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IMAGE: A 3-D GEOMETRY DISPLAY PROGRAM
VOLUME II - USERS MANUAL.

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ABSTRACT

This document describes a computer program that displays three
dimensional geometry on the Adage 340 Graphics System. The
three dimensional geometry is represented by a set of points
in space. These points are the corner points of quadrilateral
elements that approximate the three dimensional surface.
Several interactive program options are available for mani-
pulating the displayed image. Some of the options include
image rotation, translation, zooming on region of interest
and windowing. These options and others are explained in
the report.

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PREFACE

This report was prepared under Contract NAS9-14520, The Development of the Engineering Design Integration (EDIN) System, A Computer Aided Design Development Effort. The contract was funded by the National Aeronautics and Space Administration, Johnson Space Center, Engineering Analysis Division. Mr. Robert W. Abel was the contract monitor.

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IMAGE: A 3-D GEOMETRY DISPLAY PROGRAM

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SUMMARY AND INTRODUCTION

This program is used to display three dimensional geometric
configurations where the configuration may be composed of up
to twenty-five different components.   IMAGE allows the user
to delete, move, rotate and duplicate individual components
of the display and to move, rotate, zoom and window the entire
configuration on display.   Surface point data for the configura-
tion is read from Adage disk.   The user interactively specifies
the data file names and the orientation of the display to the
IMAGE Program.   This is made possible because of the interactive
graphics capabilities of the Adage 340 graphics system.

The intent of this document is to describe to a new user the
method by which this program may be run on the Adage GS340.
Program options and input methods are described.

PROGRAM EXECUTION

The IMAGE Program resides on the EDIN System disk pack A285288
in pack 23 volume 1. The name of the file containing the pro-
gram is A. The program is loaded into the computer by entering:

    RESET("A",2301)

through the alphanumeric keyboard (ANK) of the user station.
The Adage monitor system then loads the IMAGE Program and dis-
plays the program memory map on the display screen. Program
execution is initiated by entering:

    IMAGE

on the ANK. The IMAGE Program then begins to solicit informa-
tion from the user concerning the whereabouts of the geometry
data to be displayed. The first inquiry by the program appears
on the screen as:

    ENTER 1 IF IMP COMPONENT LIST, 0 OTHERWISE...

the user should enter an 1 through the ANK if the names of the
geometry data files to be displayed are contained in a data
file which is compatible with the format required by or generated
by the Interactive Mass Properties (IMP) Program. An 0 is
entered through the ANK if the user is going to enter the
geometry data file names manually.

If the component list option is chosen, i.e., 1 is entered above,
the program then displays:

    ENTER PACK/VOL OF COMPONENT LIST...

to which the user should respond by entering, via the ANK, the
octal pack and volume number of the disk space where the com-
ponent list is located. This number can be either three or
four digits and is of the form ppvv where pp is the octal pack
number and vv is the octal volume number within that pack. The
IMAGE Program then requests:

    ENTER NAME OF FILE CONTAINING COMPONENT LIST...

The alphanumeric name of the file containing the component list
should be entered through the ANK by the user. The file name
may contain any number of characters between one and ten,
inclusive. The IMAGE Program then reads the data from the file
just specified. This data specifies the names of the components
to be displayed and may also specify X,Y and Z displacements for
each component.

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If the component list option was not taken by the user, then
IMAGE solicits information from the user which will define the
number of components and names of components that are to be
displayed. IMAGE first establishes the number of data files
to be read by displaying the injuiry:

HOW MANY FILES OF DATA MUST I READ?...

After the user enters the number of files to be read, the pro-
gram will begin asking for file names by displaying on the
screen:

ENTER NAME OF FILE X...

where X is an integer ranging from one to the number of files
to be read. The user then enters the alphanumeric name of the
data file to be read and the inquiry and response process is
repeated until the number of files specified to the program
have all been named.

