NISTIR 4932

Inventory in the Advanced Deburring and Chamfering System

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TECHNOLOGY ADMINISTRATION
Robert M. White, Under Secretary for Technology

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John W. Lyons, Director

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I. INTRODUCTION

This manual provides a complete inventory of the equipment in the Advanced Deburring and Chamfering System (ADACS). The inventory lists equipment in the Workstation Controller System and the Chamfering System. A list of suppliers whose equipment is used in the ADACS is located at the end of this document in Appendix A.

1. SYSTEM DESCRIPTION

The ADACS project is a U.S. Navy sponsored joint venture between National Institute of Standards and Technology and United Technology Research Center. ADACS is located in the Automated Manufacturing Research Facility. ADACS is used for putting a 45° beveled edge or chamfer on naval aircraft engine parts. Equipment at the workstation include a six-axis electric robot used for gross positioning, a two-axis adaptive deburring tool (ADT) used for fine positioning and cutting, and a two-axis positioning table used for part maneuvering.

A part is manually placed in the vise located on the positioning table. The ADT is mounted on the wrist of the robot. The robot positions the ADT close to the edge that is to be chamfered. The ADT maintains a constant force along the edge with a carbide steel burr that is spinning at 30,000 to 100,000 rpm. The positioning table orients the part through rotation and tilt.

The robot and the ADT each have a separate controller. These two controllers are overseen by a workstation controller.

2. PURPOSE OF THIS MANUAL

The purpose of this manual is to give a complete inventory for the Advanced Deburring and Chamfering System. This inventory includes a list of the names and addresses of manufacturers whose products are used. This document is intended to serve as a guide to implementing a research facility modeled after the ADACS. It is not to be construed as a recommendation of commercial equipment.

3. HOW THIS MANUAL IS ORGANIZED

This manual is divided into four parts. The Introduction gives a brief overview of the ADACS and explains the purpose and organization of the manual. Section II provides an inventory for the Workstation Controller, the highest level of the hierarchy. Section III provides an inventory for the Chamfering System. At the end of the document are the Appendices. Appendix A provides a list of commercial suppliers whose equipment is used in the ADACS.

4. WHO SHOULD USE THIS MANUAL

This manual is intended as a guide for researchers who need to specify and procure automated manufacturing equipment, and computer hardware and software for a deburring and chamfering research facility.

5. PRODUCT ENDORSEMENT DISCLAIMER

Reference to specific brands, equipment, or trade names in this document are made to facilitate understanding and do not imply endorsement by the National Institute of Standards and Technology nor does it imply that the equipment identified are necessarily the best available for the purpose.

II. WORKSTATION CONTROLLER

The Workstation Controller is a set of software modules that interface to the user, give commands to the Chamfering System controllers and schedule events.

1. COMPUTER HARDWARE

The workstation controller runs on a Sun Sparcstation 2 and communicates to the Chamfering system controllers via ethernet link.

(a) Sun Sparcstation 2 with high resolution monochrome display

2. SOFTWARE

The software used to implement the workstation consists of the operating system (SunOS 4.1), a text editor (Emacs), C and C++ compilers and debugger, and a windowing system (Xwindows)

(a) SunOS 4.1 operating system

(b) Free Software Foundation Gnu Emacs version 18, ANSI C version 1.40 and C++ version 1.39 compilers, and gdb version 4.1 debugger

(c) MIT X Windows, version 11, revision 5

ADACS Equipment Inventory

III. CHAMFERING SYSTEM

Chamfering is performed by two robots and a servo positioning table. One robot is the AB&B Robotics (formerly Cincinnati Milacron) T3-646 six axis electric robot. The other robot is the TriKinetics ADT-1A Adaptive Deburring Tool which has two axes and force feedback control. The positioning table is made by K. N. Aronson and has two axes (tilt and rotation).

1. ROBOTIC EQUIPMENT

The T3 is used as a gross positioning device and the ADT-1A is used as a fine positioning device. The positioning table holds the part that is to be chamfered. Each device has its own separate controller. This method of control is called around the arm control. The ADT-1A is mounted on the wrist of the T3. The T3 positions the tip of the ADT-1A within its range of motion. The ADT-1A then moves its tip against the part and maintains contact with the part as the T3 moves it about through the planned trajectories. The equipment is as follows:

(a) AB&B Cincinnati Milacron T3-646 6-axis electric robot and controller

(b) Trikinetics ADT-1A Adaptive Deburring Tool and controller

(c) K. N. Aronson RAB5SD-FB 2 axis positioning table and controller

(d) carbide steel burrs

(e) NIST designed vise

2. COMPUTER HARDWARE

The T3 is controlled using the NIST developed Real-Time Control System (RCS) interfaced to the vendor supplied controller using a remote real-time interface that uses the Digital Data Communications Message Protocol (DDCMP). This protocol requires that the user compute and serially download world coordinates and ZYZ Euler angles (6 numbers) every thirty milleseconds. A six-degree-of-freedom joystick is used to teach points for the T3. The positioning table is also controlled using RCS with resolver position feedback. The resolvers are fed back to a Resolver-to-Digital VME board. The controller then outputs an analog

voltage to the vendor supplied controller corresponding to the velocity at which each axis should rotate. The ADT-1A is controlled by a vendor supplied controller and is interfaced to the workstation controller via serial connection through which it receives high level commands. The equipment is as follows:

(a) Motorola MVME712M VME backplane

(b) 3 Motorola MVE-147 cpu boards

(c) Silicon Graphics six degree of freedom spaceball joystick

(d) Acromag 9480 digital I/O board

(e) 2 - Acromag 9321 analog I/O board

(f) VIVME 4920 Resolver to digital board

(g) NIST designed equipment interface

3. SOFTWARE

The software used to implement RCS is ANSI C and C++. The source files are written and compiled on a Sun Sparcstation 2 and downloaded to a VME based system which uses VxWorks operating system.

