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CELL CONTROLLER OPERATIONS MANUAL

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By:
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I. INTRODUCTION

This manual is one in a series of operations manuals written to instruct a novice in the operation of one of the systems in the Automated Manufacturing Research Facility (AMRF) at the National Bureau of Standards. The manual assumes that the operator has some training in the use of the computer but little knowledge of the AMRF and only wants to operate the specific system in a standard configuration, not learn how or why it operates as it does. A reader interested in further information about the system should consult this document's bibliography for a list of other publications on the subject.

The AMRF, the major national laboratory for research in automated manufacturing, consists of six workstations and the control rooms and computer equipment necessary to operate them. The facility is a test bed where scientists and engineers from industry, academia, and the government work together on projects of mutual interest. Their research concentrates on the interfaces and measurement techniques needed for successful computer integrated manufacturing.

This particular manual addresses the operation of the AMRF's cell controller. The cell controller is currently the highest level controller in the AMRF. The cell controller directs the actions of five subordinate workstations: Vertical Workstation (VWS), Horizontal Workstation (HWS), Inspection Workstation (IWS), Material Handling Workstation (MHS), and Cleaning and Deburring Workstation (CDWS). There are four major sections to this manual, basic operation of the cell screen management system, startup of the cell, operation of the cell, and shutdown of the cell.

The cell controller is located in Control Room 2 on the desk facing the window. The cell controller is running on a COMPAQ deskpro 386 computer, and requires software to be running concurrently on the Sun Network computer. The Sun computer is located on the table to left of the COMPAQ 386, as you face the COMPAQ.

II. OPERATION OF THE SCREENS

The cell's screens are broken down into three major areas: menu area, data area, and the status bar. Figure 1 shows the location of the three areas on the screen.

F3: Communication state data display
F4: Mailbox display
F5: Cell control command display
F6: Cell control status display
F7: Summary display
F8: Work elements display
F9: Communication display
F10: Subordinate controller

Most of the information about the cell is presented in the second area on the screen, the data page. The data page covers from line 4 to line 24 on the screen. Many different page formats are defined which provide control and communications information to the user in real-time.

The last area on the screen, the status bar, provides summary or diagnostic information. The highlighted status bar displays the current clock cycle, the current screen identifier, communications status, and the current time. It provides constant feedback to the user that the cell is operating correctly. The current clock cycle should be updating about ten times a second. If the clock cycles have stopped updating for more than a few seconds, the system might have abnormally stopped. When the system has abnormally stopped, the computer must be turned off and then turned on. The computer is then rebooted, and the startup procedure is repeated.

III. STARTUP

1. CELL CONTROLLER STARTUP

- 1) The Sun MHS and CELL communications processes are started by either the Network operator or the AMRF operator.
- 2) Check that the power strip is connected to the COMPAQ 386 and there is no diskette in the disk drive. Check that the computer's power switch is on. When the COMPAQ 386 is ready to operate, the prompt

C>

will be the last item written on the screen.

- 3) To start the cell controller on the COMPAQ 386 enter commands

```
c:  
cd cell  
cell
```

See Figure 2 in the Appendix. The figures of the cell screens are to help users determine if their keyboard actions are producing the desired effects. The cell takes a few seconds to startup; therefore wait until clock cycles start updating before proceeding.

4) Using the arrow keys, highlight the menu option SET_COMM. Press the Enter key. See Figure 3.

5) Using the arrow keys, highlight the menu option COMM_SWITCH. Press the Enter key. See Figure 4.

6) Using the arrow keys, highlight the menu option ON. Press the Enter key. See Figure 5. (Observe on the status bar the COMM: status should be switching from IDLE to RCV about every ten seconds.) This activates communication between the cell computer and the Sun that provides a connection to the AMRF Network.

7) Enter the Esc key to return to the SET_COMM menu.

8) Enter the Esc key again to return to the main menu, CELL.

2. UNIVERSITY OF VIRGINIA (UVA) PROTOCOL TO WORKSTATIONS

9) Enter the F7 function key to bring up the Summary display. See Figure 6.

10) Using the arrow keys, highlight the menu option SET_CMDS. Press the Enter key. See Figure 7.

11) For each subordinate workstation that is being used, perform the next 6 steps on each workstation. An example of initializing the Cleaning and Deburring Workstation is shown.

