MINUTES OF 22nd MEETING
MAY 20-21, 1971
LAWRENCE RADIATION LAB
LIVERMORE, CALIFORNIA

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INTERAGENCY MECHANICAL OPERATIONS GROUP

NUMERICAL SYSTEMS GROUP

Minutes of 22nd Meeting
May 20-21, 1971
Livermore, California

S. D. Carpenter, Chairman

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22ND MEETING OF IMOG NUMERICAL SYSTEMS GROUP

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22nd MEETING OF IMOG NUMERICAL SYSTEMS GROUP

Highlights of Meeting

1. The report and opportunity to discuss positions with the Chairman of the IMOG Steering Committee. A summary of this discussion is on Page 3.

2. The reports on the planned CAD/CAM Conference, EIA Standards, Infrared Data Link, N/C and DNC in Western Europe, and UNIAPT on a PDP-10. These reports are included in Appendix C, on Page 26.


4. The Facility Reports indicating activities and equipment at each represented agency. These reports are included in Appendix D, on Page 40.
### Attendance

#### Name

**Members**

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<tr>
<td>S. D. Carpenter (Chairman)</td>
<td>M&amp;H-SM/Amarillo</td>
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<tr>
<td>G. M. Simms</td>
<td>M&amp;H-SM/Amarillo</td>
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<td>G. M. Adams</td>
<td>USAEC/ALO</td>
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<td>C. H. Turnbull</td>
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<td>K. J. Jones</td>
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<td>C. T. Shawhan</td>
<td>Mound</td>
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<td>C. R. Miller</td>
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<td>D. J. Kava</td>
<td>Dow Chemical</td>
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<td>R. V. Miskell</td>
<td>Union Carbide/Y-12</td>
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<td>M. D. Sestric, Jr.</td>
<td>Bendix, Kansas City</td>
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**Guests**

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<td>Joe Jensen</td>
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<td>Leon Smith</td>
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<tr>
<td>Hanloy Quock</td>
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MEETING MINUTES

The 22nd regular meeting of the IMOG Numerical Systems Group convened at 8:45 a.m., May 20, 1971, at the Lawrence Radiation Laboratory, Livermore, California, with Chairman S. D. Carpenter presiding. Welcoming comments and host announcements were made by R. J. Spies and B. M. Zimmerman, LRL.

Visitors introduced were Leon Smith, LRL; Hanloy Quock, SLL; and Al Jensen, LRL. D. G. Miller and G. H. Anderson, LASL, were recognized as new members of the Group.

Mike Sestric indicated that the minutes of the last meeting should be corrected on Page 21 to read, "This computer will replace an existing IBM 360/50 I."

Steering Committee Report

Al Jensen, Steering Committee Chairman, reported on recent Steering Committee activities. A special meeting was held in December, 1970, at ALO headquarters in Albuquerque, to critique papers prepared for presentation in the Technical Exchange Meeting scheduled with the National Machine Tool Builders Association. Correspondence from NMTBA immediately prior to this meeting requested postponement of the Technical Exchange Meeting from January, 1971, subject to review in June or July, 1971. Their basic reason was lack of planned participation on the part of their membership due to current economic conditions.
Mr. F. J. Arrotta of AEC/ALO challenged the Steering Committee to review the structure and value of IMOG. It was determined that this review would be conducted by having the various Subgroup Chairmen attend a Steering Committee meeting and present information relative to membership, past activities, and future plans of each Subgroup.

The Steering Committee met again in May, 1971, at Union Carbide, Oak Ridge. In this meeting, the Machine Tool Subgroup, Gaging Subgroup, and Numerical Systems Group Chairmen reported. The conclusion reached by the Steering Committee indicated that these Subgroups are beneficially conducting business in accordance with the IMOG charter, and should be continued in accordance with the outlined plans of the Chairmen.

Mr. Jensen indicated that LRL management, in general, supports IMOG very strongly and feels it is very important to continue to devote time to the organization. Interaction between the Subgroups of IMOG, such as MTG, NSG, and Gaging Group, should be emphasized. Perhaps this could be done by a few representatives from one group attending another group's meetings.

R. J. Spies brought up the question of the Steering Committee's feelings on the endorsement of ALRP/CAM-I. Mr. Jensen stated that we should approach any matters bordering on policy making very carefully, since many IMOG representatives are not in a policy making type position. Mr. Spies then raised the question that if the IMOG does not state an opinion as a group, who will. George Adams commented that groups like
ours obviously have no policy making power, but our opinions should be very important to the policy makers. These matters, however, should definitely go through the Steering Committee. It was tentatively decided that the proper course of action would be to bring each subject to the attention of the Steering Committee for their consideration.

NSG Chairman's Report

The Chairman's Report to the Steering Committee was read at this time. This report is included as Appendix B.

The NSG Chairman met, by request, with the Steering Committee of IMOG at Y-12 on May 4 and 5, 1971. The Chairmen of the Machine Tool Subgroup, the Gaging Subgroup, and the NSG presented briefings which included the benefits, past activities, and future planning of each Subgroup.

The Steering Committee offered unquestioned support of each of the three Subgroups. In reply to questions raised by the presentations, the Steering Committee offered the following recommendations applicable to the Numerical Systems Group:

1. Assure, as in the past, that all minutes are appropriately marked for classification.

2. The Stored Program Controller Symposium appears to be serving a very useful purpose, and no other AEC organization seems likely to initiate similar technical exchanges. Therefore, we should continue to sponsor the symposiums as long as we feel they are appropriate.
3. The IMOG and all Subgroups are constituted as a body for the exchange of technical information. Meeting agenda should be oriented toward this goal, and research projects, standards, etc., should not be undertaken without specific approval and direction of the Steering Committee.

4. The NSG and the Machine Tool and Gaging Subgroups have a finite overlap area which should become more pronounced with the advent of computer-controlled gages and machines. These areas should be exploited in joint meetings and direct interchange between the various Subgroups.

5. The NSG is the only mechanism within the AEC organization for effective technical information exchange about the use of small computers. We should attempt to cover the entire field, with particular emphasis on the areas common to all applications, such as programming languages, program integrity, etc., but not excluding application details of interest to the wide group.

