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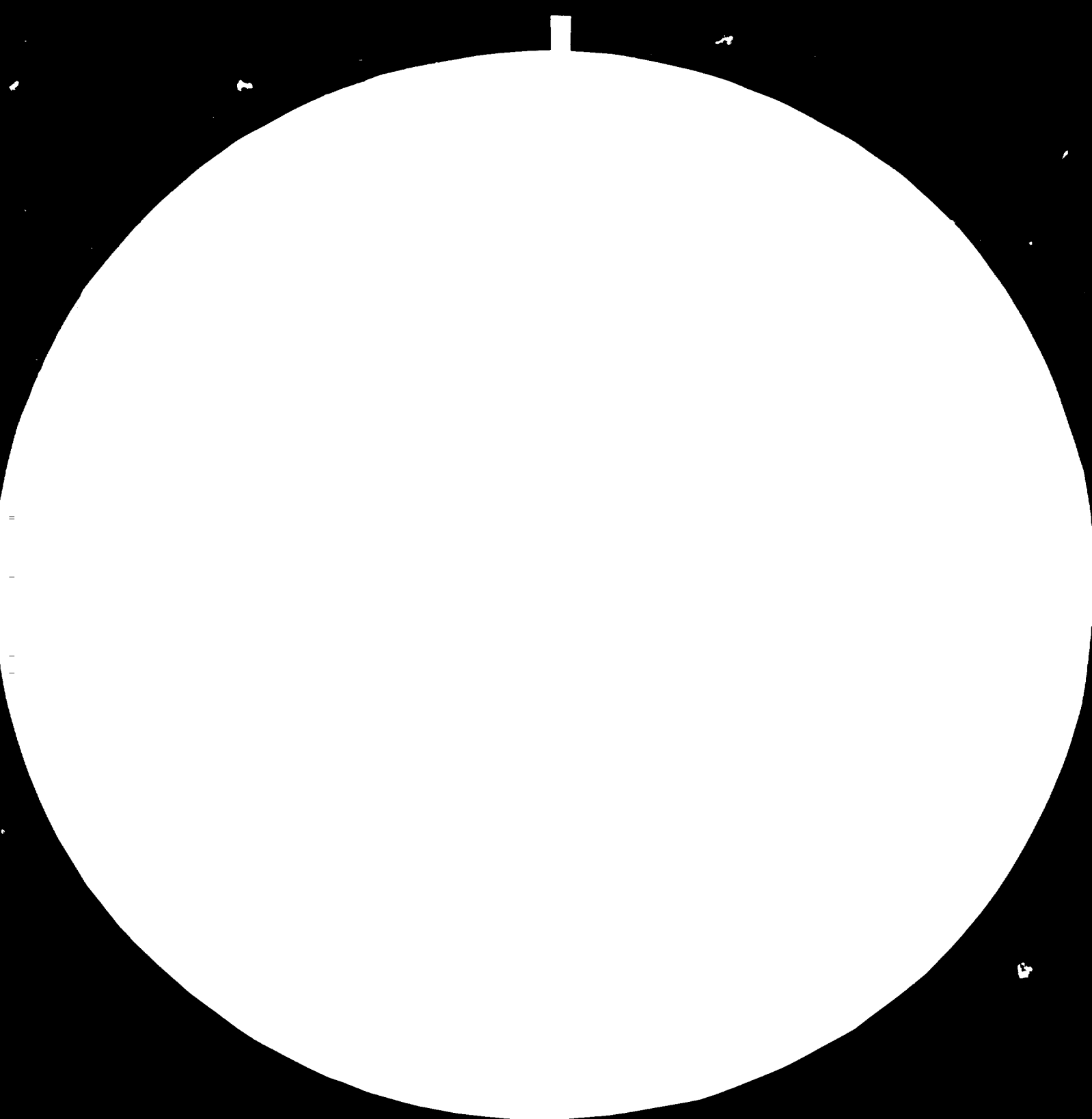