12) Using the arrow keys, highlight the menu option for the workstation desired (for this example use CDWS). Press the Enter key. See Figure 8.

13) Using the arrow keys, highlight the menu option SYNC. Press the Enter key. See Figure 9.

14) Wait for the workstation to return a SHUTDOWN status. See Figure 10.

15) Using the arrow keys, highlight the menu option WARM. Press the Enter key. See Figure 11.

16) Wait for the workstation to return a READY status. See Figure 12.

- 17) Enter the Esc key to return to the SET_CMDS menu.
- 18) If there are more subordinate workstations to be initialized, repeat steps 12 through 19 for each workstation.
- 19) Enter the Esc key, and this will return to the main menu.
- 20) The cell controller is now fully operational.

IV. OPERATION OF THE CELL

There are two main operations the cell can perform, entering orders and monitoring.

1. ORDER ENTRY

To enter an order do the following.

- 1) While in the main menu CELL, use the arrow keys to highlight the menu option ORDERS and press the Enter key. See Figure 13.
- 2) Using the arrow keys, highlight the menu option ENTRY. Press the Enter key. See Figure 14. (The list of orders in the figure is an example of a possible screen.)
- 3) To select an order use the up and down arrows to highlight the desired order. Once the correct order has been highlighted, press the Enter key. The cell will acknowledge by displaying the message ORDER ACCEPTED, see Figure 15.
- 4) To enter another order repeat step 3.
- 5) If there are no more orders to select, press the Esc key. The menu area for the ORDERS screen will return, see Figure 16.
- 6) Press the Esc key and the main menu CELL will return.
- 7) To enter more orders in the future return to the ORDER ENTRY screen and repeat steps 2 through 4.

2. MONITORING

The second operation of the cell is to monitor the status messages of the subordinate workstations. This monitoring is displayed on the summary screen. To bring up the summary screen enter the function key F7. An example of the summary screen is shown in Figure 17. The summary screen shows the commands being sent to the subordinate workstations and the

status of the workstation. In this example, the Inspection Workstation was given a work order to receive a tray with a lot type of MIXED and quantity of four items in the lot. The Material Handling Workstation is in a READY state.

V. SHUTDOWN

- 1) Return to the main menu CELL by entering the Esc key until the main menu CELL is on the screen.
- 2) Using the arrow keys, highlight the menu option SET_CMDS. Press the Enter key.
- 3) Press the function key F7 to bring up the summary screen. (This will blank out the menu area. The menu area will return when an arrow key is entered.)
- 4) For each subordinate workstation that is being used, perform the next 4 steps. (An example of shutting down the Cleaning and Deburring Workstation is shown.)
- 5) Using the arrow keys, highlight the menu option for the workstation desired (for this example use CDWS). Press the Enter key.
- 6) Using the arrow keys, highlight the menu option SHUTDOWN. Press the Enter key. See Figure 18.
- 7) Wait for the workstation to return a SHUTDOWN status. The COMPAQ's screen should look roughly like Figure 19 when the SHUTDOWN status has been returned.
- 8) Enter the Esc key to return to the SET_CMDS menu.
- 9) If there are more subordinate workstations to be shutdown, repeat steps 5 through 8 for each workstation.
- 10) Using the arrow keys, highlight the menu option EXIT. Press the Enter key. See Figure 20 for the menu portion of the EXIT screen.
- 11) Using the arrow keys, highlight the menu option YES. Press the Enter key.
- 12) The COMPAQ computer's prompt should return on the screen.
- 13) Turn off the power on the COMPAQ computer.
- 14) The cell controller is now shutdown.