6. In view of the number and speed of small computer implementations, should we consider more frequent meetings?

The Chairman proposed a joint meeting with the Machine Tool Subgroup, in accord with the recommendations of the Steering Committee. A motion was made and seconded that Mr. Carpenter meet with the Chairman of the Machine Tool Subgroup on the matter of a combined or parallel meeting. The MTG will meet at Pantex Plant the week of May 24, 1971.
Election of Vice-Chairman

A motion was made and seconded that we would not elect an interim replacement for Vice-Chairman Lynn Parkinson. The motion carried.

Stored Program Controller Symposium

The Stored Program Controller Symposium, conducted May 18 and 19, was reviewed by the membership. A total of 76 persons attended the Symposium, of which approximately one-half represented LRL and SL. Discussion indicated that participants in the Symposium gained some valuable and worthwhile information, and that similar Symposiums should be conducted at approximately 18 month intervals. Some of the means of providing more advance details and publicity for future Symposiums were discussed. It was recommended that consideration of videotaping future Symposiums for distribution throughout the complex be investigated. A review of videotape equipment compatibility throughout the complex will be attempted, possibly through an AESOP Study Group currently working in this area.

It was recommended that the NSG Chairman send letters of appreciation, with invitation for comments about future planning, to the people who gave papers at the Symposium.

NSG membership was requested to investigate the possibility of hosting the next Symposium in the Fall of 1972.
Special Reports

The following reports were made at this point in the meeting. Detailed reports are included in Appendix C.

EIA Standards  Ron Miskell
ANSI Y 14-26  Mike Sestric
CAD/CAM Conference  Gene Emerson
N/C and DNC, Western Europe  Ron Miskell
Infrared Link  Don Kava
ALRP/CAM-I  Gene Emerson
Remote Access to Univac 1108 for APT Processing  Gene Emerson
APT/IGS at Bendix  Mike Sestric
NMTBA Subgroup Organization  Mike Sestric
UNIAPT on the PDP-10 at Sandia/Albuquerque  J. H. LeRoy

Computer Program Specifications

Ron Miskell gave a short report on Small Computer Program Specifications and distributed copies of the UCNC standard specification. He indicated experience had proven the need for a complete specification to assure receipt of a well documented and functional operating system. Issuance of and forced adherence to the specification will result in cost increases.

The discussion on this subject led to a discussion on overall benefits of IMOG participation. It was recommended that those cases resulting in actual cost savings, or avoidance, be reported to the appropriate cost reduction personnel for record.
Chuck Miller gave a brief summary of his Symposium presentation, followed by a question and answer session. He said that the direct numerical control software was written in assembly language on a CDC-1700. He stated that the CDC-1700 total cost was approximately $300,000, but stressed that this was not entirely dedicated to DNC. Each interface costs approximately $3,600, and the cabling required was of the shielded twisted pair type, costing $5 to $15 per foot, installed.

Mr. Miller mentioned that a very good article on numerical control had been published in Control Engineering (March, 1971). The article, written by P. Mesniaeff, is entitled "The Technical Ins and Outs of Computerized Numerical Control."

Ray Spies reported that LRL had formed their own CAD/CAM Group for the purpose of future planning. He stated that this was for the purpose of designing a general system to handle not only N/C, but other things, such as design graphics, job orders and change orders, and business applications. He stated that the current feeling was that it would probably be a mistake to simply attempt to computerize existing procedures; most likely, new procedures would have to be developed.

N/C Tape Preparation
A discussion on this subject was instigated by D. J. Kava and served as a general exchange of information about tape preparation techniques and times. Mr. Kava stated that, in his organization, approximately 4.2
direct man hours were spent in preparation of a tape, with total turn around time of less than 3 days.

Another subject discussed in this area was the structuring of the tape preparation group within the organization. Mr. Kava stated that they had an express keypunch facility (less than 3 coding sheets), which provides them with 20 minute turn around time; their regular keypunch facility ordinarily gives 1 hour turn around time.

Ray Spies stated that, in his organization, he has 2 programmers in Engineering, 2 programmers in the Shop, and 2 in Computation. He said that, although this does tend to create communication problems, they seem to be able to clear up the problems by getting together each Friday morning at coffee break.

At Bendix Kansas City, the numerical control tape preparation and computer programming is a part of the Management Systems organization, consisting of the following functions:

1. Computer Technology
2. Management Systems Services, which includes the Data Center, ComCenter, and Administrative Services

The Numerical Control organization is an ideal position in the fact that all items relating to numerical control tape preparation are within a central body, making it less difficult to meet our objectives. Also, it
acts as a service organization for the entire plant where N/C equipment is decentralized. In this manner, no allegiances are formed and no one is favored. The most important job with the greatest priority is completed first.

N/C Part Programming Schools

C. T. Shawhan led a brief discussion on obtaining part programming talent from N/C part programming schools. It was mentioned that Brigham Young University has a 2 semester course in APT, and that Northern Illinois, at Dekalb, offers a degree in N/C. It was also mentioned that McGraw-Hill has published a very good text book on APT.

There was a brief discussion on the recent meeting of the Numerical Control Society. Ray Spies mentioned that some papers which were given at the meeting were not included in the published proceedings.

Computerized PERT Charts: M. D. Sestric, BX/KCD

Bendix has made an extensive search for a PERT Plot Program which would be compatible with the IBM 360 Computer, the CalComp 718 Plotter, the IBM 360 PERT Program, and the objectives of BKC. At this time, only one facility meets all these requirements and has actually demonstrated their capabilities with Bendix product data. That company is Systonetics, 600 North Euclid, Anaheim, California 92801, telephone 714/778-1600.

It is felt that this PERT Program can be a cost savings to any facility utilizing PERT networks to a large degree, because of the fact that there
is a significant time lag in obtaining an updated PERT plot or the manpower required to maintain it.

Basic package cost is approximately $25,000, with full system costing approximately $35,000. Additional data regarding Bendix experience will be presented at future meetings.

Small Computer Program Libraries
R. V. Miskell led a short discussion on small computer program libraries. A round table discussion on the question of the feasibility of maintaining a central library of programs followed. Mr. Miskell also mentioned Y-12's work with a PDP-8 Simulator on S/360. The concept of using peripherals of a large computer system to save time in preparing programs for a small computer is becoming more popular.