The IMAGE Program is now ready to read and process the geometry
data. The names of the data files are known to IMAGE but the
pack/volume numbers are not. The program gets this information
from the user by requesting:

ENTER PACK/VOL FOR name(i)...

where name (i) is the alphanumeric name of the ith component to
be displayed. The user should respond with a three or four
digit octal number of the form ppvv described above. The inquiry
and response process if repeated until all of the data file
locations have been specified. The geometry data is now read,
scaled and converted to a move/draw vector list suitable for
display on the Adage Graphics System. The geometry display will
appear on the screen and the user can modify the display by
means of the function switches, ANK and variable control dials.
Figure 1 depicts the function switch assignments and can be
used as a template for constructing an overlay which will fit
on the face of the function switch box. This overlay will
visually define the individual switch functions and will
facilitate their use. The functions of the individual switches
are briefly described as follows:

SWITCH   FUNCTION

   1   This switch kills the display and returns control
            to the Adage monitor system.

   5   This switch is enabled only if the geometry dis-
            play is on the screen. Its function is to kill
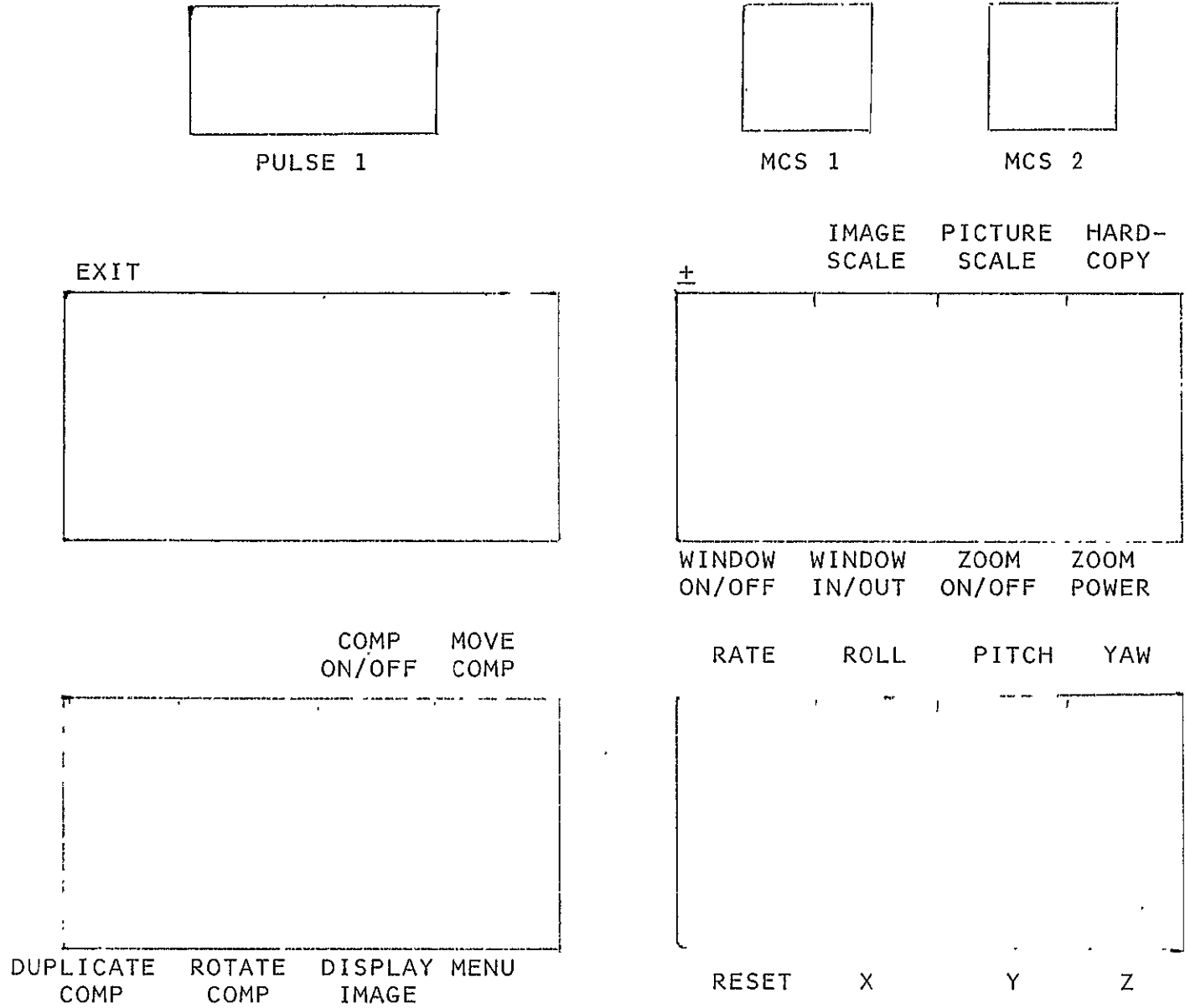   the geometry display and activate the menu display.

