INTEGRATED INFORMATION SUPPORT SYSTEM (IISS)
Volume VIII - User Interface Subsystem
Part 10 - Graph Support System Unit Test Plan

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**Integrated Information Support System**

**Vol VIII - User Interface Support Subsystem**

**Part 10 - Graph Support System Unit Test Plan**

**Abstract:**

This unit test plan establishes the methodology and procedures used to test the Graph Support System computer program.

**Block 11:**

**Integrated Information Support System**

**Vol VIII - User Interface Support Subsystem**

**Part 10 - Graph Support System Unit Test Plan**

**Distribution/Availability of Abstract:** Unclassified/Unlimited

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**Name of Responsible Individual:** David L. Judson

**Telephone No. (Include Area Code):** (513) 255-7371

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FOREWORD

This technical report covers work performed under Air Force Contract F33600-87-C-0464, DAPro Project. This contract is sponsored by the Manufacturing Technology Directorate, Air Force Systems Command, Wright-Patterson Air Force Base, Ohio. It was administered under the technical direction of Mr. Bruce A. Rasmussen, Branch Chief, Integration Technology Division, Manufacturing Technology Directorate, through Mr. David L. Judson, Project Manager. The Prime Contractor was Integration Technology Services, Software Programs Division, of the Control Data Corporation, Dayton, Ohio, under the direction of Mr. W. A. Osborne. The DAPro Project Manager for Control Data Corporation was Mr. Jimmy P. Maxwell.

The DAPro project was created to continue the development, test, and demonstration of the Integrated Information Support System (IISS). The IISS technology work comprises enhancements to IISS software and the establishment and operation of IISS test bed hardware and communications for developers and users.

The following list names the Control Data Corporation subcontractors and their contributing activities:

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<th>SUBCONTRACTOR</th>
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<td>Control Data Corporation</td>
<td>Responsible for the overall Common Data Model design development and implementation, IISS integration and test, and technology transfer of IISS.</td>
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<tr>
<td>D. Appleton Company</td>
<td>Responsible for providing software information services for the Common Data Model and IDEFIX integration methodology.</td>
</tr>
<tr>
<td>ONTEK</td>
<td>Responsible for defining and testing a representative integrated system base in Artificial Intelligence techniques to establish fitness for use.</td>
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<tr>
<td>Simpact Corporation</td>
<td>Responsible for Communication development.</td>
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<tr>
<td>Structural Dynamics Research Corporation</td>
<td>Responsible for User Interfaces, Virtual Terminal Interface, and Network Transaction Manager design, development, implementation, and support.</td>
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<tr>
<td>Arizona State University</td>
<td>Responsible for test bed operations and support.</td>
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normalized projection coordinates (NPC): the hypothetical cartesian coordinate system defined within the unit cube (X, Y, and Z coordinates lie between or equal to zero and one). This allows a device independent method for defining a view area.

Page: instance of forms in windows that are created whenever a form is added to a window.

Programmer's Hierarchical Interactive Graphics System (PHIGS): A 2 and 3-dimensional graphics draft standard which is defined independently of any programming language or system.

polyline: a graphics primitive consisting of one or more sequential line segments.

polymarker: a graphics primitive consisting of one or more markers, all of which use the same marker type.

post: to identify a PHIGS structure for display on an open workstation (to display the structure).

redraw all structures: to clear the display surface and then redisplay all previously shown graphics.

structure: a series of elements, transformation definitions, and/or aspects of primitives which define an output image when traversed in a forward direction.

structure network: a set of one or more related structures which combine to form an output display image. Posting of the root structure will display the entire image. The individual structures can not be related in a recursive manor.

transformation: a mathematical conversion which controls the position and orientation of points in space.

text: a geometric primitive consisting of one or more characters. This primitive has the aspects of character height and character color index.

unpost: To remove a structure network from a particular workstation, thereby removing the image from the specified display surface.

update workstation: to display all graphical information which is awaiting display on the display surface of a given workstation.

Window: dynamic area of a terminal screen on which predefined forms may be placed at run time.

workstation: an abstract graphical workstation which provides the logical interface to the applications program. It is analogous to a form in a window.

workstation window: The region in normalized projection coordinates for which graphical output is allowed.
workstation viewport: the true region on the display surface to which the normalized projection coordinates are mapped. The units used for this definition are device specific.
SECTION 2
DEVELOPMENT ACTIVITY

2.1 Statement of Pretest Activity

During system development, the computer programs were tested progressively. Functionality was incrementally tested to verify correct operation of the code. Any bugs which were discovered during this process were corrected as found.

Each form used in the UTP for the Graphics Support System was tested individually. This was conducted by the developer in a manual mode, entering data and then observing the results.

2.2 Pretest Activity Results

Each Graphics Support System callable routine was tested individually. The test program ARTEST was modified to accommodate the calling of the PHIGS C binding routines. This test program allowed the developer to type in the commands and then to immediately observe the results for verification. With this test, all Form Processor calls may be executed. ARTEST is the major testing tool for the Unit Test Plan of the Graphics Support System.
SECTION 3
SYSTEM DESCRIPTION

3.1 System Description

The Graphics Support System is a direct application program interface which allows the generation and manipulation of 3-dimensional graphics information. The system follows the PHIGS standard as closely as possible.