Facility Reports
Each organization represented on the NSG presented a brief report of recent and current activities in the areas of numerically controlled equipment and associated usage of computers. Details of these reports are included in Appendix D.

Computer Security Policies
Ray Spies instigated a general discussion on problems caused by computer security policies. His main points were 1) security policies are not logical, and 2) they are a hindrance to progress. The question was raised as to whether IMOG/NSG can do anything to rectify the situation. It was
brought out that the AESOP Subgroup has just completed a study on computer security. It was recommended that concerned people investigate the results of this study.

Future NSG Activities

Discussions indicated the existence of four beneficial activities that the NSG could undertake.

1. Security
   a. Physical
   b. Software

2. Stored Program Control Software Library

3. An investigation of the impact of the AEC 1801 Manual Chapter on the procurement of fourth generation machine control systems

4. EIA Standards review

The Chairman was requested to discuss these activities with the Steering Committee for their concurrence.
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APPENDIX A

AGENDA

THURSDAY, MAY 20, 1971

A. M. Session

8:30  Badge Pick-up and Check-in

8:45  Convene Meeting - Jade Room
      Welcome and Host Announcements

9:00-11:45  Visitor Introduction
            Review Minutes of Last Meeting
            Introduction of New Members
            Review and Additions to Agenda
            Reports from other IMOG Subgroups
               1. Steering Committee - J. A. Jensen
               2. NSG Chairman's Report
               3. Other Subgroups
            IMOG-NMTBA Meeting Status
               NMTBA Subgroup Organization - M. D. Sestric
            Nominating Committee Appointment
            Review of Stored Program Controller Symposium

11:45-12:45  Lunch

P. M. Session

12:45-4:30  Standardization Committee Reports
            1. EIA - R. V. Miskell
            2. ANSI Y 14-26 - M. D. Sestric
            Society of Manufacturing Engineers - E. L. Emerson
            CAD/CAM Conference
            N/C and DNC in Western Europe - R. V. Miskell
            Infrared Data Link - D. J. Kava
            ALRP/CAM-I Organization and Status
               1. Management Steering Committee - E. L. Emerson
               2. March, 1971, Meeting - Discussion
               3. Development Projects - Round Table
                  a. Supporting
                  b. Proposing
               4. AEC Contractor Contract Guide Status -
                  R. V. Miskell
               5. Future - Discussion
Remote Access to Univac 1108 for APT Processing - E. L. Emerson
CDC APT/IGS at Bendix - M. D. Sestric
Y-12 Standard Specification for Small Computer Operating Programs - R. V. Miskell
IMOG Status - Discussion
Activities/Benefits
Future
Local Internal Communications
Special Interest Group Planning

FRIDAY, MAY 21, 1971

A.M. Session
8:30-11:45
Bendix KCD DNC Survey Report - C. Miller
LRL CAM Study Group - R. J. Spies
N/C Processing on PDP-10 (SLA) - E. L. Emerson
N/C Tape Preparation - D. J. Kava
Organizational Location - Round Table
Equipment
Functions
Economics
N/C Part Programming Schools Other than OEM, Computer Mfg., or IITRI - C. T. Shawhan
Numerical Control Society Technical Meeting - Discussion

11:45-12:45
Lunch

P.M. Session
12:45-4:30
PERT Plot Program at Bendix - M. D. Sestric
Small Computer Program Libraries - R. V. Miskell
Fourth Generation Machine Controls - Discussion
Facility Reports - Round Table
Planning for Next Meeting
Computer Output Microfilmer - E. L. Emerson
Activities Generated from First Stored Program Controller Symposium
APPENDIX B

NSG CHAIRMAN'S REPORT TO STEERING COMMITTEE

I. Membership

Twelve participating AEC agencies with 21 assigned members

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<th>Agency</th>
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6 generally engineering programs
5 N/C total supervisory
1 computer systems supervisory

II. Meetings

Normally schedule 2 meetings per year of approximately 2 1/2 days.

Afternoon of the third day, hosts are available for tours as desired. Additionally - Stored Program Controller Symposium - 18 month interval - 2 special meetings in 10 years.

III. Benefits of IMOG NSG

A. Most finite and notable:

1. Method of interpolation of point defined curves
2. Weapon part definitions compatible with N/C
B. General and Continuing:

1. Personal contact in uninhibited technical discussions between people of like disciplines.
2. Current knowledge of other personnel working on similar or identical projects or systems.
3. Design agency activity reports to give guide to future production activity requirements.
4. Combining IMOG trips with other business to minimize cost factors (approximately 15%).
5. Exchange, on an as needed basis, technical data and N/C programs for mutual benefit of involved contractors.
6. Emergency backup support for N/C programming problems (i.e., SLA support for Pantex when hardware for APT delayed).
7. Stored Program Controller Symposium.
8. National and international standards groups participation.

IV. Current NSG Activities

A. Analyses and recommendations relative to ALRP/CAM-I program.
B. Focal point within AEC complex for small computer use in manufacturing process.
C. Analysis and commentary on complex-wide computer systems proposals in technical fields.
D. Means of improving reliability and speed of developmental part fabrication and data transmission.
E. Technical information interchange relative to the use of computers in the design and manufacture of weapons components.
V. Future Activities
   A. Continuation of current as applicable.
   B. Gradual (as implementation) change in emphasis from N/C tape preparation to CAD/CAM.
   C. Increased emphasis on technology interchange in small computer usage in manufacturing process pointed toward a degree of standardization of software features for machining and gaging. This area we see as primary interest in the immediate future.

VI. Goal of NSG
The goal of the Numerical Systems Group is through periodic exchange of detailed technical information between technical personnel of similar disciplines to assure that each participating AEC agency is aware of and has access to the latest technology available within the AEC complex in the area of utilization of computers in the design and manufacture of weapons components.

VII. Problems
   A. Scope of small computer applications too broad for small (20) group to be adequately knowledgeable.
   B. Time from the day to day pressure of the job to prepare and participate in meetings.
   C. Question - "What to do with subjects that logically reach a conclusion and/or complex-wide recommendation"?

VIII. General
We in the NSG feel unanimously that the IMOG concept is necessary and desirable within the AEC complex, and that the NSG, in particular
has served and will continue to serve a function that actually results in benefits to the AEC complex that far exceed the costs of the organization (approximate annual cost for travel is $10,800). We feel that the majority of the benefits are not feasibly assigned economic values and, therefore, have not attempted an economic justification.