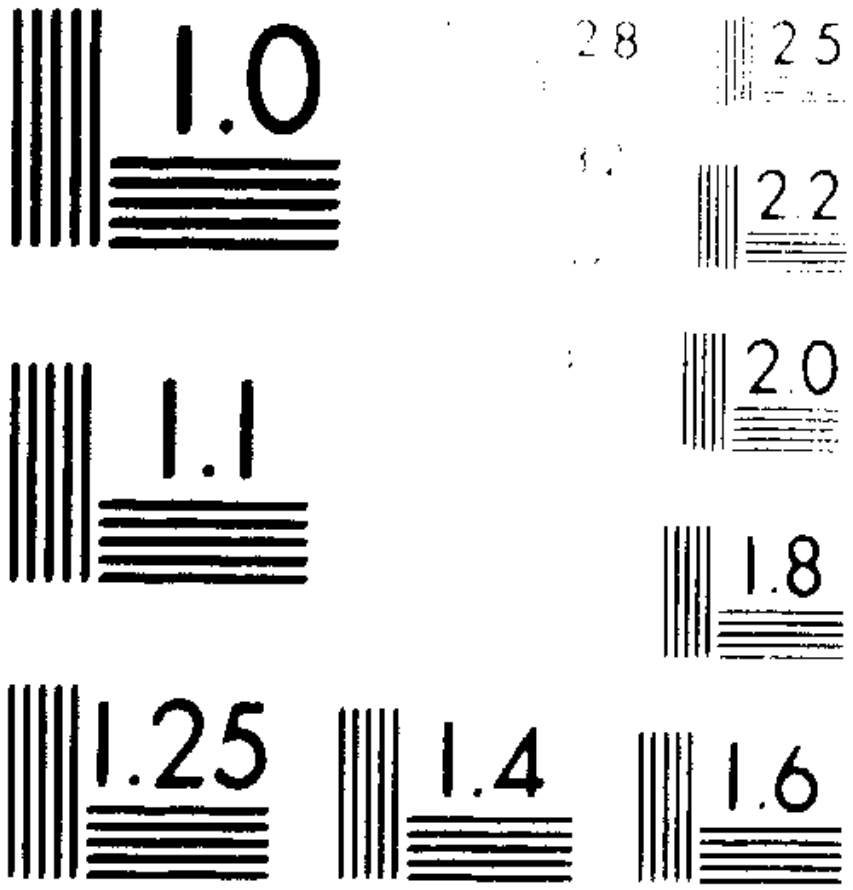
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DP/ID/SER.B/~~350~~ 356
25 August 1982
English

INDIA. ESTABLISHMENT OF A NUMERICAL CONTROL CENTRE FOR THE METAL WORKING INDUSTRY CMTI, BANGALORE.

DP/IND/73/014

INDIA

Terminal report*

Prepared for the Government of India
by the United Nations Industrial Development Organization,
acting as executing agency for the United Nations Development Programme

Based on the work of M.A. Szafarczyk,
expert in numerical control machine tool research

United Nations Industrial Development Organization
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ESTABLISHMENT OF A NUMERICAL CONTROL CENTRE FOR THE METAL WORKING INDUSTRY CMTI, BANGALORE

DP/IND/73/014

INDIA

Terminal report

Corrigendum

Document DP/ID/SER.B/350, dated 25 August 1982, should bear the symbol DP/ID/SER.B/356.

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I N T R O D U C T I O N

The aim of the IND/73/014 project is to provide assistance in the establishment of a Numerical Control Centre under the direction of the Central Machine Tool Institute in Bangalore. After several years of work the NC Centre has very good facilities and highly qualified personnel helping both manufacturers and users in proper selection and utilisation of NC machine tools. Also NC Centre is designing and developing its own CNC systems and CNC machine tools.

Several UNIDO consultants of different specialisations have been assigned subsequently to the project. My main role was to advise in testing of NC machine tools. Learning the high capabilities of the NC Centre I proposed to widen the scope of my advice to the research and development in the field of NC machine tools.

Thanks to the visits, organised by the Project Manager to several factories. I had the opportunity to form my own opinion as to the needs and capabilities of Indian industry. The machine tools manufacturers (M/s.HMT, M/s.Mysore Kirloskar) have enough means and expertise to produce NC machine tools for local users and for export. The Indian industry seems to need both highly sophisticated multiaxis machining centres and simplified "low cost" NC machine tools. Even if the latter are not so easy to justify because of low cost of labour, in some cases reliable read-out and semi-NC systems should be applied. At the present level of development of the Indian industry the implementation of NC technique seems to be a necessity.