3.2 Testing Schedule

The execution of the Graphic Support System (GSS) is dependent upon the Form Processor, which is in turn dependent upon the NTM subsystem of IISS when it is not configured stand-alone. Testing of the Graphics Support System must be done only after the NTM and Form Processor have been successfully tested. In this unit test plan, the Graphic Support System is dependent upon (and an integral part of) the Form Processor (FP), which is dependent on the Application Interface (AI) and the Virtual Terminal (VT).

3.3 First Location Testing

The tests of the Graphics Support System require the following:

   Equipment: Air Force Testbed, Tektronix 4100 series computer terminal.


   Personnel: One integrator familiar with the IISS.

   Training: The FP User Manual has been previously provided with the current release.

   Deliverables: Current release of the User Interface System

   Test Materials: This test may be run interactively by input of the appropriate data and observing the output as outlined in this test plan. A script file has been created to run this unit test plan and save the resulting output.

   Security Considerations: None.

3.4 Subsequent Location Testing

The requirements as listed above need to be met; however, in subsequent testing it is advantageous to create a script file of the outlined tests and run this, saving the output of the test for future comparisons.
SECTION 4

TEST SPECIFICATIONS AND EVALUATIONS

4.1 Test Specifications

The Unit Test Plan is designed to cover specific functionality of the Graphic Support system, as outlined in the Form Processor development specification. The divisions of the functional requirements test follow, each of which contains the list of steps during the test (described in Section 5) in which each is used.

A. Controlling the Graphic Support System

1. open PHIGS
2. close PHIGS
3. open workstation
4. close workstation
5. set workstation window 2-D
6. set workstation window 3-D
7. set workstation viewport 2-D
8. set workstation viewport 3-D

B. Transformation Utilities

9. scale 2-D
10. scale 3-D
11. translate 2-D
12. translate 3-D
13. rotate about X axis
14. rotate about Y axis
15. rotate about Z axis
16. rotate 2-D
17. compose matrix 2-D
18. compose matrix 3-D
19. transform point 2-D
20. transform point 3-D
21. build transformation matrix 2-D
22. build transformation matrix 3-D
23. compose transformation matrix 2-D
24. compose transformation matrix 3-D

C. Displaying Messages

25. message
26. error handler
27. error log

D. Controlling Graphic Display

28. redraw all structures
29. update workstation
30. post structure
31. unpost structure
32. unpost all structures
E. Adding or Removing PHIGS Structures

33. open structure  ( 6, 14, 21, 29, 33, 41, 55, 61, 87, 93, 97 )
34. close structure ( 13, 20, 28, 32, 40, 46, 58, 64, 90, 95, 99 )
35. delete structures ( 49 )
36. delete structure network ( 104 )
37. delete all structures ( 105 )

F. Adding Data to PHIGS Structure

38. polyline 2-D  ( 10, 27 )
39. polyline 3-D  ( 11 )
40. polymarker 2-D ( 36 )
41. polymarker 3-D ( 39 )
42. text 2-D   ( 17, 18 )
43. text 3-D   ( 19 )
44. fill area 2-D  ( 31 )
45. fill area 3-D  ( 24 )
46. set local transform 2-D  ( 88 )
47. set local transform 3-D  ( 56, 62 )
48. set global transform 2-D  ( 94 )
49. set global transform 3-D  ( 98 )
50. execute structure  ( 12, 42, 43, 44, 45, 57, 63, 89 )

G. Changing Characteristics of Graphic Primitives

51. set line type ( 9, 26 )
52. set line color index ( 8, 25 )
53. set marker type ( 35, 38 )
54. set marker color index ( 34, 37 )
55. set character height ( 16 )
56. set text color index ( 15 )
57. set interior style ( 23 )
58. set interior color index ( 22, 30 )

H. Transferring Data Between GSS and Applications

59. inquire list of available workstation ( 106 )
60. inquire workstation connection and type ( 107 )
61 inquire display space size 2-D  ( 109 )
62. inquire display space size 3-D  ( 108 )

4.2 Test Methods and constraints

The tests as outlined in section 5 must be followed. The required input is stated for each test. This test procedure uses the normal operation of the functions, and does not exercise all the possible error combinations.

4.3 Test Progression

The progression of testing is fully outlined in section 5 of this unit test plan. These steps should be followed exactly to insure successful testing of the IISS configuration item.
4.4 **Test Evaluation**

The test results are evaluated by comparing the information returned on the various output screens to that specified as successful for the given test. As outlined in section 5, each test of the Graphic Support System functionality will provide an input screen with the required data entry specified and the resulting output for a successful test.
SECTION 5
TEST PROCEDURES

5.1 Test Description

A general description of this test was supplied in Section 3 of this manual.