(a) RCS-3c (NIST developed software)

(b) VxWorks Inc. VxWorks 5.0.2 realtime operating system

APPENDIX A. LIST OF SUPPLIERS

AB&B Robotics
2487 S. Commerce Drive
New Berlin, WI 53151
(414) 785-3405

Manuals:

Communications Manual for Cincinnati Milacron® Acramatic® Version 4 and 5 Robot Control, Part Number 5010321-195, Publication Number 10-IR-87026, 1987

Control Manual for Cincinnati Milacron® Acramatic® Version 4 and 5 Robot Control, Part Number 5010321-160, Publication Number 5-IR-86018, 1987

Data Format Manual for Cincinnati Milacron® Acramatic® Version 5 Robot Control, Release 2 Software, Part Number 5010321-194, Publication Number 10-IR-87029, 1987

Installation Manual for Cincinnati Milacron® T3®646 Industrial Robot with Acramatic® Version 5.0 Robot Control, Part Number 5010321-150, Publication Number 7-IR-86033, 1987

Operating/Teach Manual for Cincinnati Milacron® T3®600/700/800 Series Industrial Robots with Acramatic® Version 5 Robot Control, Release 5.0, Manual Part Number 5010321-244, Publication Number 16-IR-87002-4, 1987

Parts Manual for Cincinnati Milacron® T3®646 Industrial Robot, Part Number 5010321-159, Publication Number 2-IR-86034, 1987

Remote Real Time Interface Specification for T3 700 Series Industrial Robots 1988

Service Manual for Cincinnati Milacron® T3®646 Industrial Robot with Acramatic® Version 5 Robot Control, Part Number 5010321-211, Publication

Number 3-IR-86032-1, 1987
User Guide to Cincinnati Milacron® Version of MS-DOS® for Cincinnati Milacron T3® Industrial Robots with Acramatic® Version 5 Robot Control, Part Number 5010321-162, Publication Number 6-IR-87007, 1987

Acromag Incorporated
30765 Wixom Road
Wixom, MI 48096
(313) 624-1541

Manuals:
Series 9320/9321 High Speed Analog Input Board User's Manual, Publication Number 8500-194, 1987

Series 9480 Digital I/O Board Manual User's Manual, Publication Number 8500-189-A08620, 1987

Augat Incorporated
452 John Dietsch Boulevard
Attleboro Falls, MA 02763
(508) 699-9800

Free Software Foundation
675 Massachusetts Avenue
Cambridge, MA 02139

Manual:
GNU Emacs Manual, Sixth Edition Version 18, March 1987, Richard Stallman

Fullerton Tool Company
P.O. Box 2008
Saginaw, MI 48605
(517) 799-4550

K.N. Aronson
PO Box 307
635 West Main Street
Arcade, NY 14009

(716) 492-2400

MIT X Consortium
Laboratory for Computer Science
545 Technology Square
Cambridge, Ma 02139

Motorola Incorporated
Computer Group
Microcomputer Division
2900 South Diablo Way
Tempe, AZ 85282

Manual:
MVME147 MPU VMEmodule User's Manual, 1988

The Precise Corporation
3715 Blue River Avenue
Racine, WI 53405
(414) 632-6173

Manual:
Solid State Frequency Converter PVSF 2 Operating Instructions, Revision 461-E

Spatial Systems Incorporated
472 Old Bedford Road
Concord, MA 01742
(508) 369-8588

Manuals:
Spaceball Application Developer's Reference, Document Number D1005 Revision 4.0, 1989

Spaceball Technical Reference, Document Number D1003 Revision 2.0, 1989

SUN Microsystems Incorporated
2520 Garcia Avenue
Mountain View, CA 94043

(415) 960-1300

Manuals:
Document Set SX-09/SX-4.1.2-09, 1992

SunOS Reference Manual, Part Number 800-3827-10, 1990

TriKinetics
256 Charles Street
Waltham, MA 02254
(617) 891-6110

VME Microsystems International Corporation
12090 South Memorial Parkway
Huntsville, AL 35803
(205) 880-0444

Manual:
VMIVME-4920 Dual Synchro/Resolver-to-Digital Input Module Instruction Manual, Document Number 500-004920-000, 1991

Wind River Systems Incorporated
1351 Ocean Avenue
Emeryville, CA 94608
(415) 428-2623 1-800-545-WIND

Manuals:
VxWorks Programmer's Guide, 1990

VxWorks Reference Manual, 1991

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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 provides a complete inventory of the equipment used in the Advanced Deburring and Chamfering System of the Automated Manufacturing and Research Facility of the National Institute of Standards and Technology.

12. KEY WORDS (6 TO 12 ENTRIES; ALPHABETICAL ORDER; CAPITALIZE ONLY PROPER NAMES; AND SEPARATE KEY WORDS BY SEMICOLONS)

Advanced Deburring and Chamfering System; Automated Manufacturing and Research Facility; chamfering; deburring; inventory; manufacturing; robotics

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