APPENDIX FIGURES OF CELL SCREENS

```
CELL
SET_COMM SET_CMDS SET_STATS ORDERS TYPE SCREEN EXIT
COMM_SWITCH COMM_UNIT EXIT
|||||
AMRF Cell Version 2.2 August 1987
```

CYCLE: 2 SCRN:STARTUP SYS:CDWS COMM:OFF TIME:16:08.49

CELL Menu
Figure 2

SET_COMM
COMM_SWITCH COMM_UNIT EXIT
ON OFF EXIT
|||||
AMRF Cell Version 2.2 August 1987

CYCLE: 4 SCRN:STARTUP SYS:CDWS COMM:OFF TIME:13:39.18

SET_COMM Menu
Figure 3

COMM_SWITCH
ON OFF EXIT
|||||
AMRF Cell Version 2.2 August 1987

CYCLE: 5 SCRN:STARTUP SYS:CDWS COMM:OFF TIME:13:39.20

COMM_SWITCH Menu
Figure 4

COMM_SWITCH
ON OFF EXIT

|||||
AMRF Cell Version 2.2 August 1987

CYCLE: 5 SCRN:STARTUP SYS:CDWS COMM:IDLE TIME:13:39.20

COMM_SWITCH menu
Figure 5

CELL
SET_COMM SET_CMDS SET_STATS ORDERS TYPE SCREEN STUFF_MB EXIT
COMM_SWITCH COMM_UNIT EXIT
|||||
Ctrl Msg Transition Order Element Lot Type
Name Nr # - Keyword # - Keyword & Plan Id & Qty

CDWS 0 0
0 0

HWS 0 0
0 0

IWS 0 0
0 0

MHS 0 0
0 0

TWS 0 0
0 0

VWS 0 0
0 0

CYCLE: 2 SCRN:SUMMARY SYS:CDWS COMM:IDLE TIME:13:31.22

CELL Menu
Figure 6

```

SET_CMDS
CDWS  HWS  IWS  MHS  TWS  VWS  VISION  EXIT
SYNC  WARM  CDWS_LOT_TYPE  RCV_TRAY  DBURR_LOT  SHIP_TRAY  SHUTDOWN  EXIT
|||||
Ctrl Msg  Transition          Order          Element          Lot Type
Name Nr   # - Keyword          # - Keyword          & Plan Id        & Qty
CDWS  0    0
     0    0
-----
HWS   0    0
     0    0
-----
IWS   0    0
     0    0
-----
MHS   0    0
     0    0
-----
TWS   0    0
     0    0
-----
VWS   0    0
     0    0
-----
CYCLE:          3  SCRN:SUMMARY  SYS:CDWS  COMM:IDLE  TIME:16:36.45

```

SET_CMDS Menu
Figure 7

```

CDWS
SYNC  WARM  CDWS_LOT_TYPE  RCV_TRAY  DBURR_LOT  SHIP_TRAY  SHUTDOWN  EXIT
|||||
Ctrl Msg  Transition          Order          Element          Lot Type
Name Nr   # - Keyword          # - Keyword          & Plan Id        & Qty
CDWS  0    0
     0    0
-----
HWS   0    0
     0    0
-----
IWS   0    0
     0    0
-----
MHS   0    0
     0    0
-----
TWS   0    0
     0    0
-----
VWS   0    0
     0    0
-----
CYCLE:          4  SCRN:SUMMARY  SYS:CDWS  COMM:IDLE  TIME:16:36.47

```

CDWS Menu
Figure 8


```

CDWS
SYNC WARM CDWS_LOT_TYPE RCV_TRAY DBURR_LOT SHIP_TRAY SHUTDOWN EXIT
|||||
Ctrl Msg Transition Order Element Lot Type
Name Nr # - Keyword # - Keyword & Plan Id & Qty
CDWS 1 1 SYNC
0 0
-----
HWS 0 0
0 0
-----
IWS 0 0
0 0
-----
MHS 0 0
0 0
-----
TWS 0 0
0 0
-----
VWS 0 0
0 0
-----
CYCLE: 5 SCR:SUMMARY SYS:CDWS COMM:IDLE TIME:16:36.51

```

CDWS Menu
Figure 9

```

SET_CMDS
CDWS HWS IWS MHS TWS VWS VISION EXIT
SYNC WARM CDWS_LOT_TYPE RCV_TRAY DBURR_LOT SHIP_TRAY SHUTDOWN EXIT
|||||
Ctrl Msg Transition Order Element Lot Type
Name Nr # - Keyword # - Keyword & Plan Id & Qty
CDWS 1 1 SYNC
1 1 SHUTDOWN
-----
HWS 0 0
0 0
-----
IWS 0 0
0 0
-----
MHS 0 0
0 0
-----
TWS 0 0
0 0
-----
VWS 0 0
0 0
-----
CYCLE: 12 SCR:SUMMARY SYS:CDWS COMM:IDLE TIME:16:37.11