5.2 Test Control

As outlined, this unit test may be done manually or run automatically using a supplied script file. To manually perform this unit test would require the tester to be logged into the IISS system and enter SDARTESTZZ on the IISS function screen.

5.3 Test Procedures

This unit test uses the ARTEST program and its associated forms. The specific forms (before and after each test step) are supplied after the listing of test steps (pages 5-6 through 5-233). They allow one to fully interrogate the 2 and 3-dimensional graphics abilities of the system.

The commands which have been made available are those routines which are described in the Form Processor Development Specification (ref. [3]). A complete description of these commands is supplied in Appendix A.

The test steps will proceed as follows:

1) set up graphics screens: graphics
2) Open PHIGS: popph
3) Open workstation: popwk 1 .screen.gfl.wl
4) set workstation window: pswkw 1 0 1 0 .50908675
5) set workstation viewport: pswkv 1 0 65535 0 33363
6) open workstation 2: popwk 2 w2
   -- make structure #1 with X-Y-Z space triad
7) open structure: popst 1
8) make lines RED: psslci RED
9) make solid lines: psln SOLID
10) add X->O->Y polyline: ppl 3 .8 .2 .2 .2 .2 .8
11) add O->Z polyline: ppl3 2 .2 .2 0 .2 .2 .8
12) display labels: pexst 2
13) close the structure: pclst
   -- make structure #2 with labels for triad
14) open structure: popst 2
15) make characters blue: pstxci BLUE
16) set height=small: pschh .1
17) add X text: ptx .8 .2 X
18) add Y label: ptx .2 .8 Y
19) add Z label: ptx3 .2 .2 .8 0 0 1 0 0 1 Z
20) close structure: pclst

-- place a green triangle fill offset by Z=1.

21) open structure: popst 3
22) fill color green: psici GREEN
23) set interior style: psis SOLID
24) fill area: pfa3 3 0 0 1 1 0 1 0 1 1

-- make structure #3 as 2-D wire frame square box

25) make white lines: psplci WHITE
26) make lines dashed: psln DASH
27) make box: ppl 5 0 0 1 0 1 1 0 1 0 0
28) close structure: pclst

-- make structure #4 as yellow filled diamond inside #3

29) open structure: popst 4
30) fill color yellow: psici YELLOW
31) add region: pfa 4 .5 0 1 .5 .5 1 0 .5
32) close structure: pclst

-- make structure #5 as red stars at vertices of #4

33) open: popst 5
34) marker color red: pспорц RED
35) marker type to star: psmk STAR
36) position: ppm 4 .5 0 1 .5 .5 1 0 .5

-- place MAGENTA circles at vertices of fill in #3

37) marker color magenta: pспорц MAGENTA
38) marker type=circle: psmk CIRCLE
39) 3-D positions: pperm3 3 0 0 1 1 0 1 0 1 1
40) close structure: pclst

-- make structure displaying above definitions

41) open: popst 6
42) yellow fill in box: pексст 4
43) box w/ fill area: pексст 3
44) markers in structures: pексст 5
45) display triad: pексст 1
46) close structure: pclst

47) display from 2-D view: ppost 1 6 1
48) post in smaller window: ppost 2 6 1

49) delete labels from triad: pdst 2
50) update display in #1: puwk 1 PERFORM
51) update display on #2: puwk 2 PERFORM
52) remove graphic display: pupost 1 6
53) update empty workstation: puwk 1 PERFORM

-- rotate picture 45 degrees about X axis

54) make rotation matrix: prox 45 A3
55) open new structure: popst 7
56) add local matrix: pslmt3 A3 POST
57) bring in displays: pexst 6
58) close pclst
59) display rotated figure: ppost 1 7 1

-- overlay this with rotate 45 degrees about Y axis

60) make rotation matrix: proy 45 B3
61) open new structure: popst 8
62) add local matrix: pslmt3 B3 POST
63) bring in displays: pexst 7
64) close pclst
65) display rotated figure: ppost 1 8 1

-- test 2 dimensional transformation utilities

66) translate 2-D: ptr 10 10 C2
67) rotate in 2-D: pro 180 B2
68) compose 2-D: pcom C2 B2 A2
69) scale 2-D: psc 10 100 B2
70) add to matrix: pcom A2 B2 C2
71) transform point 2D: ptp 1 0 C2
72) transform point 2D: ptp 0 1 C2

73) trans. matrix 2D: pbltm 10 20 -10 -20 2 4 180 A2
74) mult w/ previous: pcotm A2 -10 -20 10 20 .5 .25 180 B2
75) verify back to identity: ptp 1 1 B2

-- test 3-D transformation utilities

76) translate: ptr3 10 10 10 C3
77) rotate about Z: proz 45 B3
78) compose 3D: pcom3 C3 B3 A3
79) scale 3-D: psc3 10 100 1000 B3
80) add to matrix: pcom3 A3 B3 C3
81) transform point: ptp3 1 1 1 C3

82) make transf. matrix: pbltm3 10 20 30 1 2 3 2 4 8 180 0 0 A3
83) compose transform: pcotm3 A3 -10 -20 -30 -1 -2 -3 -180 0 0 .5 .25 .125 B3
84) verify identity: ptp3 1 1 1 B3