PULSE 1

MCS 1   MCS 2

IMAGE   PICTURE   HARD-
SCALE   SCALE   COPY

EXIT

±

WINDOW   WINDOW   ZOOM   ZOOM
ON/OFF   IN/OUT   ON/OFF   POWER

COMP   MOVE
ON/OFF   COMP

RATE   ROLL   PITCH   YAW

DUPLICATE   ROTATE   DISPLAY MENU
COMP   COMP   IMAGE

RESET   X   Y   Z

FIGURE 1   FUNCTION SWITCH ASSIGNMENTS.

The menu display allows the user to delete, move, duplicate and rotate individual components. It also displays the name and number of each component, each components offset position and a display status for each component.

11   This switch is enabled only if the IMAGE menu is being displayed. The function of the switch is to either suppress or activate the display of any one component of the configuration being displayed. Switch activity causes the program to display on the screen:

          ENTER COMP NO,

          to which the user responds with the number of one of the components shown on the menu display. The program then reverses the display status of that component.

12   This switch is enabled only if the IMAGE menu is being displayed. The function performed is to allow the user to move a component from where it is to some other location. Switch activation causes the program to display:

          ENTER COMP NO,

          to which the user replies by typing in the number of the component in the displayed menu list that he wishes to move. The program then displays:

          ENTER DELX

          to which the user responds. The same procedure is followed for DELY and DELZ. The component list displayed will immediately reflect the component moves as soon as the Z component of the move is entered.

13   This switch is enabled only if the IMAGE menu is being displayed. Its function is to allow the user to duplicate the display of a component at some other location in the image space. Switch depression causes the program to display:

          ENTER COMP NO,

to which the user replies by entering the number
of the component to be duplicated from the current
menu list. The program then interrogates the user
concerning the desired location for the duplicated
component by displaying the same:

ENTER DELX

sequence described above. After the position has
been defined, the program seeks a name for the new
component by asking:

WHAT DO YOU WANT TO CALL IT?

The user can assign an alphanumeric name of up to
ten characters to the component. The name and
position of the duplicated component is added to
the component list displayed by the menu as soon
as the data entry is complete.

14   Switch 14 is enabled only if the IMAGE menu is
            being displayed. Its function is to allow the
            user to rotate any component about its midpoint.
            The order of rotation applied to the component
            is roll, pitch and yaw. Activation of the switch
            causes the program to display:

ENTER COMP NO.

The user must enter the number of the component
that he wishes to rotate. The component numbers
are available from the displayed menu list. The
IMAGE Program will solicit the rotation angles by
displaying:

ENTER ROLL ANGLE

on the screen. The user must enter the desired
roll angle in degrees. Similar requests for
entering the pitch and yaw angles are displayed
and user inputs are expected. IMAGE then performs
the component rotation by processing the move/
draw list through a transformation matrix.

15   Switch 15 kills the IMAGE menu and reinstates the
            display of the geometry configuration. All changes
            requested while the menu was active will show up
            on the displayed configuration.