```

SET_CMDS Menu
Figure 10

CDWS
 SYNC WARM CDWS_LOT_TYPE RCV_TRAY DBURR_LOT SHIP_TRAY SHUTDOWN EXIT

| Ctrl | Msg | Transition | Order | Element | Lot Type |
|---------------|-----|----------------|--------------|-----------|-----------|
| Name | Nr | # - Keyword | # - Keyword | & Plan Id | & Qty |
| CDWS | 1 | 1 WARM_STARTUP | | | |
| | 1 | 1 SHUTDOWN | | | |
| ----- | | | | | |
| HWS | 0 | 0 | | | |
| | 0 | 0 | | | |
| ----- | | | | | |
| IWS | 0 | 0 | | | |
| | 0 | 0 | | | |
| ----- | | | | | |
| MHS | 0 | 0 | | | |
| | 0 | 0 | | | |
| ----- | | | | | |
| TWS | 0 | 0 | | | |
| | 0 | 0 | | | |
| ----- | | | | | |
| VWS | 0 | 0 | | | |
| | 0 | 0 | | | |
| ----- | | | | | |
| CYCLE: | | 13 | SCRN:SUMMARY | SYS:CDWS | COMM:IDLE |
| TIME:16:37.14 | | | | | |

CDWS Menu
 Figure 11

SET_CMDS

CDWS HWS IWS MHS TWS VWS VISION EXIT
 SYNC WARM CDWS_LOT_TYPE RCV_TRAY DBURR_LOT SHIP_TRAY SHUTDOWN EXIT

| Ctrl | Msg | Transition | Order | Element | Lot Type |
|---------------|-----|----------------|--------------|-----------|-----------|
| Name | Nr | # - Keyword | # - Keyword | & Plan Id | & Qty |
| CDWS | 1 | 1 WARM_STARTUP | | | |
| | 1 | 1 READY | | | |
| ----- | | | | | |
| HWS | 0 | 0 | | | |
| | 0 | 0 | | | |
| ----- | | | | | |
| IWS | 0 | 0 | | | |
| | 0 | 0 | | | |
| ----- | | | | | |
| MHS | 0 | 0 | | | |
| | 0 | 0 | | | |
| ----- | | | | | |
| TWS | 0 | 0 | | | |
| | 0 | 0 | | | |
| ----- | | | | | |
| VWS | 0 | 0 | | | |
| | 0 | 0 | | | |
| ----- | | | | | |
| CYCLE: | | 19 | SCRN:SUMMARY | SYS:CDWS | COMM:IDLE |
| TIME:16:37.31 | | | | | |

SET_CMDS Menu
 Figure 12

ORDERS
ENTRY STATUS HISTORY EXIT

|||||
AMRF Cell Version 2.2 August 1987

CYCLE: 3 SCRN:STARTUP SYS:CDWS COMM:IDLE TIME:16:11.50

. ORDERS Menu
Figure 13

|||||
ORDER ENTRY

| SEQ | PART_ID | BATCH_ID | FILE |
|-----|--------------|----------|-------------|
| 1 | MIXED_510 | IWS_510 | PLAN5 |
| 2 | MIXD_520 | IWS_520 | PLAN22 |
| 3 | MIXED_530 | IWS_530 | PLAN6 |
| 4 | DOG | CWS_400 | PLAN20 |
| 5 | LCLEVIS | CWS_440 | PLAN21 |
| 6 | BLOCK_FH | CWS_410 | PLAN7 |
| 7 | PIPECLAMP_FV | CWS_430 | PLAN8 |
| 8 | NIPPLE | TWS_303 | PLAN19 |
| 9 | SLBEARING | TWS_305 | PP_CELL_183 |
| 10 | LCLEVIS | VWS_200 | PLAN10 |