-- check misc. items

85) set workstation window: pswkw3 1 0 1 0 .69999237 0 1
86) set workstation viewport: pswkv3 1 0 65535 0 33363 0 65535

-- check usage of 2-D local/global matrices

87) open new structure #9: popst 9
88) set local 2D transform: pslmt A2 POST
89) reference other: pexst 8
90) close structure: pclst
91) display w/ transform: ppost 1 9 1
92) unpost all structures: pupast 1 9

93) append global transform: popst 9
94) set global 3-D matrix: psgmt B2
95) close structure: pclst
96) display (no change): ppost 1 9 1

97) append global transform: popst 9
98) identity 3-D: psgmt3 B3
99) close structure: pclst
100) display (same display): ppost 1 9 1

101) redraw structures: prst 1 ALWAYS
102) update workstation: puwk 1 PERFORM
103) send message: pmsg "GSS UTP output is completed"
104) delete structure network: pdsn 6 DELETE
105) delete all structures: pdas
106) inquire available workstations: pqewk
107) inquire workstation conn. and type: pqwkc 1
108) inquire display space size 3-D: pqdsp3 w1
109) inquire display space size 2-D: pqdsp w1
110) error handler: perhnd 0 0
110a) examine message queue results
111) error log: perlog 0 0
111a) examine message queue results
112) close workstation 1: pclwk 1
113) close workstation 2: pclwk 2
111) close PHIGS: pclph

5-4
Figure 5-1a (BEFORE)
Figure 5-1b (AFTER)
Figure 5-2a (BEFORE)
Figure 5-2b  (AFTER)
Command Line: `laptop l_screen, gfl.wl` form gfl

Figure 5-3a (BEFORE)
Figure 5-3b  (AFTER)
Figure 5-4a (BEFORE)
Figure 5-4b  (AFTER)
Figure 5-5a (BEFORE)
MSG: Workstation 1, 2-D viewport set

Figure 5-5b (AFTER)
Figure 5-6a  (BEFORE)
Figure 5-6b (AFTER)
Figure 5-7a  (BEFORE)
Figure 5-7b  (AFTER)
Figure 5-8a (BEFORE)
Figure 5-8b (AFTER)
Figure 5-9a (BEFORE)
Command Line: polysolid

Figure 5-9b (AFTER)
Figure 5-10a  (BEFORE)
Figure 5-10b  (AFTER)
Figure 5-11a (BEFORE)
Figure 5-11b (AFTER)
Figure 5-12a  (BEFORE)
Figure 5-12b  (AFTER)

MSG: 1 execute structure 2 element inserted

Application
Figure 5-13a (BEFORE)
Figure 5-13b (AFTER)
Figure 5-14a (BEFORE)
Figure 5-14b  (AFTER)
Figure 5-15a (BEFORE)
Command Line: `psstxci blue`

Figure 5-15b  (AFTER)
Figure 5-16a  (BEFORE)
Step 415
Output:

MSG: 1 character height set to 0.1 of nominal

Figure 5-16b (AFTER)
Figure 5-17a (BEFORE)
Command Line  "ptx_18-2X: application"

Step 416:

MSG: 12-D text string added to structure

Figure 5-17b (AFTER)
Figure 5-18a (BEFORE)
Figure 5-18b  (AFTER)
Figure 5-19a (BEFORE)
Figure 5-19b  (AFTER)
Figure 5-20a (BEFORE)
Figure 5-20b  (AFTER)
Figure 5-21a  (BEFORE)
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Figure 5-24a (BEFORE)
Figure 5-24b  (AFTER)
Figure 5-25a (BEFORE)
Figure 5-25b  (AFTER)
Figure 5-26a (BEFORE)
Figure 5-26b (AFTER)
Figure 5-27a  (BEFORE)
Figure 5-27b (AFTER)
| Command Line | polyline inserted | form gfl |

Figure 5-28a (BEFORE)

MSG: 2-D polyline element inserted

application
Figure 5-28b (AFTER)
Figure 5-29a  (BEFORE)
Figure 5-29b (AFTER)
Figure 5-30a (BEFORE)
Figure 5-30b  (AFTER)
Figure 5-31a (BEFORE)

MSG: interior color set to YELLOW
Figure 5-31b (AFTER)

MSG: 2-D fill area element inserted
Figure 5-32a (BEFORE)
Figure 5-32b (AFTER)
Figure 5-33a (BEFORE)
Figure 5-33b (AFTER)
Figure 5-34a  (BEFORE)
Figure 5-34b  (AFTER)
Figure 5-35a (BEFORE)

MSG: Marker color set to RED
Figure 5-35b (AFTER)
Figure 5-36a (BEFORE)
Figure 5-36b (AFTER)
Figure 5-37a (BEFORE)
Figure 5-37b  (AFTER)
Figure 5-38a (BEFORE)

