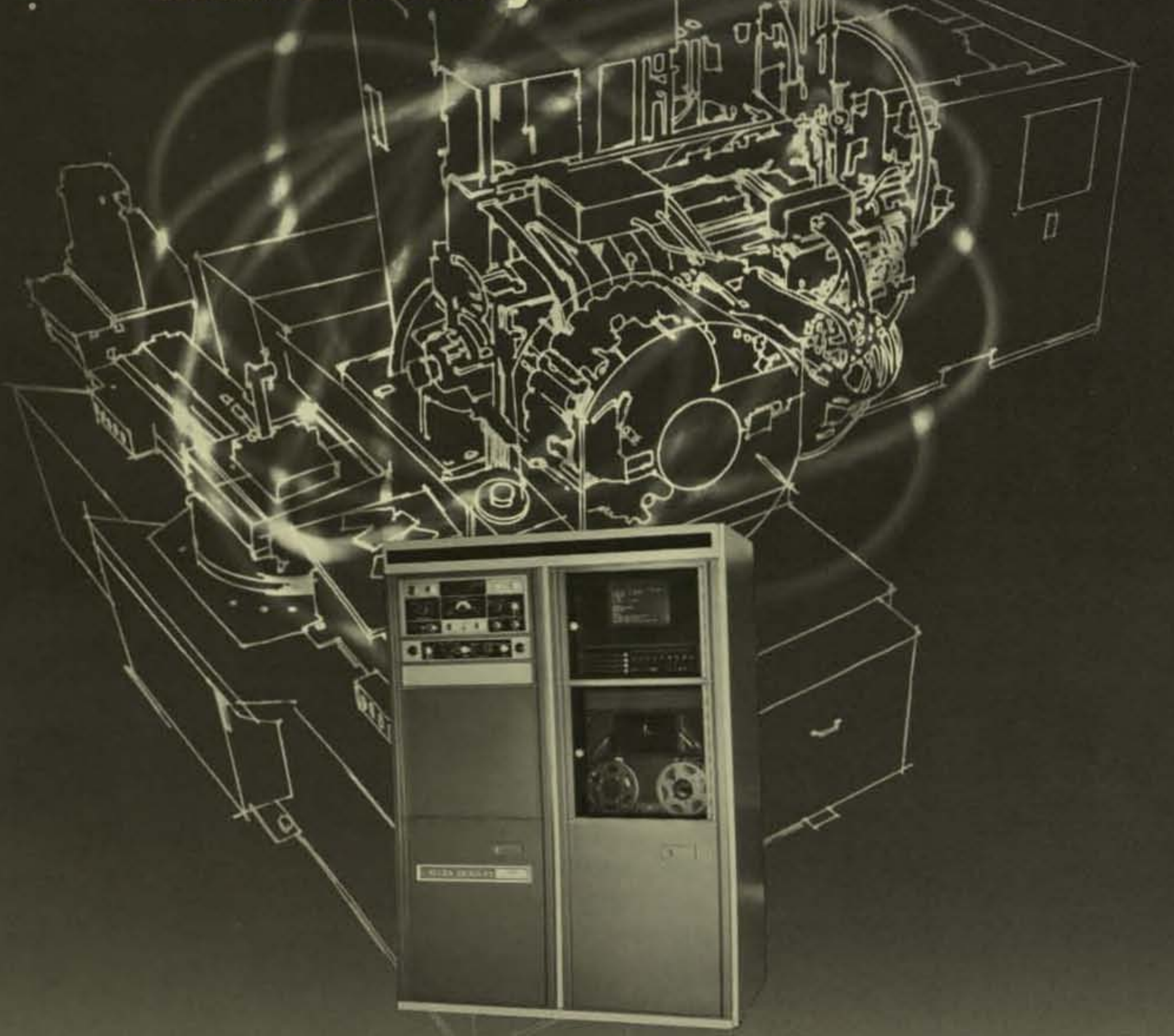
NCS Publications

NCS is preparing to expand its publishing activities. On tap for late 1973 and early 1974 release are two new periodicals–watch for details in the next issue of the *NC Scene*.

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).

This CNC is right for now ...and ready for tomorrow



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Standardization. The programming, the hardware and the training (both operator and maintenance) are common to all 7300 systems. Saves you time, money and part inventory headaches.

Additional features. The System 7300 has other important N/C capabilities that equip you for tomorrow, even if they are not required today:

- Program storage
- Tape Edit • Axis calibration
- Format compatibility
- Auto Accel/Decel • Digitizing
- Status Reporting • New interpolation techniques

And it's DNC compatible, of course.

So, to profitably increase your productivity through computerized numerical control, take a closer look at the Allen-Bradley System 7300. Write for details.