How do you evaluate:

1. technical knowledge?
2. personal contact?
3. planning information?

We must consider the alternatives to the functions served by the NSG.

A. Technical knowledge is the life of the progressive organization and, therefore, must be assimilated. It would be far more costly to the AEC complex to have all contractors participating in each technical information program than, as currently done, have some contractors participate and present information obtained at an IMOG meeting.

B. Personal contact is the prime mover of technical knowledge. Few individuals have the capacity to generate new technology when isolated from their peer group. Individually we could study and attempt to absorb all written information related to our technical field, which would leave us without time to accomplish work; or through personal contacts, we can obtain summaries of technological changes and study only those applicable to our work.

C. Planning information is the foundation of successful operation.
The AEC provides management level planning information through
periodic management meetings and planning documents. The local personnel are required to input the technical impact of this data. Much of the basis of technical impact is gained through more detailed technical data and impact information gained through IMOG contacts.

Most major industries have some semblance of an IMOG organization or technical information coordinator (i.e., Western Electric's N/C Committee; Westinghouse's N/C Coordinator) on the Corporate staff. It is too costly to have various divisions each pioneer the various technological levels.

We feel that more participation in the Subgroup and more guidance by the Steering Committee would be desirable and may be necessary in the future. The various facets of the transition from Numerical Control through Direct Numerical Control to Computer Aided Manufacturing are going to exceed the capacities of the NSG as now formulated. Priority establishment might best be made by the Steering Committee.

We are divided on the issue of the NSG functioning, on occasion, as an official body with recommendations applicable to the full AEC complex. It appears, from analysis of all Subgroup activities, that both sides of the issue are active in individual Subgroups.

It might be considered that each AEC facility, through NSG contracts, has available as consultants an experience level in the field of N/C applications in excess of 200 man years for the cost of participating
in the IMOG Numerical Systems Subgroup. At the technical working level, we use this consultation very frequently.

IX. What if IMOG NSG were Dropped

As previously stated, we feel that many benefits are gained through the technical information exchanges at the NSG meetings, and that technical knowledge is of paramount importance to progressive organizations. Our experience has been that very little, if any, advantage is gained by either individual or informal efforts to exchange technical information. An effective interchange of technical information must be formally organized at a specific time and place; this is the justification of IMOG.

We estimate that the rate of technical growth of most AEC contractors would decrease by an order of magnitude if the NSG organization were dropped and the costs of participation "put in the bank." If these costs were expended to increase participation in commercial technical interchange organizations, the loss in growth rate would be reduced.

We believe that the effectiveness of the AEC weapons complex has been greatly enhanced by the NSG interchanges created through personal member relationships. This effectiveness would decrease with time as contacts were lost through job changes and deterioration of the personal relationships. In three to five years, the complex would have 11 independent numerical systems in use, resulting in near chaotic situation.
APPENDIX C

SPECIAL REPORTS

EIA Report - R. V. Miskell

The standard on punched tape, RS-227, has been revised and should shortly be available to industry. The significant changes in RS-227A are the addition of physical parameters on punched and unpunched tape, provision for other than paper material, and inclusion of environmental conditions in which the tape will be used.

The standard on variable block format for continuous path machines, RS-274B, is undergoing a rather major revision. The new standard, RS-274C, will encompass the presently used contents of, besides RS-274B, the variable block format for positioning machines RS-273A, and the fixed block format RS-326A. Our aim is to have one format standard for numerical control machines.

The standards on tape code RS-244A and RS-358 are, likewise, undergoing revision. The revision to RS-358 will entail the addition of the various control codes specified in ASCII. EIA has requested that the RS-244 and RS-358 codes be registered. Thus far, official reply on escape sequence problems associated with registering these codes has not been received from the ANSI Committee X3L2.

Automation Bulletin 3B, "Glossary of Numerical Control Terms," is undergoing a major revision. Basically, terms that have often caused confusion in the N/C field are being added, and terms which are defined by other
national committees are being removed. TR-31 feels that control theory and accuracy terms are quite adequately defined by the ANSI C85 document, "Terminology for Automatic Control."

TR-31's initial effort in standards for computerized N/C will be a standard for an interface between a numerical control system and data terminal equipment which would typically be connected to a computer source or sink. This standard would be applicable to a BTR (Behind the Tape Reader) type of direct numerical control. The standard will be written around 5 volt integrated circuit logic.

The TR-31 presently represents the United States on the International Standards Organization Committee on Numerical Control; namely, ISO/TC97/SC8. The Europeans' marked increase in N/C participation is reflected in the increased time allocated at TR-31 meetings on international activity. Heretofore, the intent of most of the EIA standards has been incorporated in ISO numerical control standards. As the European interest and knowledge of N/C grows, however, it is more difficult to get the United States viewpoint completely accepted. Presently, an ISO standard for numerical control symbols is being drafted. The EIA contribution in this area, RS-379, will be reflected in this ISO proposal. The current activity on the Behind the Tape Reader standard will also be submitted as a USA contribution on direct numerical control.

The European community is quite interested in the standardization of the interface between the numerical control system and the magnetic panel. The TR-31 committee feels that the US trend is toward direct control of the machine tool functions by logic or software in the N/C unit.
ANSI Y 14-26 - M. D. Sestric

On January 18, 1971, a new subcommittee was formed. Its official title is ANSI Y 14-26 Subcommittee on Computer Graphics. The meeting mentioned above was for the purpose of organizing its activities toward applying drafting standards to plotters and CRT's. The current chairman of this committee is R. W. Rau, Corporate Manager, Technical Systems and Procedures at McDonnell-Douglas Corporation, Department H213, Building 107, Room 225, P. O. Box 514, St. Louis, Missouri 63166.

CAD/CAM Conference - E. L. Emerson

The Society of Manufacturing Engineers is sponsoring a conference - "CAD/CAM - the Present and the Future."

It is presently scheduled for February 2-4, 1972, at the Royal Coach Motor Hotel, Atlanta, Georgia. The fee will probably be $150 for SME members and $170 for non-members.

The CAD/CAM Advisory Committee of the Manufacturing Division of SME, with Dr. Maurice Nelles, Chairman, is responsible for organizing the conference.