MSS: marker color set to MAGENTA
Command Line: usmk circle

MSG: marker type set to CIRCLE

Figure 5-38b (AFTER)
Figure 5-39a (BEFORE)
Figure 5-39b (AFTER)
Figure 5-40a (BEFORE)
Figure 5-40b  (AFTER)
Figure 5-41a  (BEFORE)
Figure 5-41b (AFTER)
MSG: structure 6 opened

Figure 5-42a (BEFORE)
Figure 5-42b (AFTER)

MSG: execute structure 4 element inserted
Figure 5-43a (BEFORE)
Command Line: `gfl`

MSG: 1 execute structure 3 element inserted

Figure 5-43b (AFTER)
Figure 5-44a (BEFORE)
Figure 5-44b (AFTER)
Command Line: `execute structure 5 element inserted` form gfl

Figure 5-45a (BEFORE)
Figure 5-45b  (AFTER)
Figure 5-46a  (BEFORE)
Figure 5-46b  (AFTER)
Figure 5-47a (BEFORE)
Figure 5-47b (AFTER)
Figure 5-48a (BEFORE)
Figure 5-48b (AFTER)
Figure 5-49a (BEFORE)
command line

output:

MSG: structure 2 deleted from CSS

Figure 5-49b (AFTER)
MSG: 1 structure 2 deleted from CSS

Figure 5-50a  (BEFORE)
Figure 5-50b  (AFTER)
Figure 5-51a  (BEFORE)
Figure 5-51b  (AFTER)
Figure 5-52a (BEFORE)
Figure 5-52b (AFTER)
Figure 5-53a (BEFORE)
Step #52
Output:

MSG: workstation 1 updated

Figure 5-53b (AFTER)
Figure 5-54a (BEFORE)
Command Line: `rox 45 a3`

Figure 5-54b (AFTER)
Step 153
Output:

MSG: 3-D rotation matrix created

Figure 5-55a (BEFORE)
Figure 5-55b  (AFTER)
Figure 5-56a  (BEFORE)
Figure 5-56b  (AFTER)
Figure 5-57a (BEFORE)
MSG: execute structure 6 element inserted  

Figure 5-57b (AFTER)
Figure 5-58a (BEFORE)
Figure 5-58b  (AFTER)
Figure 5-59a (BEFORE)
Command Line: post 1 7 1

Step #58
Output:

MSG: 1 structure 7 posted on workstation 1 at priority 1

Figure 5-59b (AFTER)
Figure 5-60a (BEFORE)
Figure 5-60b (AFTER)
Step #59
Output:

MSG: 3-D rotation matrix created

Figure 5-61a (BEFORE)
Figure 5-61b  (AFTER)
Figure 5-62a (BEFORE)
Figure 5-62b (AFTER)
Figure 5-63a (BEFORE)
Step 162
Output:
MSG: execute structure 7 element inserted

Figure 5-63b (AFTER)
Command Line: clst

 MSG: execute structure 7 element inserted

Step 162
Output:

Figure 5-64a (BEFORE)
Figure 5-64b  (AFTER)
Figure 5-65a  (BEFORE)
Step #64
Output:

MSG: 1 structure 8 posted on workstation 1 at priority 1

Figure 5-65b  (AFTER)
MSG: [structure 8 posted on workstation 1 at priority 1]

Figure 5-66a  (BEFORE)
Figure 5-66b (AFTER)
Command Line: `str 10 10 c2`

Figure 5-67a (BEFORE)

MSG: 2-D transition matrix created
Figure 5-67b  (AFTER)
Step #66
Output:

MSG: 2-D rotation matrix created

Figure 5-68a  (BEFORE)
Figure 5-68b  (AFTER)
Figure 5-69a (BEFORE)
Figure 5-69b  (AFTER)
Figure 5-70a (BEFORE)
Command Line
\texttt{acom \textbf{a2 b2 c2}}

\texttt{form gfl}

\texttt{MSG: 2-D matrix multiply complete application}

Figure 5-70b (AFTER)
Command Line: `step 1 0 cz`

Output:

MSG: 2-D matrix multiply complete

Figure 5-71a (BEFORE)
Command Line: `otp l 0 c2`

MSG: 2-D transform point complete

Step 170
Output transformed coordinates = 110, 1000

Figure 5-71b (AFTER)
Step #70
Output: Transformed coordinates = -110, -1000

MSG: 2-D transform point complete

Figure 5-72a (BEFORE)
Command Line: `utp 0.1 c2`

Step 471
Output: Transformed coordinates: -100, -1100

MSG: 2-D transform point complete

Figure 5-72b (AFTER)
Figure 5-73a (BEFORE)
Command Line: `bitm 10 20 -10 -20 2 4 180 a2` form gfl

**Figure 5-73b (AFTER)**
Figure 5-74a  (BEFORE)
Command Line: `cotm a2 -10 -20 10 20 .5 .25 180 b2` form gfl

Figure 5-74b (AFTER)