I. OBJECTIVES

A. To help in developing test spectifications for NC machine tools which are in final stage of design and in familiarisation of different test proceaures needed for Indian industry.

B. To help in establishing the most needed directions of development in the field of NC machine tools and to formulate some concepts which could form the basis for research and development.

II. FINDINGS AND CONCLUSIONS

A. In the scope of testing of NC machine tools the work was concentrated on the following subjects:

1) Establishing different kinds of tests, their aims and typical procedures. The essence of the author's view is presented in Appendix 1.

2) Specification of test procedure of a prototype of NC machine tool with particular reference to the lathe for which control system is developed by the NC Centre. The main points of specification are listed in Appendix 2. The work was concentrated on testing procedure of contouring accuracy, design of test work pieces and testing of feed drive characteristics. These points seems to be most demanding.

3) Testing of the NC grinding machine which did not keep proper accuracy of workpiece diameters. This was practical example of diagnostic testing for failure to achieve specified accuracies. Tests revealed the inappropriate circulation of oil in tank and wrong placement of sensing units of temperature measurement and control equipment. The detailed report is in possession of the NC Centre.

4) The concept of standard diagnostic plug which would be built in control systems of all the NC machine tools used in India.

The plug would allow to standardise both equipment and procedure for basic diagnostic needed in case of machine tool failure. Some sort of standardisation seems to be very attractive because of great variety of NC machine tools and control systems already installed in Indian industry. The subject was left at the concept level because of the time limit.

B. The analysis of needs of Indian industry and possiblities of the NC Centre revealed that the research and development should proceed both in the direction of sophisticated multiaxis machining centres and in the direction of "low cost" NC machine tools. The following projects were discussed, formultated and in some cases the preliminary research was performed. Restricted time did not allow to go farther.

1) In-process inspection on CNC machining centre with 3-D touch trigger probe automatically loaded into the spindle nose. On the basis of the author's experience the project proposal was documented. The summary of the proposal is presented in Appendix 3. Some research was made and the best design solutions discussed.

2) Automatic presetting of tools and checking of their cutting adge wear by a trigger probe mounted on the table of CNC machining centre. The concept was discussed and evaluated.

3) Boring head with automatic change of diameter. The new concept based on the usage of ratchet mechanism actuated during idle rotation of spindle by a stop pushed out or swing-up by a solenoid. Automatic adjustment of the diameter of hole to be bored without the need of additional NC axis. If successful it would reduce the number of tools needed in the machining centre magazine and could be used for automatic correction of the hole diameter.

4) Design and application of a touch probe based on the precise limit switch or inductive pick-up for automatic correction of tool length on "low cost" CNC lathe. The simple device can eliminate the need for presetting of tools and at the same time increase accuracy of workpiece diameters. The concept was discussed and accepted.

5) The author proposed to make a research and to develop simple on line diagnostic system which, using the parameters of electric signals supplying a stepping motor, would check if all steps required by the control system are really performed. Stepping motors are relatively inexpensive digital driving units already made in India. The increase of reliability would considerably widen their use(small NC machine tools, plasma and laser cutting machines, digital plotters etc,.)

III. RECOMMENDATIONS

As a result of efforts of UNIDO and the Indian Authorities, very good institution has been created which is able not only to advise on selection and proper utlisation of NC machine tools, train technical personnel or demonstrate the advantages of NC technique; but also to be active in its own research and development in the field of NC machine tools. For the proper utilization of the modern, expensive NC machine tools and equipment as well as highly trained personnel it is vital to maintain close contacts with similar institutes abroad either by granting overseas fellowships to the CMTI employees or organising short term (2-3 months) visits of foreign consultants.

A P P E N D I X 1.

To avoid misunderstandings some classification of machine tool testing should be accepted. The authort proposes to distinguish following groups of tests.