The first two conferences relating to CAD/CAM were sponsored by the Department of Defense. Spokesmen for DOD, after the Davenport conference, indicated that they did not wish the lead role in the next conference, and apparently neither did any of the other participating groups of Panel 14.

At the January meeting of the Advisory Committee, the decision was made to go ahead with the conference planning.
The agenda, as it now stands, will encompass the following topics:

**SESSION I**
- Welcoming Address - Frank Ford, President, SME
- Importance and Need of CAD/CAM
- CAD/CAM in the World Market
- Curriculum for CAD/CAM
- Review of Conference Theme

**SESSION II**
- State of the Art of CAD Technology
- State of the Art of CAM Technology
- CAD/CAM Technical Problems and Opportunities
- CAD/CAM Management Problems and Opportunities

**SESSION III**
- Application of CAD Equipment
- Application of CAM Equipment
- Wedding of CAD to CAM
- Software Creation and Evaluation for CAD/CAM

**SESSION IV**
- Economic Consideration of CAD/CAM
- Applying CAD/CAM to Mass Production
- Applying CAD/CAM to Job Shops
- Present Resources for those desiring to use CAD/CAM

**SESSION V**
- Road Blocks to Automation (Legal, Social, Education)
- Industry (Government) Academic Relationships
- SME Policies, Plans, and Programs

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N/C and DNC in Western Europe - R. V. Miskell

The Germans express considerable interest in DNC (Direct Numerical Control) and adaptive control. This is indicative of their progress in N/C and their leadership in N/C in Europe.

Both German and Swiss engineers voiced the opinion that the multiple machine control concept is still a number of years away in Europe. They felt a one-on-one, or a machine controlled by a dedicated computer, is probably the first step in DNC, and that hardwired interpolation would be used in the initial systems.

Europe, in general, is still squeezing out the advantages and profits of N/C. They seem to be hesitant to get into DNC until distinct economic advantages are revealed. The European interest in standards on transducers and interfaces reflects their desire to be able to marry N/C system to numerous types of machines at minimal cost. They feel that this standardization will assist the future use of DNC. The USA National Committee on N/C is presently doing work in this field and may exchange ideas with the German National Committee.

After a review of a number of control builder plants and discussions with various European engineers, a rough estimate of the status of their N/C technology is as follows:

- Germany - Very close to the USA
- Switzerland - About one year behind the USA
- France, Italy, United Kingdom - One to three years behind the USA
- Hungary, Poland - More interested in obtaining USA or German controls than developing their own N/C technology
The lack of the large defense and space markets that the USA builders have has curtailed rapid expansion. The acceptance of N/C by numerous consumer industries will, however, result in a very stable N/C market in Europe.

Infrared Data Transmission Device Study Project - D. J. Kava

Contract Arrangements: ALO and Institute for Telecommunications Sciences (ITS), Department of Commerce

Purpose: To investigate the workability of an infrared data transmission device for secure and non-secure data transmission for AEC applications.

Proposed Work to be Done by ITS:

1. Functional Capability of Device
   a. Install an operational infrared data transmission device to evaluate the capability of transmitting data at 40,800 bits/sec over distances of a few hundred feet
      1) near visible light
      2) interfaced to AT&T 303 modem or equivalent
      3) build or buy infrared device
   b. Test reliability of device under operating conditions
      1) determine transmission error rates during different atmospheric conditions
      2) correlate signal strength with error rates
      3) estimate percentage of downtime
      4) recommend equipment improvements based on experience with reliability testing
2. Other Areas of Investigation

a. Install an operational infrared data transmission device or a simulated unit at ITS to complete the following work

b. Investigate and measure security factors including probability of signal interceptions over transmission distances of at least 1 kilometer

1) Consider
   a) beam dispersion
   b) beam reflection
   c) beam refraction and diffraction
   d) power levels
   e) miscellaneous effects

2) Build a "super receiver" to investigate the intercept potential from stray signals

3) Evaluate theoretical methods of signal interception and determine theoretical limits for unauthorized detection of signals

4) Establish beam patterns at various power levels and effects of distance on beam geometry

5) Recommend automated method for overcoming security limitations, e.g., automatic control of transmitter power levels, automatic audible alarm when signal power drops below a pre-set level, etc.

6) Recommend methods of evaluating security of operational infrared devices
c. Determine feasibility of transmitting analog signals considering signal quality, bandwidth, distances, and atmospheric conditions.

d. Recommend improvements to the infrared device to make it equivalent to a high-grade coaxial system for similar data rates.

3. Prepare a report summarizing the study project and giving guidelines for general application and procurement of operational devices from commercial sources.

Estimated Cost of Study Project: $42,500 approximate cost of device < $6,500

Application: Short range transmission of data

Justification: 1. Government-wide use
2. Elimination of data lines
3. No need for encryption


Present Status: Funding is available and contract between ITS and ALO is nearing approval.

Schematic of Potential Use:
The Management Steering Committee is continuing activities toward finite organization of this program, as well as evaluation of the goals and long range plans. Dr. J. H. Harrington and Doug Ross have been engaged as consultants to evaluate and recommend the feasibility of the organization as generally outlined. Their reports are due to the Steering Committee on July 20, 1971. A legal firm in Chicago has been engaged to recommend legal contracts and organization consistent with anti-trust and technical society laws.

Development projects are getting underway and should have good definition and progress reports in the Fall meeting. There are four AEC contractors supporting the APT IV project. One AEC contractor is supporting the sculptured surface project.

IITRI is continuing a long range planning survey of all current participants and should have a compiled plan to present at the Fall meeting.

The Management Steering Committee is initiating action to obtain proposals from interested companies to act as administrative contractors for 1972. IITRI will submit a proposal to be evaluated on an equal basis with other proposals.

Remote Access to the Univac 1108 for APT Processing - E. L. Emerson

The APT parts programmers are presently using the Univac Demand Terminal system for inputting programs.
The system allows the part programmer to input his program, revise the program using the text editor, store the program on drum files, execute APT through SEC. 3, and receive error diagnostics. After correction of diagnostics, the postprocessor name is added, as is CLPRNT and PRINT/3 ALL. The program is stored on the Fastrand Drum. Complete execution for output tapes can be made from the teletype by transmitting a message to the computer operator for tape mounting or by the preferred way of submitting the job by cards for input into the normal job stream.