**MSG:** 2-D compose transformation matrix complete

**Step 173**
Output: Transformed coordinates = 1100, 1100
Step #73
Output transformed coordinates = -100, -1100

MSG: 1 2-D compose transformation matrix complete

Figure 5-/75a (BEFORE)
Step #74
Output: transformed coordinates = 231466, 104323

MSG: 1 2-D transform point complete

Figure 5-75b (AFTER)
Figure 5-76a (BEFORE)
Command Line: `tr3 10 10 10 c3`  

**Step 175**  
Output: **transformed coordinates** = [-2.31466, 04323]  

**MSG:** 3-D transition matrix created

Figure 5-76b (AFTER)
Step 175
Output: Transformed coordinates = \( 231466, 204323 \)

MSG: 3-D transition matrix created

Figure 5-77a (BEFORE)
Step 476
Output: Transformed coordinates = 231466, 104323

MSG: 3-D rotation matrix created

Figure 5-77b (AFTER)
MSG: 3-D rotation matrix created

Figure 5-78a (BEFORE)
MSG: 3-D matrix multiply complete

Figure 5-78b (AFTER)
Command Line: `sc3 10 100 1000 b3` form gif

Figure 5.79a (BEFORE)

MSG: 3-D matrix multiply complete
Step 178
Output: Transformed coordinates = 231466, 104323

MSG: 3-D scale matrix created

Figure 5-79b (AFTEF)
MSG: 3-D scale matrix created application

Figure 5-80a (BEFORE)
Step 179
Output: transformed coordinates = 231466, 204323

MSG: 3-D matrix multiply complete

Figure 5-80b (AFTER)
Figure 5-81a (BEFORE)
Figure 5-81b  (AFTER)
Command Line: btm 10 20 30 1 2 3 2 4 8 180 0 0 a3

Figure 5-82a (BEFORE)
Command Line: `bltm3 10 20 30 1 2 3 2 4 8 180 0 0 a3` form gfl

Step #81
Output: transformed coordinates: 0, 555.64, 1000

MSG: 3-D transformation matrix complete

Figure 5-82b (AFTER)
Figure 5-83a (BEFORE)
Command Line: `scotm3 a3 -10 -20 -30 -1 -2 -3 -180 0 0` for gfl

Step 482
Output: Transformed coordinates = 30, 555, 64, 1000

MSG: 3-D compose transformation matrix complete

Figure 5-83b (AFTER)
Figure 5-84a (BEFORE)
Figure 5-84b (AFTER)
Figure 5-85a (BEFORE)
Figure 5-85b  (AFTER)
Figure 5-86a (BEFORE)
Command Line: `swkv3 1 0 65535 0 33363 0 65535` form gfi

Figure 5-86b (AFTER)
Step #85
Output: transformed coordinates = -810.5, -34.5929, -2
       9.3008

MSG: WorkStation 3-D viewport set

Figure 5-87a (BEFORE)
Figure 5-87b  (AFTER)
Figure 5-88a  (BEFORE)
Step 187
Output: Transformed coordinates = (810.5, 3445929, -29, 3008

MSG: 2-D transformation matrix element inserted

Figure 5-88b (AFTER)
Figure 5-89a (BEFORE)
Figure 5-89b  (AFTER)
Figure 5-90a (BEFORE)
Figure 5-90b (AFTER)
Figure 5-91a (BEFORE)
Command Line  post 1 9 1  form gfl

Step 190
Output: transformed coordinates = -810.5, 34.5929, -2
       -93008

MSG: structure 9 posted on workstation 1 at priority 1

Figure 5-91b  (AFTER)
MSG: Mstructure 9 posted on workstation 1 at priority 1

Figure 5-92a (BEFORE)
Figure 5-92b  (AFTER)
Step 91
Output: Transformed coordinates = -810.5, 34.5929, 9.3008

MSG: All structures unposted from workstation 1

Figure 5-93a  (BEFORE)
Step 192
Output: transformed coordinates = 810.5, -34.5929, -2
      9.3038

MSG: structure 9 opened

Figure 5-93b (AFTER)
Figure 5-94a (BEFORE)

Step #92
Output: Transformed coordinates: -810.5, -34.5929, -2.308

MSG: 1 structure 9 opened
Figure 5-94b (AFTER)
Step 493
Output: Transformed coordinates = -810.5, -34.5929, -2
       0.3008

MSG: 2-D transformation matrix element inserted

Figure 5-95a (BEFORE)
Commanji Line  
c1st  
form gfl

Figure 5-95b  (AFTER)
Figure 5-96a (BEFORE)
Command Line: post 1 9 1

MSG: 1 structure 9 posted on workstation 1 at priority 1

Figure 5-96b (AFTER)
Figure 5-97a (BEFORE)
Figure 5-97b (AFTER)
Figure 5-98a (BEFORE)
Command Line: \texttt{usgml3 b3 form gfl}

Step 497
Output: Transformed coordinates: $-810.5, 34.5929, -2$

MSG: 3-D transformation matrix element inserted

Figure 5-98b (AFTER)
Figure 5-99a (BEFORE)
Figure 5-99b  (AFTER)
<table>
<thead>
<tr>
<th>Command Line</th>
<th>cpost 191</th>
<th>form gfl</th>
</tr>
</thead>
</table>