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NC51 A

CALL FOR PAPERS

Numerical Control Society Eleventh Annual Meeting and Technical Conference

March 31-April 3, 1974
Royal York Hotel, Toronto

GUIDELINES FOR PAPERS

The papers to be presented will be separated into three groups and the international aspects of NC will receive considerable attention:

I. Papers focused on solving today's cost-price problems. Special emphasis will be placed on how-to-do-it, practical guidelines, description of successfully operating facilities, from small shops to large concerns, and any other topics that will help end users in the audience to get into NC or to use their existing NC facilities more effectively;

II. Papers on trends, techniques, new developments, new applications, etc., that will be broadly encompassed under the title "the state of the NC art"; and

III. Tutotial papers on basics of NC economics, use, realization, and standards.

TOPICS

NC Programming and Software Development. Languages; Sculptured Surfaces; Special Macro Developments; Programming Techniques for Metalcutting and Nonmetalcutting Applications.

DNC and CNC. Hardware and Software Developments; Interpolation Techniques; Post Processing; Retrofitting; Adaptive Control.

NC System Applications. Leather; Textiles; Woodworking; Electronics; as well as Metalworking, including Robots.

CAM. Automated Factory Concepts; On-Line Computer Control of Groups of Machines; Scheduling of Machines, Tools, and Materials; Integration of Management Function Within a Manufacturing System.

Maintenance for NC. Established NC Preventive Maintenance Systems; In-House vs. Contract Maintenance; Costing.

NC Graphics and Data Base. Data-Base Developments; New Approaches Using Graphic Displays.

Management Aspects of NC. Economics of NC, DNC, and CNC; Machine Tool Selection; Programmer Selection, Qualification, and Training.

Other Topics. Design; Inspection; NC Abroad; Any Other Topic Related to NC/CAM Not Specifically Listed Above.

DEADLINES

Abstracts: 6 copies of one- to two-page, double-spaced abstract, accompanied by biographical sketch, must be submitted by October 1, 1973 to the Technical Program Chairman, Dr. K. G. Adams, Mechanical Engineering Department, University of Waterloo, Waterloo, Ontario N2L3G1, Canada.

Papers: 3 copies of the final paper for presentation and publication in the conference proceedings, typed, double-spaced, and accompanied by supporting 8 x 10 glossies and/or slides, with drawings in pen and ink, are due December 1, 1973. Submit one copy to Technical Program Chairman, above address; one copy to National Meeting Coordinator George R. Gibson, Industrial Development Officer, Government of Ontario, 950 Yonge Street, Toronto, Ontario, Canada; and submit the original with original art and photos to Editor Mary A. De Vries, NCS, P. O. Box 26, Concord, N. H. 03301.

George R. Gibson, National Meeting Coordinator
Alan Mundy, Conference Chairman
K. G. Adams, Technical Program Chairman

B/NC REPORT

Pay off begins at plug in.

That's what E. M. Machine & Tool Corp., Clifton, N.J., found out when it took delivery on a Bridgeport Series II N/C milling machine. Within days this shop was delivering completely acceptable blister pack molds to a major customer, and already has a second Bridgeport NC machine on order.

Prototypes the first day

Fact is, Philip Moherek, President of E. M. Machine & Tool, produced prototype molds the day after the N/C machine was installed. Although unfamiliar with N/C, programming and the Series II machine, Phil himself programmed the tape for the prototypes. Phil's shop has since produced several other parts, including right and left hand parts from the same tape program. (This is done simply by reversing the X and Y axes).

Simple Programming, Setup, and Operation

Getting the Series II N/C into production this quickly is possible because the B/NC system requires no special operator skills. The operator uses familiar planning methods,so learning how to program and operate it is relatively easy. Simplified fixturing and qualified tooling make setup easier,too.

Bridgeport shows you how

To make learning how even easier, Bridgeport provides programming and operating instruction. Phil Moherek of E. M. Machine & Tool took the programming course and finished programming the tapes for his production molds while attending our school. Specialized training in logic, computer programming, and maintenance is also offered.

E. M. Machine & Tool buys a second machine

The reasons: fast payoff from the first N/C miller; capacity to handle bigger jobs; faster, closer tolerance machining. For details on the capabilities and production economy of our N/C millers, see your Bridgeport dealer. Or write for our N/C catalogs. Bridgeport Machines, Bridgeport, Conn. 06606.

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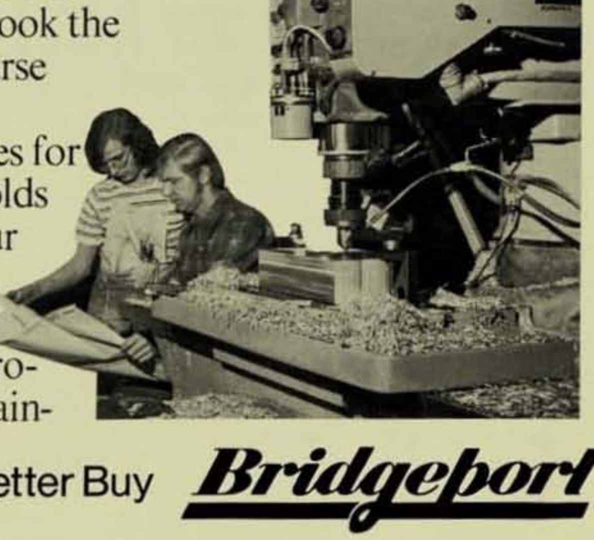

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