In the case of diagnostics, the error message only is returned. If additional information is needed for debug, a limited CLPRNT can be requested giving CL printout ahead of the error location.

The system is proving to be very efficient in debugging parts programs and improving the turnaround time of the complete job.

APT/IGS at Bendix - M. D. Sestric

Recently there have been some inquiries with regard to the CDC hardware and software relating to APT/IGS and the distance requirements for each basic unit.

Figure I on Page 36 shows a configuration for the CDC APT/IGS processing hardware and its distance requirements.

Regarding the APT/IGS Project, the current completion date is September 15, 1971, and at this time the date looks realistic. It is this writer's understanding that the first release of CDC APT/IGS will be public domain and will be available to CDC users on request.
CONFIGURATION FOR REMOTE APT/IGS' PROCESSING

The 1700 station may also be used for Remote Batch Submission {concurrent with IGS operation} with addition of card reader (1726/405 or 1729) and Line Printer (1742 or 1740/501).

- DISK DRIVE- 1 or 2 per 1738 Controller
- DISK CONTROLLER- 1 to 8
- 1738 Controller
- 1774 CPU
- 24K 1700
- Expandable 32K
- One 274 per 1744

DATA SET DATA
- 40 A BAUD
- SET
- TRANSMISSION

DATA SET BUFFER DATA
- Available
- FROM AT&T GRAPHICS CONTROLLER
- 4 or 8K words

DATA SET CONTROLLER
- Available
- FROM AT&T

DATA SET
- AVAILABLE
- FROM AT&T

50' CHANNEL

6600 COMPUTER

6673 or 6674

DATA SET CONTROLLER

6673 connects to one or two 3018's. 6674 connects to 1 to four 3018's. 6673 field convertible to 6674.

3018

50'

3018

50'

200'

3018

1747

1706 1 to 3

1774 CPU

Bendix, Kansas City.

FIGURE I
UNIAPT is an N/C programming system that closely resembles APT, but is designed to operate in 8K of 12-bit word core with a 65K disk. This is the minimum size computer system that will accommodate UNIAPT, and because of the limited memory, does not permit use of the UNIAPT features TABCYL, PATERN, COPY, and POCKET. However, 12K of core will permit use of these features, and in addition, will run part programs about 50 percent faster than will 8K of core.

The vocabulary of UNIAPT is the same as APT. It is anticipated that part programmers currently using APT will need retraining only in the use of the PDP-10 Time Share terminal. UNIAPT has the capability of computing for 3 axis simultaneous motion, plus 2 axes of uncoordinated motion. This capability will be adequate for at least 85 percent of SLA's part programming for N/C machine tools. Having a PDP-10 terminal located in the office with the shop programmers, UNIAPT on the time-shared computer will carry by far the major portion of the APT computing load.

A programmer will use the system by creating a file on the PDP-10 disk containing his part program, beginning with PARTNO and ending with FINI. This file may be created either by keypunching the program and having the cards read onto disk at the PDP-10 console, or by typing in the program from the teletype terminal in the office. This file must be assigned the file name prescribed by UNIAPT for its input file, and then, upon initiation of UNIAPT, it will be processed. All errors in spelling, punctuation, and format (APT Section 1 errors) are diagnosed
by Pass 1 and further processing is inhibited until such errors have been corrected. Errors will be denoted by listing on the teletype the statement containing the error, followed by a number which refers to a diagnostic statement in a manual. The entire source program will not be listed on the teletype, only those statements containing errors. These errors will be immediately corrected using a PDP-10 text editor and the corrected file again input to UNIAPT for processing.

Section 2 errors will then be handled in a similar manner in a second pass. After successful completion of Pass 1 and 2 processing, the specified postprocessor is called. UNIAPT Pass 2 produces the CL record as a disk file which becomes input to the postprocessor and is also retained for output listing as the completion of the run. The postprocessor produces a disk file, also, which is saved for listing and used as input for punching tape.

The time-share system allows no output peripherals other than disk to be assigned to a particular program. As previously mentioned, all output records are written as disk files which require system commands outside of UNIAPT to have them listed on the line printer or punched onto tape. The user's teletype will be used to list only the errors for debugging. All other output listings will be printed on the system line printer.

UNIAPT is being purchased from United Computing Corporation, Carson, California, along with nine postprocessors, for a cost of $41,815. The system is scheduled to be up and running by June 30, 1971. This is United's first implementation of UNIAPT on a PDP-10 time-share system, and the cost
includes $10,000 for coding the "driver section" in PDP-10 assembly language. At the present time, this driver section is being tested, and the coding is 95 percent complete. The most annoying question now is how to output the postprocessor disk file onto punched tape. Incompatibilities in format and code seem to exist.

PDP-10 core utilization of 15K 36-bit words has been allotted to the UNIAPT system. It will be accessible from any of the PDP-10 time-share terminals, as well as through the dial-up capability.
APPENDIX D

FACILITY REPORTS

Bendix Kansas City

New Computer Facility:
Within the last several weeks the IBM 360 Model 65, Model 50, CDC 6600, and the CalComp Plotter have been installed. At the present time, the facility for Management Systems Personnel is under construction. Personnel will not move until approximately July 1, 1971.

Bendix Kansas City has received the following equipment since the last NSG meeting:

1. One Index 3842 Vertical Mill 2-Axis Machine with a SWELEC 700 control unit.
2. One Ex-Cell-O Model 982 Contour Milling Machine with a Bendix 1500 3-Axis Control.
3. One SLO-SYN Positioning System with a SLO-SYN Control Unit.
4. Two Pantex designed Spherical Drills with Cincinnati Acramatic Controls in operation.

The following machines are on order:

1. Ex-Cell-O Model 982 Contour Milling Machine with a Bendix 1500 Control.
2. One Pratt & Whitney Model 3133 Jig Borer with a P & W Control.
4. Two Burgmaster Econ-O-Center Econ III-25 with a Bendix 400 control.
5. One American 4025 N/C Engine Lathe with a Bendix 1800 control.

OCR:
A Scan-Data 2000 Optical Character Reader has been delivered to BKC. It is currently in the 30 day acceptance period. From all indications, it appears to be a very reliable piece of hardware and software.