Step 98
Output: Transformed coordinates: -810.5, 34.5929, -2
-9.3008

MSG: 1 structure closed

Figure 5-100a (BEFORE)
Command Line: `post 1 9 1`

form gfl

MSG: Structure 9 posted on workstation 1 at priority 1

Figure 5-100b (AFTER)
Figure 5-101a  (BEFORE)
Figure 5-101b  (AFTER)
Figure 5-102a  (BEFORE)
Figure 5-102b  (AFTER)
Figure 5-103a (BEFORE)
Figure 5-103b (AFTER)
Step 101
Output: transformed coordinates = -810.5, 84.5929, -2
     9.3008

MSG: GSS UTP output is complete

Figure 5-104a (BEFORE)
Command Line: dsn 6 delete

Figure 5-104b (AFTER)

MSG: structure 6 network deleted
Figure 5-105a (BEFORE)
Command Line: modas form gfl

Step #103
Output: transformed coordinates= -810.5, 34.5929, -2
Message: all structures deleted

Figure 5-105b (AFTER)
Figure 5-106a (BEFORE)
Command Line: form gfl

Step 4104
Output: error find (return code) is 0
      total size required is 120
2 types are in the message queue

MSG: 1 FP WINDOWS

Figure 5-106b  (AFTER)
Step #104
Output: error ind (return code) is 0
Total size required is 120
1 types are in the message queue

MSG: 1 FP WINDOWS

Figure 5-107a (BEFORE)
Figure 5-107b (AFTER)
Command Line: gqsp3 wl

Step 105
Output: workstation is connected to window: screen gfl.wl

MSG: workstation connection listed above

Figure 5-108a (BEFORE)
Figure 5-108b  (AFTER)
Figure 5-109a (BEFORE)
Figure 5-109b  (AFTER)
Figure 5-109c  (Message Queue, AFTER)
Figure 5-110a (BEFORE)
Message Queue

**Msg:** 2 no error
**Msg:** 1 PHIGS error 0000 from routine UNKNOWN is

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Figure 5-110b  (AFTER)
Figure 5-110c  (Message Queue, AFTER)
Figure 5-111a (BEFORE)
Message Queue

Msg: no error
Msg: PHIGS error 0000 from routine UNKNOWN is

Figure 5-111b (AFTER)
Figure 5-112a (BEFORE)
Figure 5-112b (AFTER)
Figure 5-113a (BEFORE)
Figure 5-113b (AFTER)
APPENDIX A

Commands for ARTEST

Commands are of the following form:

\langlecommand\rangle \langlearg1\rangle \langlearg2\rangle \ldots \langleargn\rangle

where the angle brackets are not actually entered.
\langlecommand\rangle refers to the actual procedure call
\langlearg1\rangle refers to argument 1, \langlearg2\rangle to argument 2, etc.
arguments are separated by blank(s), and arguments which
contain blanks are enclosed in double quotes.

To allow communication of transformation data, six
predefined matrices have been supplied. These are referred to
as 'matrix ID' in the calling argument string. It is the user's
responsibility to maintain the data in each. The names of
these are:

2-dimensional: A2, B2, C2
3-dimensional: A3, B3, C3

The results from inquire functions and point transforms
will be shown in the "Display" output region, thus avoiding the
need for extra local variables.

The available commands will be the short form as described
by the PHIGS C language binding. A description of these calls
follows:

