NISTIR 88-3810

INVENTORY OF EQUIPMENT IN THE TURNING WORKSTATION OF THE AMRF

By:
Kang Lee

June 22, 1988
Issued
June, 1989

U.S. DEPARTMENT OF COMMERCE
National Institute of Standards & Technology

INVENTORY OF EQUIPMENT IN THE TURNING WORKSTATION OF THE AMRF

Kang Lee

Sensor Integration
Automated Production Technology Division
National Institute of Standards
and Technology
Gaithersburg, Maryland

Certain commercial equipment is identified in this paper to adequately describe the systems under development. Such identification does not imply recommendation or endorsement by the National Institute of Standards and Technology, nor does it imply that the equipment is necessarily the best available for the purpose.

TABLE OF CONTENTS

I. INTRODUCTION TO THIS MANUAL

This manual serves as an inventory guide to all electronic and mechanical systems in the Turning Workstation of the AMRF. It contains pertinent information on commercially supplied equipment, as well as equipment specially designed and built by NIST for use in the Turning Workstation.

II. SYSTEM OVERVIEW

The Turning Workstation consists of two large pieces of commercial equipment, the turning center and the robot. The turning center is a Hardinge 3-axis CNC lathe modified to accomplish automated tool changing and collet changing. The CNC lathe controller is enhanced with additional hardware and software for interfacing to a remote computer or controller. A higher-level machine-tool controller is implemented as a front-end unit for the CNC lathe controller. Remote control of the lathe is achieved through this higher-level controller. The robot is equipped with an interface so that the workstation controller can communicate to it.

The rest of the components are necessary to implement automated operations in the turning workstation. Many of these components represent advances both in design and state-of-the-art applications.

III. MAJOR COMPONENTS

1. TURNING WORKSTATION CONTROLLER

The turning workstation controller, based on the Intel System 310/286 microcomputer, consists of:

a) Intel 80286/10 single-board computer
b) 40 Mbyte Winchester drive
c) 5 1/4 inch floppy drive
d) 1 Mbyte RAM memory
e) Intel 84/188 8-channel serial communication board
f) RMX86, a real-time, multi-tasking operating system
g) Motorola 68000-based AMRF network communication board
h) Application control software written in PLM86

2. TURNING CENTER

The turning center is a Hardinge SuperSlant Turning Center with an Allen Bradley 8200 CNC controller. It is a three-axis, two-turret, slant-bed high-precision machine, capable of a resolution of 10 microinches. In order to fully utilize the lathe to machine precision parts, collets are used as workpiece holding devices. In addition the turning center is equipped with a chip conveyer to remove chips from the lathe to an external container.

2.1. Higher Level Machine Tool Controller

The higher level machine tool controller, based on the Intel 86/30 microcomputer, was designed at NIST. It consists of:

a) Intel 8086 single-board microcomputer
b) Intel SBC 534 4-channel serial communication board
c) Intel SBC 519 parallel I/O board
d) Intel SBC 556 opto-isolated parallel I/O board, 2 each.
e) Motorola 68000-based AMRF network communication board

2.2. Keyboard Interface

The turning-center keyboard interface was designed and built in house, based on the Intel 8751 single chip microcontroller. It is used for the entry of data and commands into the CNC controller from a remote computer.

3. ROBOT MANIPULATOR

The robot manipulator is a Bendix model AA-160 six-axis electric robot with a Bendix CNC controller. It is mounted on a gantry for easy access to the work volume of the slant-bed lathe.

3.1. Robot Front-End Controller

The robot front-end controller was designed and built in house, based on the Intel 8751 8-bit microcontroller. It functions as an interface between the workstation controller and the Bendix robot controller. This controller communicates with the workstation controller via a RS-232C link at 1200 baud.

3.2. Robot Gripper

The robot gripper was designed and built in house, as no commercially available robot gripper met all the necessary specifications. The robot gripper has two sets of fingers mounted back-to-back and is pneumatically actuated. The gripper fingers can exert a force up to 600 lbf. Furthermore, the gripper fingers can be changed to handle various tasks such as tool changing and collet loading.

3.3. Robot Gripper Controller

The robot gripper controller was designed and built in house, based on the Intel 8751 single chip microcontroller. It interfaces with the workstation controller to actuate the robot gripper.