This OCR hardware configuration consists of: a scanner, one 9 track magnetic tape drive, one teletype, 16K words of core, PDP-8I, paper tape reader, and paper tape punch. This equipment is located in the new computer facility.

Omni-Cutter Development for the CalComp 718 Plotter:
The development to produce curved cuts on Ruby-Lyth peal coat film terminated recently, because it was concluded that the rough edges of the cut was the result of a vibrating action of the cutter holder assembly. However, CalComp indicated to BKC that this vibrating action can be corrected by modifying the software so that the plotter data is in the zip mode and not in incremental modes. We feel certain that this will eliminate a great deal of the problem. As yet, we have not had the opportunity to modify the software to further evaluate the process.
The interactive digitizing system has been installed. The system is based on a Bendix Datagrid (TM) Digitizer interfaced to the PDP-10 time sharing system. Data may be input by a Teletype ASR-33 keyboard, on paper tape, digitizer cursor, digitizer keyboard, or digitizer console record buttons. Output is via the teletype printout, paper tape punch, or Zeta plotter. An active portion of the digitizing area is used for menu selection.

The main application is the digitizing of non-dimensional layouts for mass properties analysis.

The Sandia Interactive Graphics System is undergoing final acceptance testing. The system is based on Lundy scopes driven by PDP-9 computer, which is interfaced to the CDC-6600 computer.

The Sundstrand Omnimil OM-3 is undergoing a major overhaul. It has had 8 years of single shift operation.

New Machines:
K&T 3 1/2 Axis Machining Center (3 axis plus 8 position rotation of table)
General Electric - 7500 series postprocessor from K&T

New Programs:
COED: Computer Oriented Engineering Drawing accents the input which was prepared for our digital code used for producing control tapes for printed
circuit boards. From this data, we are generating control tapes for the Gerber to produce an Engineering Drawing of the printed circuit board.

New Techniques:
We are using Standard CDC APT 2.2 on the 6600 with the Scope 3.3 monitor system.

The part programmers are now using the UPDATE routines in Scope to put the part program on tape and make corrections, thus eliminating the handling of large decks.

**Mound Laboratory**

The 3 axis Gorton Mill is operational at this time with Allen-Bradley BR3100 Control.

Additional core is being added to the IBM 360/50. It will be expanded to 512K by June 15, 1971.

**Los Alamos Scientific Laboratory**

Machine Tools:
We have received, but not installed, an analog tape controlled EN-TEC filament winding machine and a Winslow 2 axis spotter. We are in the process of placing an order for a Kearney and Trecker Mod II 5 axis machine. This machine will have full contouring in all axes, an Allen-Bradley BR7300 MCU, including a Hewlett Packard 2100 minicomputer (8K-16 bit words), and a local and a remote CRT display. The LASL Shop has
received a Heald 2 axis turning machine for plutonium work and two 912 Excello turning machines. These three machines all have Bendix Dynapath 1802 MCU's.

Software:
We are now running some of our longer design codes on the CDC 7600 at a 4 to 7:1 time savings. We are increasing our APT usage and the main shop has been running APT on a remote batch terminal. Group GMX-3 is investigating the feasibility of a time-share link to a United Computing Service Center with APT 2.6.

Computers:
We have received a Varian 6201 and the data line to the CCF has been made. We will not be able to send classified data until mid 1972. At that time, the CCF will be capable of safeguarding classified information. The data link from the S/360 to our IBM 1130/Gerber is being installed.

Union Carbide Y-12

An APT processor for part programming continuous path dimensional inspection machines is operational and used to provide input tapes for dual head inspection machines.

Two stored programmed controlled continuous path inspections machines are on order from AA Gage Company. The system is controlled with a Modcomp II computer.
Status of activities at BAECP is

1. Completing specifications for a 4 axis machine for the Tool and Die Shop. Will consist of 3 linear and 1 rotary axis.
2. Writing specs for 2 N/C drilling machines for HE drilling.
3. Writing specs for a computer controlled gage to indicate hole position and surface continuity and calculation and printout of data.
4. Will receive a magnetic tape controller for the CalComp 563 Plotter in July.
5. Implementing APT for tape production for polar axis machine and 4 axis machine. Will continue with ADAPT for other machines.
6. Using IBM 2770 terminals for the remote job entry concept for engineering, statistical, and commercial jobs.
7. Working on simulation of production lines.

Lawrence Radiation Laboratory

Machine Tools:

Our Cincinnati-Gilbert 3 axis point to point horizontal boring mill is operating after a 5 month delay due to several mechanical problems. Software check-out proves everything okay.

The Bostomatic 3 axis contouring milling machine is on line in the Precision Shop. This machine was originally intended for our HE facility at Site 300. It will stay in the mechanical shops area for familiarization.
We have not received our XLO 922 Bendix yet. There are still some mechanical problems at the factory test stand.

A 3 axis Sheffield Cordax Model 5000 is in the inspection lab and working very well.

The magnetic tape drive for one Gerber Drafting machine is on site and some software is being written for this machine.

Software:

We have implemented all of our postprocessors except Gecent on the CDC 7600 computer. Gecent should be completed by the end of July, 1971.

We are ready to start using our TMDS (Television Monitor Display System) for on line CL data verification.

This system has a CRT receiver connected to the 6600/7600 computer center. With the Octopus TTY, we run the part program; and with other routine called through the TTY, we see the CL data displayed. After checking for errors, we then can continue the program through the postprocessor.

Dow/Rocky Flats

A. N/C Equipment

1. New Machine Tools - No new N/C machine tools have been installed since the last meeting.

2. Rigid Arm Sweep Gage System - Currently, three of the nine computer controlled gages have been certified. The gages exceed our
expectations, and the AEC is planning to accept parts based only on the results of the rigid arm sweep gage inspections. Thus, the AEC reinspection of sampled quantities will be eliminated.

The inspection methods are now being modified to overcome the sensitivity of the gages to dirt and dust by providing a capability for reinspection of short segments of the part.

Rocky Flats is planning to use the translation section of Y-12's mathematical centering method.

3. DNC - The procurement of a prototype system for an R&D project is still in process. The DNC system will eventually control a number of N/C machine tools and gages and provide feedback of inspection data from the gages to adjust the machining of the next part.