1. Prototype and development tests.

   1.1 Testing of the prototype as to the accordance with design specifications and standards.

   1.2 Comparative tests of the prototype and and the similar machine tools with the aim of evaluation its merits and drawbacks.

   1.3 Research tests with the aim of improving the design from the specified point of view.

2. Production tests.

   2.1 In-process inspection and testing during the manufacturing process.

   2.2 Acceptance tests of the finished machine tool.

3. User tests.

   3.1 Diagnostic tests in case of failure aimed at the discovery of its reason.

   3.2 Diagnostic tests aimed at the discovery of "weak points" and preventing of failure.

   3.3 Tests aimed at the evaluation of machine tool quality after certain time of use.

The main points of interest, during visit of the consultant in the NC Centre, were in 1.1 and 3.1.

APPENDIX 2.

The following points of testing procedure of the prototype NC lathe were specified and discussed.

1. Specification verfication
2. Functional tests
3. Safety and ergonomics
4. Capacity utlization (cutting without chatter, chuck holding force, slide clamping, drop in speed under load)
5. Idle run tests (idle power, spindle temperature, noise, vibration)
6. Worm-up time and stabilization of temperature.
7. Feed drive characteristics
8. Accuracy without cutting (geometrical accuracy, positioning and repeatability, controuring accuracy)
9. Workpiece capability and accuracy.
10. Reliability (48 hrs run)

The points : 4, 7, 8, 9 and 10 has been discussed in detail and test workpieces have been designed.

APPENDIX 3.

In-process inspection with 3-D touch trigger probe automatically loaded into the spindle nose of CNC machining centre.

1. Principles of operation.

The 3-D touch trigger probe is mounted on an appropriate tool holder and can be called, like any other tool, from tool magazine of the CNC machining centre. Using the CNC system the probe can be moved relatively to the workpiece in the same manner as the tool is moved during machining. The probe is sensitive in any direction in XY plane and in direction of -Z. Any touch of the finger of the probe causes the change in electrical signal by opening the switch inside. The signal is trasmitted to the properly adopted CNC system which stores the value of coordinates at the moment of touch.

2. Possible applications.

a) Measurement of the co-ordinate value of the point on the surface of the workpiece by positioning the spindle with the probe in two axes and then moving along the third axis in the direction of the workpiece until the contact occurs. By measuring co-ordinates of points lying on datum surfaces of the workpiece its position before machining can be automatically checked (and corrected).

b) Compensation of errors of location of the probe in relation to the spindle of the machining centre by touching the surfaces of the datum element fixed to the table and moving the zero of co-ordinates accordingly.

c) In case of several workpieces mounted on the table of the machining centre it is possible to have separate datum elements situated near workpieces and use them for proper adjusting of the co-ordinate system before machining of each workpiece.

d) The measurement of co-ordinate values of chosen points of the workpiece surfaces after machining for automatic checking (and correcting) of errors caused by: tool setting, tool wear, deflections during machining etc,.

e) Automatic, simple checking of NC pick-ups accuracy and geometrical accuracy of the machining centre by measuring a master workpiece clamped to its table.

f) Automatic scanning of a casting or a welded workpiece clamped to the table of the machining centre to check machining allowances and to chose the best position of co-ordinate system, thus avoiding marking-out before machining.

3. Signal transmission.

After evaluation of alternative designs from the points of view of: cost, maintenance, noise immanity in workshop environment facility of installation and automatic loading from tool magazine the optical, infra-red transmission has been proposed.

Transmitter in the probe tool holder is powered by a built-in battery. The power supply is switched on when the probe is loaded into the spindle. Opening of the switch in the probe, at the moment of touch, changes frequency of a voltage sensitive oscillator supplying an infra_red LED. The modulated infra-red

signal is received by a photo-transistor mounted on the column of the machining centre. After amplification and demodulation the signal is sent to the CNC system.

4. Co-ordinate value registration.

The possibility of separation and registration of the co-ordinate value at the moment of probe touch was discussed and the tests were carried out on the CNC co-ordinate table developed and built in CMTI. The biggest delay in the measurement of co-ordinate value is caused by the resolver used as a pick-up (till 300 ns) but this error can be still kept below 0.001 mm.

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