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SWITCH	FUNCTION

17   Switch 17 is active only if the geometry display is active. Its function is to reverse the direction of action invoked by the switches which cause image rotations, translations, etc. If switch 17 is lighted, the direction of action is negative.

18   Switch 18 is active only if the geometry is being displayed. Its function is to vary the Adage image scale. The image scale is increased or decreased depending on the state of switch 17. Under normal conditions, the image scale allows the display on the screen to range in size from ten inches maximum to zero minimum.

19   Switch 19 is enabled only if the geometry display is active. Its function is to vary the Adage picture scale. The picture scale is increased or decreased depending on the state of switch 17. The picture scale varies the display size from a maximum of forty-eight inches to a minimum of zero.

20   Activation of switch 20 causes the IMAGE Program to generate a hardcopy of the screen display. This process takes about thirty seconds and the screen will be blank during the process time. The copy is produced by the Gould printer/plotter device.

21   Switch 21 is enabled only if the geometry display is active. Its function is to turn the hardware windowing function on or off. The windowing function is on when the switch is lighted.

When windowing is active, the variable control dials have the following assignments:

         A&D - Varies the left and right window boundaries (screen X axis).

         B&E - Varies the top and bottom window boundaries (screen Y axis).

         C&F - Varies the boundaries into and out of the display screen (screen Z axis).

22   Switch 22 is enabled only if the geometry display is on and hardware windowing is active. Its function is to alter the inside/outside flag for

SWITCH	FUNCTION

the windowing function. The switch is lighted when blanking is inside the window, not lighted when blanking is outside the window.

23   Switch 23 is enabled only if the geometry display is active. Its function is to turn the zoom function on or off. The switch is lighted when the zoom function is active. When zoom is active, the variable control dials have the following function:

A&D - Varies the X&Y position of the point of zoom.

B&E - Varies the X&Y screen position of the midpoint of a window into which the zoomed image will be projected.

C&F - Varies the horizontal and vertical dimensions of the window into which the zoomed image will be projected.

24   Switch 24 is enabled only if the geometry is on and switch 23 is lighted. Its function is to vary the power of the zoom. Each switch activation increases the magnification power by a factor of two until maximum zoom is reached; the next activation returns the magnification power to one.

25   This switch is enabled only if the geometry display is on. Its function is to modify the rate at which the rotations, translations, etc. occur. Depressing the switch adds a positive delta to the rate of action.

26   Switch 26 is enabled only when the geometry display is on the screen. Its function is to cause the displayed geometry to rotate about is own X axis. The direction of rotation is dependent upon the setting of switch 17.

27   Switch 27 is enabled only when the geometry display is on the screen. Its function is to cause the displayed geometry to rotate about its own Y axis. The direction of rotation is dependent upon the setting of switch 17.

28   Switch 28 is enabled only when the geometry display is on the screen. Its function is to cause the

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displayed geometry to rotate about its own Z axis. The direction of rotation is dependent upon the setting of switch 17.

29   Switch 29 is enabled only if the geometry display is on the screen. Its function is to reset the display to its original state, i.e., no rotations, no translations, etc.

30   Switch 30 is enabled only when the geometry display is active. Its function is to cause the displayed geometry to be moved in a direction along its own X axis. The direction of movement depends upon the setting of switch 17.

31   Switch 31 is enabled only when the geometry display is active. Its function is to cause the displayed geometry to be moved in a direction along its own Y axis. The direction of movement depends upon the setting of switch 17.

32   Switch 32 is enabled only when the geometry display is active. Its function is to cause the displayed geometry to be moved in a direction along its own Z axis. The direction of movement depends upon the setting of switch 17.

GEOMETRY DATA FILE

The first line of a geometry data file must be blank. The
following lines contain two data points each. The data is
arranged as:

    X1,Y1,Z1,STAT1,X2,Y2,Z2,STAT2

on each line. The data format is $2(3F10.X,I1)$. Each status
indicator, STAT1 and STAT2, specify whether its associated
point is the first point in a section, the first point in a
component, the last point on the data file or just an ordinary
point. The order in which the data points should be input and
the values given to the status indicators is described in
Volume I of this report.