1. open PHIGS
  \langlepopph\rangle
2. close PHIGS
  \langlepclph\rangle
3. open workstation
  \langlepopwk\rangle <WS ID number> <path to window>
  \langledevice name\rangle <parent window ID> <page in window>
4. close workstation
  \langlepclwk\rangle <WS ID number>
5. set workstation window 2-D
  \langlepswk\rangle <WS ID number> <min X> <max X> <min Y> <max Y>
6. set workstation window 3-D
  \langlepswk3\rangle <WS ID number> <min X> <max X>
  <min Y> <max Y> <min Z> <max Z>
7. set workstation viewport 2-D
  \langlepskwv\rangle <WS ID number> <min X> <max X> <min Y> <max Y>
8. set workstation viewport 3-D
  \langlepskwv3\rangle <WS ID number> <min X> <max X>
  <min Y> <max Y> <min Z> <max Z>
9. scale 2-D
  \langlepsc\rangle <scale X> <scale Y> <matrix ID>
10. scale 3-D
    \langlepsc3\rangle <scale X> <scale Y> <scale Z> <matrix ID>
11. translate 2-D
<ptr> <delta X> <delta Y> <predefined matrix ID>
12. translate 3-D
<ptr3> <delta X> <delta Y> <delta Z> <matrix ID>
13. rotate about X axis
<prox> <angle (degrees)> <matrix ID>
14. rotate about Y axis
<proy> <angle> <matrix ID>
15. rotate about Z axis
<proz> <angle> <matrix ID>
16. rotate 2-D
<pro> <angle> <matrix ID>
17. compose matrix 2-D
<pcom> <matrix ID 'A'> <matrix ID 'B'> <matrix ID (=AxB)>
18. compose matrix 3-D
<pcom3> <matrix ID 'A'> <matrix ID 'B'> <matrix ID (AxB)>
19. transform point 2-D
<ptp> <input X> <input Y> <matrix ID>
20. transform point 3-D
<ptp3> <input X> <input Y> <input Z> <matrix ID>
21. build transformation matrix 2-D
<pbltm> <ref X> <ref Y> <delta X> <delta Y>
 scale X> <scale Y> <rotate angle> <matrix ID>
22. build transformation matrix 3-D
<pbltm3> <ref X> <ref Y> <ref Z> <delta X> <delta Y>
 <delta Z> <scale X> <scale Y> <scale Z> <rotate X>
 rotate Y> <rotate Z> <result matrix ID>
23. compose transformation matrix 2-D
<pcomt> <matrix ID> <ref X> <ref Y> <delta X> <delta Y>
 scale X> <scale Y> <rotate angle> <resulting matrix ID>
24. compose transformation matrix 3-D
<pcomt3> <matrix ID> <ref X> <ref Y> <ref Z> <delta X>
 <delta Y> <delta Z> <scale X> <scale Y> <scale Z>
 <rotate X> <rotate Y> <rotate Z> <resulting matrix ID>
25. message
<pmsg> <message string>
26. error handler
<perhnd> <error number> <function number>
27. error log
<perlog> <error number> <function number>
28. set error handler mode
<pserhm> <new mode (=ON, OFF)>
29. inquire error handler mode
<pqerhm>
30. redraw all structures
<pqrst> <workstation ID> <control (=CONDITIONALLY, ALWAYS)>
31. update workstation
<pwuk> <workstation ID> <regen flag (=PERFORM, POSTPONE)>
32. post structure
<ppost> <workstation ID> <structure ID> <priority level>
33. unpost structure
<pupost> <workstation ID> <structure ID>
34. unpost all structures
<pupast> <workstation ID>

A-2
35. open structure
   <popst> <structure ID>
36. close structure
   <pclst>
37. delete structure
   <pdst> <structure ID>
38. delete structure network
   <pdsn> <structure ID> <ref flag (=DELETE, KEEP)>
39. delete all structures
   <pdas>
40. polyline 2-D
   <ppl> <num points> <X1> <Y1> <X2> <Y2> ... <Xn> <Yn>
41. polyline 3-D
   <ppl3> <num points> <X1> <Y1> <Z1> <X2> <Y2> <Z2> ...
   ... <Xn> <Yn> <Zn>
42. polymarker 2-D
   <ppm> <num points> <X1> <Y1> <X2> <Y2> ... <Xn> <Yn>
43. polymarker 3-D
   <ppm3> <num points> <X1> <Y1> <Z1> <X2> <Y2> <Z2> ...
   ... <Xn> <Yn> <Zn>
44. text 2-D
   <ptx> <X coord> <Y coord> <text string>
45. text 3-D
   <ptx3> <X> <Y> <Z> <Vec X-x> <Vec X-y> <Vec X-z>
   <Vec Y-x> <Vec Y-y> <Vec Y-z> <text string>
46. fill area 2-D
   <pfa> <num points> <X1> <Y1> <X2> <Y2> ... <Xn> <Yn>
47. fill area 3-D
   <pfa3> <num points> <X1> <Y1> <Z1> <X2> <Y2> <Z2> ...
   ... <Xn> <Yn> <Zn>
48. set local transform 2-D
   <pslmt> <matrix ID> <type (=PRE, POST, REPLACE)>
49. set local transform 3-D
   <pslmt3> <matrix ID> <type (=PRE, POST, REPLACE)>
50. set global transform 2-D
   <psgmt> <matrix ID>
51. set global transform 3-D
   <psgmt3> <matrix ID>
52. execute structure
   <pexst> <structure ID>
53. set polyline type
   <psln> <linetype (SOLID, DASH, DOT, DOTDASH)>
54. set polyline color index
   <psplci> <line color index (RED, WHITE, GREEN, etc.)>
55. set polymarker type
   <psmk> <marker type (POINT, PLUS, STAR, 0, X)>
56. set polymarker color index
   <pspmci> <marker color index (RED, WHITE, GREEN, etc.)>
57. set character height
   <pschh> <character height>
58. set text color index
   <pstmtci> <text color index (RED, WHITE, GREEN, etc.)>
59. set interior style
60. set interior color index
   <psici> <color index (RED, WHITE, GREEN, etc.)>

61. inquire list of available workstation
   <pqewk>

62. inquire workstation connection and type
   <pqwkc> <workstation ID>

63. inquire display space size 2-D
   <pqdsp> <device name> <window ID> <page>

64. inquire display space size 3-D
   <pqdsp3> <device name> <window ID> <page>

65. in addition, the command "GRAPHICS" will be used to
initialize the screen specifically designed for 3-D graphics.
The command "FORM" may be used to return to the initial ARTEST
setup screen.

   <graphics>