B. N/C Software:

1. Postprocessors - An operational version of the generalized postprocessor for the Bendix 1802 controllers has still not been delivered. The postprocessor is still not functioning on the Bendix-Detroit computer. The initial version, delivered on the date specified, never has been operational on the Rocky Flats' computer.

2. APT - IITRI's APT 4 x 3 was tested and compared with IBM 360 APT 4 x 2. The testing showed that 360 APT processes part programs in less time and produces more reliable TABCYL calculations.
3. Family-of-Parts for Tape Preparation - The Family-of-Parts concept seems like a very practical approach which is still under study at Rocky Flats. We plan to use a design program from LRL Device Engineering for one leg of the Family-of-Parts System. We also plan to implement, if the conversion effort is reasonable, the syntax editing routine from Bendix/KC for Section I of APT. A recent study showed that 60% of Rocky Flats' part programming errors occur in the Section I input.

4. Tape Preparation Backup - Bendix/KC and Rocky Flats are currently arranging and testing procedures which will provide RF with emergency backup for tape production. Bendix has copies of RF's APT system and postprocessor libraries. Preliminary testing and transmission of part programs over SADIE have been successful.

C. Computer Capability:

1. SEL 840MP Computer for Lab. Data Acquisition System - This computer system has been installed and passed acceptance testing. The computer is operational, but analytical instruments have not yet been connected to it. We plan to interface a high resolution mass spectrometer to the 840 during the next month or two. Some of the off-site time-sharing calculations for the laboratories will also be transferred to the SEL 840.

2. IBM 360 System - The Model 40 and 50 have been connected and are operating with OS MVT on the 50 and MFT on the 40. The two 2314's are operational and are linked to both processors through shared
files. All except two drives can be accessed by both processors. The computer center submitted a request for approval to begin processing classified information over our terminal network. We are using an in-house developed security method which is part of the "front end" of our teleprocessing control system software.

3. Terminal System - Rocky Flats now has 37 operational IBM 1031 terminals which are used for data collection and status reporting of in-process production work. We also have 13 IBM 1050 terminals which are preparing production job orders for Production Control and providing data input for the work-in-process system. The 1050's will be placed on-line to the 360 system as soon as Rocky Flats receives approval from Security and developmental effort for two application systems is completed.

4. Minicomputers - A Sundstrand Omnicontrol system using a PDP-11 is being procured for the DNC project mentioned in A.3.

An Interdata 3 is the controller for a strain gage system for NDT testing. This application is not currently operational, but it has been tested and proved-out.

A pulse height analyzer in the analytical labs is being controlled by a PDP-8.

A controller (type similar to a PDP-8) is being used to convert codes and allow a Unimate robot to be connected with timesharing for facilitating the development of a prototype remote handling facility.
Procurement actions are underway or planned to obtain minicomputers for an autoclave data logging application, controlling a prototype foundry facility, and controlling a developmental coating process.

Other procurements are in the evaluation stages. Examples are data acquisition and control for a new Pu recovery process, calorimeter data acquisition and reduction, data acquisition and control of waste barrel counters, extending the SEL 840MP system to more instruments, testing of mechanical processes, X-ray scanning application, and others.

5. Turnaround Time - Currently, the N/C tape preparation group is experiencing an average turnaround time of 1.5 elapsed hours per job (prime shift only) from our Data Processing Center. This is excellent service, and we are rather proud of DP's effort to support our efforts to improve delivery times for control tapes.

D. Production Storage and Retrieval System

The construction of a new storage facility utilizing an X-Y retriever has been completed, and the facility is currently being tested by the contractor. Approximately 430 storage positions are available, and the X-Y retriever operates with a positioning accuracy of .080". A General Automation SPC-12 computer is the controller and a teletype is the man/machine interface. The total cost of the facility, including the inert vault, is approximately $600,000. Additional information on this facility will be provided upon request.
During the past six months, we have installed a new 2 axis N/C turning machine in our HE production area, an additional Mason & Hanger designed Spherical Drill in our plastics production machining area, and ordered another Ex-Cell-O N/C Turret Turning Machine with Bendix 1802 control. The machine installed in the HE production area is an Olofsson 20 inch diameter by 20 inch long capacity machine with a three (3) position turret, an LVDT type automatic tool setter, air bearing spindle, and GE 7500 control. Final installation and testing should start next week. A revised version of GECENT III was required to support the 7500 control. Implementation of this postprocessor encountered a few opportunities for revision to enable maintenance of the existing sub-routines on the new system.

Some part programming problems were encountered on parts from Sandia Livermore when it was found that two elements of the defined geometry did not intersect. These problems were solved by a telephone conversation with Bruce Zimmerman, LRL, who had made some initial test pieces. He had encountered the same problem and had a previously approved solution.

A CDC 3600 was installed in April, 1971, to supplement the IBM S/360. It will be used primarily to process technical and scientific information. There are two main benefits to be derived from the use of this computer:

1. To provide relief for the S/360 by conversion of those technical and scientific programs which have been running
on it. One of the large applications that falls in this category is APT and the postprocessors.

2. To provide our research and development with the capability of running large hydrodynamic simulation codes which they have not previously had access to because of limited core storage or available time.

The computer has 64K words of main storage and eight (8) magnetic tape drives.

Our chemical laboratory will be acquiring a PDP-8/E for use as a process controller for a mass spectrometer in February of 1972. This will have 12K of core and an 830K disk storage device. In the future, this computer will be used to control gas chromatography.

In our development area, we are expanding a PDP-8/I computer which is being used as a process controller for physical property measurement tests. The expansion will bring the total core storage up to 8K with two (2) magnetic tape drives and two (2) disk storage devices. Normally, these tests are quite long and the extra capability will enable us to run several of them concurrently. The extra equipment is expected to be in in September of 1971. Also, for use in our development group, we are acquiring a PDP-12 process controller for various tests pertaining to the thermal properties of high explosives and related materials. The controller will have 8K of core and magnetic tape capabilities. It is expected to be delivered in September of 1971. Since January, 1971, our safety department has been
using a Nuclear Data, Inc., small computer in conjunction with a gamma spectroscopic device. This computer has 8K of core, a CRT, and a capability to make small hard copy plots.
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