EXAMPLES OF OUTPUT

Figures 2 through 11 depict the types of displays that can be
expected from the IMAGE Program. Figure 2 shows a typical
display of a launch/boost vehicle. This is the type of picture
that first appears on the screen after the geometry is read in
and the display list is created. This display can be modified
by means of the function switches as described in the previous
section. Figures 3 through 5 show examples of rotations, zoom-
ing and hardware windowing. The component list, shown in
figure 6, can also be used to modify the display. Notice that
in the list shown in figure 7 a component has been added by
duplicating and moving component number three to form horizontal
stabilizers for the tail. The resulting configuration is shown
in figure 8. Figure 9 shows a configuration in which one of
the components has been rotated. The component, CAN1, was
rotated 15 degrees about the configuration's Z axis. Figures
10 and 11 show the component list and resulting configuration
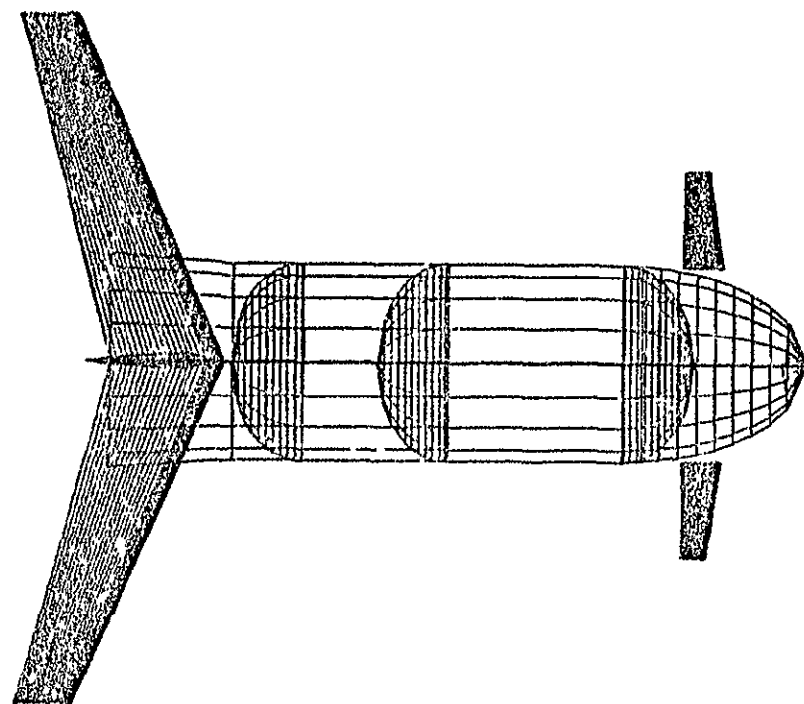displays obtained when the COMP DISPLAY option is used.
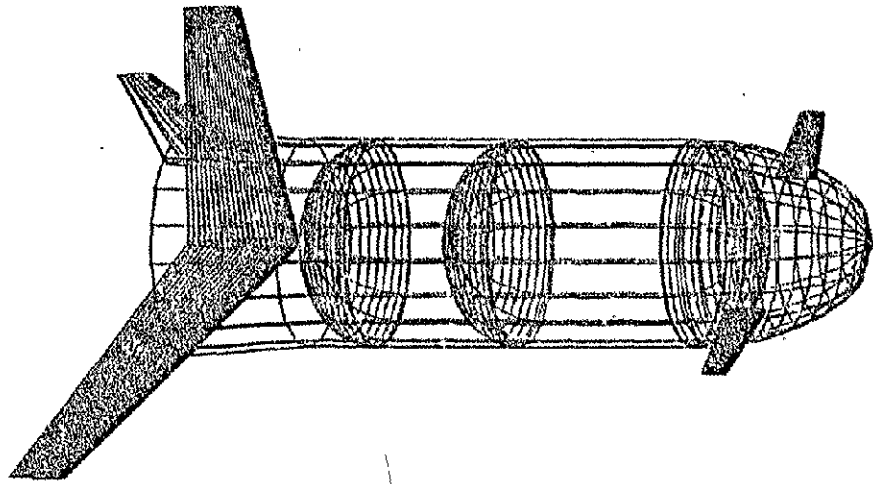
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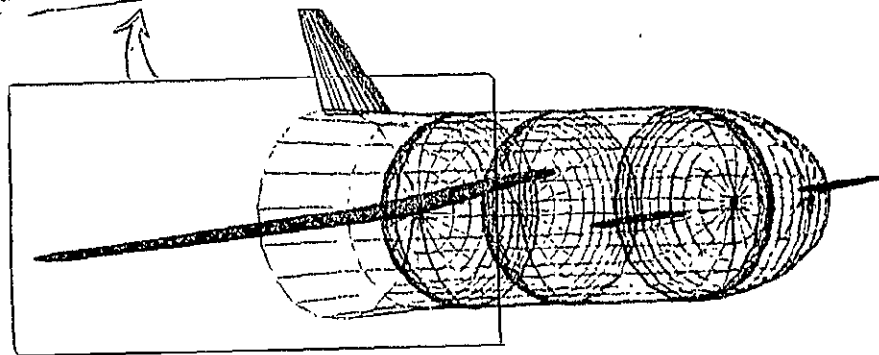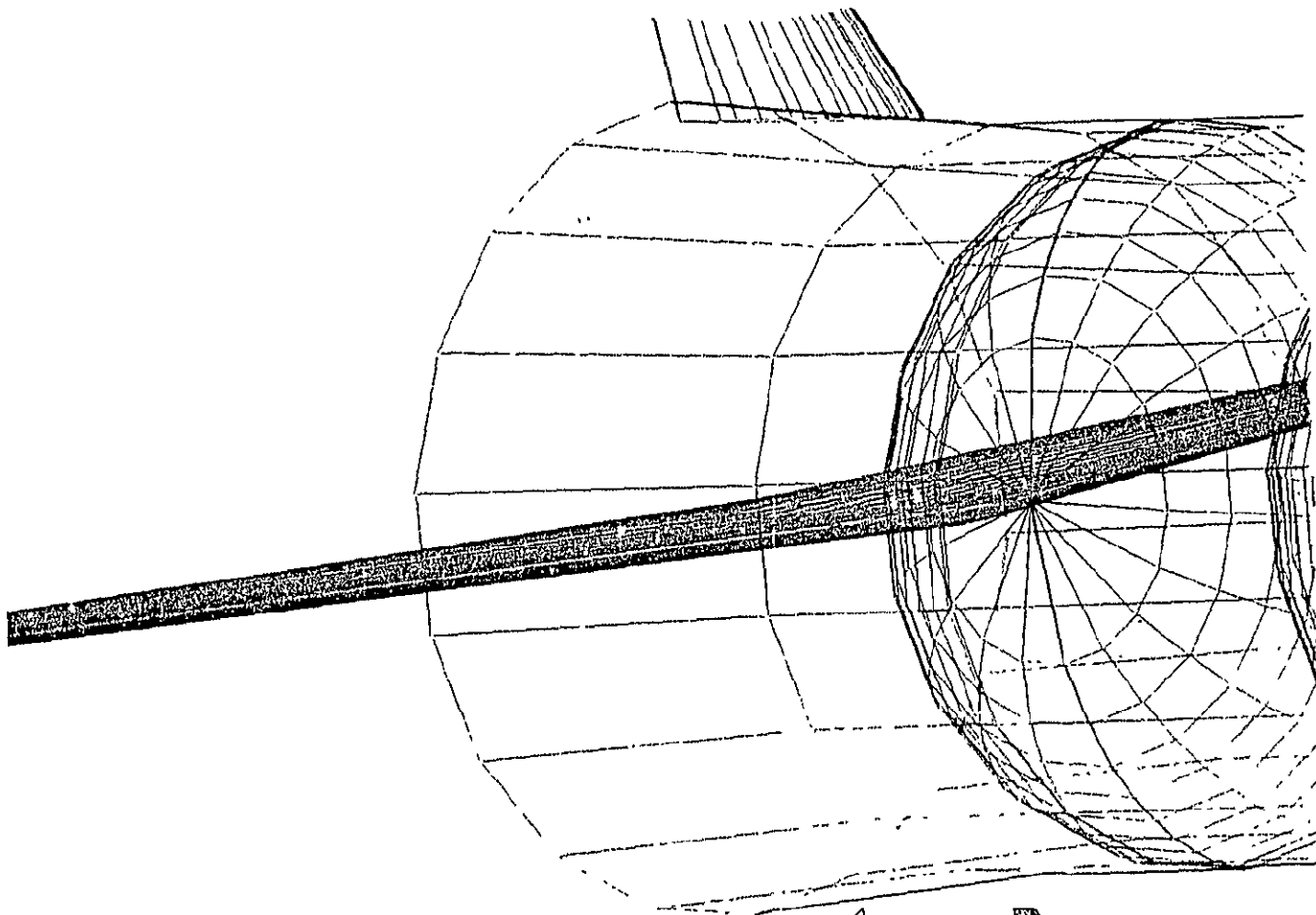FIGURE 2   INITIAL IMAGE DISPLAY.