4. MICROMANIPULATOR

The micromanipulator was designed and built in house. It is a hydraulically actuated servo-controlled fine-positioning mechanical device used to enhance the repeatability of the Bendix robot. The micromanipulator has five degrees of freedom and is attached between the wrist of the robot and the gripper. With the micromanipulator, complex tasks such as collet loading, collet changing, gripper finger changing, and tool changing can be easily accomplished.

4.1. Micromanipulator Controller

The micromanipulator controller, based on the Intel 8086 microprocessor with an 8087 math coprocessor, consists of:

a) Intel 86/30 single-board microcomputer
b) Intel SBX 311 ADC board
c) Intel SBX 312 DAC board
d) Custom design servo valve controller board
e) Control software written in PLM86

5. TURNTABLE

The turntable was designed and built in house and is a microprocessor-controlled rotating platter used as a buffer storage device for storing tooling and collets for the turning center and gripper fingers for the robot. It can store up to 66 items weighing up to 200 lbs. The microprocessor-based controller performs servo control functions as well as communication with the workstation controller.

6. PROGRAMMABLE STOP

The programmable stop was designed and built in house to provide a reference stop-point for parts placed in the collet. It is a motor-driven leadscrew mechanism inside the spindle of the turning center. It has a linear travel of seven inches and repeatability of 100 microinches.

7. COLLET CHANGER

The collet changer was designed and built in house to allow unattended operation of the turning center. It consists of a mechanical system which is a clutch assembly activated by a pneumatic piston, a motor controller, and an inductive sensor to count the appropriate turns of the drawbar. The microprocessor-based controller has interface capability for local as well as remote operation.

8. TOOL-SETTING STATION

The tool-setting station, designed and built in collaboration with Hardinge Bros., is a LVDT-based sensor system. The mechanical system consists of an LVDT-based gage head and a hydraulically actuated, precision four-bar mechanism for positioning the gage head. The controller hardware consists of two specially designed, printed-circuit boards, one of which is an Intel 8088-based computer with an Intel 8087 math coprocessor. The other board contains analog signal conditioning circuits for the LVDT sensors.

9. MALFUNCTION DETECTOR

The malfunction detector consists of two accelerometers, mounted on the turret assemblies of the turning center. It is controlled by two in house designed printed-circuit boards. One board provides signal conditioning and A/D conversion; the other is the microcomputer.

10. LOAD/UNLOAD STATION

The load/unload station is a remote-controlled roller table that receives and sends trays to and from the robot cart. It is equipped with a microprocessor-based controller that interfaces with the material handling system through an RS-232C link. The station accepts trays up to 22 inches square.

IV. REFERENCE

The equipment in the Turning Workstation are described in more details in " The Turning Workstation In The AMRF ", NBSIR 88-3749, April 20, 1988. Copies of this report can be obtained from U. S. Department of Commerce, National Institute of Standards and Technology, Building 233, Room B106, Gaithersburg, Maryland 20899.

NBS-114A (REV. 2-8C)

U.S. DEPT. OF COMM. BIBLIOGRAPHIC DATA SHEET (See instructions)	1. PUBLICATION OR REPORT NO. NISTIR 88-3810	2. Performing Organ. Report No.	3. Publication Date MAY 1989

4. TITLE AND SUBTITLE

Inventory of Equipment in the Turning Workstation.

5. AUTHOR(S)

Kang B. Lee

6. PERFORMING ORGANIZATION (If joint or other than NBS, see instructions)

NATIONAL BUREAU OF STANDARDS
DEPARTMENT OF COMMERCE
WASHINGTON, D.C. 20234

7. Contract/Grant No.

8. Type of Report & Period Covered

9. SPONSORING ORGANIZATION NAME AND COMPLETE ADDRESS (Street, City, State, ZIP)

U. S. Navy Manufacturing Technology Program

10. SUPPLEMENTARY NOTES

☐ Document describes a computer program; SF-185, FIPS Software Summary, is attached.

11. ABSTRACT (A 200-word or less factual summary of most significant information. If document includes a significant bibliography or literature survey, mention it here)

This manual serves as an inventory guide to all electronic and mechanical systems in the Automated Turning Workstation at the Automated Manufacturing Research Facility (AMRF).

12. KEY WORDS (Six to twelve entries; alphabetical order; capitalize only proper names; and separate key words by semicolons)

Turning center, robot, workstation controller, equipment list.

13. AVAILABILITY

☒ Unlimited

☐ For Official Distribution. Do Not Release to NTIS

☐ Order From Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

☒ Order From National Technical Information Service (NTIS), Springfield, VA. 22161

14. NO. OF PRINTED PAGES 11

15. Price $9.95