CYCLE: 3 SCRN:SEQS SYS:CDWS COMM:IDLE TIME:16:11.51

ORDER ENTRY Screen
Figure 14

|||||
ORDER ENTRY

| SEQ | PART_ID | BATCH_ID | FILE |
|-----|--------------|----------|-------------|
| 1 | MIXED_510 | IWS_510 | PLAN5 |
| 2 | MIXED_520 | IWS_520 | PLAN22 |
| 3 | MIXED_530 | IWS_530 | PLAN6 |
| 4 | DOG | CWS_400 | PLAN20 |
| 5 | LCLEVIS | CWS_440 | PLAN21 |
| 6 | BLOCK_FH | CWS_410 | PLAN7 |
| 7 | PIPECLAMP_FV | CWS_430 | PLAN8 |
| 8 | NIPPLE | TWS_303 | PLAN19 |
| 9 | SLBEARING | TWS_305 | PP_CELL_183 |
| 10 | LCLEVIS | VWS_200 | PLAN10 |

ORDER ACCEPTED

CYCLE: 4 SCR:SEQS SYS:CDWS COMM:IDLE TIME:15:14.42

ORDER ENTRY Screen
Figure 15

ORDERS
ENTRY STATUS HISTORY EXIT

|||||
ORDER ENTRY

| SEQ | PART_ID | BATCH_ID | FILE |
|-----|--------------|----------|-------------|
| 1 | MIXED_510 | IWS_510 | PLAN5 |
| 2 | MIXED_520 | IWS_520 | PLAN22 |
| 3 | MIXED_530 | IWS_530 | PLAN6 |
| 4 | DOG | CWS_400 | PLAN20 |
| 5 | LCLEVIS | CWS_440 | PLAN21 |
| 6 | BLOCK_FH | CWS_410 | PLAN7 |
| 7 | PIPECLAMP_FV | CWS_430 | PLAN8 |
| 8 | NIPPLE | TWS_303 | PLAN19 |
| 9 | SLBEARING | TWS_305 | PP_CELL_183 |
| 10 | LCLEVIS | VWS_200 | PLAN10 |

CYCLE: 5 SCR:SEQS SYS:CDWS COMM:IDLE TIME:15:14.46

ORDERS Menu
Figure 16

```

CELL
SET_COMM SET_CMDS SET_STATS ORDERS TYPE SCREEN EXIT
ENTRY STATUS HISTORY EXIT
|||||
Ctrl Msg Transition Order Element Lot Type
Name Nr # - Keyword # - Keyword & Plan Id & Qty
-----
CDWS 0 0
    0 0
-----
HWS 0 0
    0 0
-----
IWS 0 0          2 EXECUTE RECEIVE_TRAY MIXED
    0 0          NO_STATUS                4
-----
MHS 0 0
    1 0 READY
-----
TWS 0 0
    0 0
-----
VWS 0 0
    0 0
-----
CYCLE:          6  SCRN:SUMMARY  SYS:CDWS  COMM:IDLE  TIME:16:11.59

```

CELL Menu
Figure 17

```

CDWS
SYNC WARM CDWS_LOT_TYPE RCV_TRAY DBURR_LOT SHIP_TRAY SHUTDOWN EXIT
|||||
Ctrl Msg Transition Order Element Lot Type
Name Nr # - Keyword # - Keyword & Plan Id & Qty
-----
CDWS 1 1 WARM SHUTDOWN
    1 1 READY
-----
HWS 0 0
    0 0
-----
IWS 0 0
    0 0
-----
MHS 0 0
    0 0
-----
TWS 0 0
    0 0
-----
VWS 0 0
    0 0
-----
CYCLE:          22  SCRN:SUMMARY  SYS:CDWS  COMM:IDLE  TIME:16:37.42

```

CDWS Menu
Figure 18

CDWS
SYNC WARM CDWS_LOT_TYPE RCV_TRAY DBURR_LOT SHIP_TRAY SHUTDOWN EXIT

```
|||||
Ctrl Msg Transition Order Element Lot Type
Name Nr # - Keyword # - Keyword & Plan Id & Qty
CDWS 1 1 WARM_SHUTDOWN
      1 1 SHUTDOWN
-----
HWS 0 0
     0 0
-----
IWS 0 0
     0 0
-----
MHS 0 0
     0 0
-----
TWS 0 0
     0 0
-----
VWS 0 0
     0 0
-----
CYCLE:      14  SCRN:SUMMARY  SYS:CDWS  COMM:IDLE  TIME:16:56.27
```

CDWS Menu
Figure 19

EXIT
YES NO

```
|||||
```

EXIT Menu
Figure 20

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