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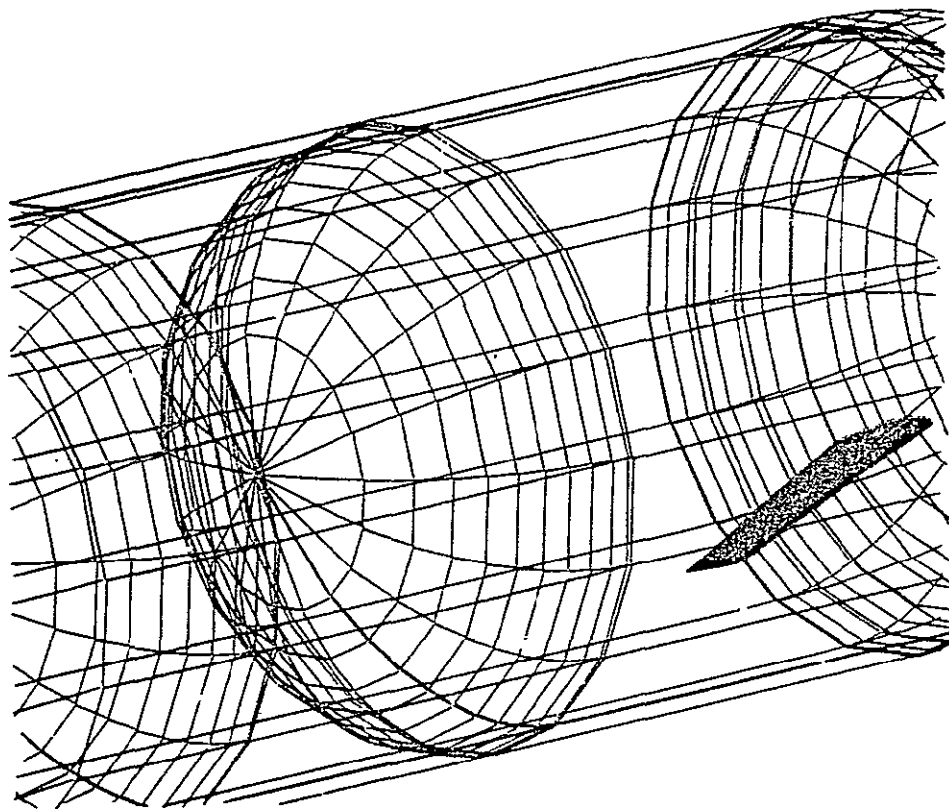FIGURE 3   ROTATED DISPLAY.

FIGURE 4   ZOOMED DISPLAY.
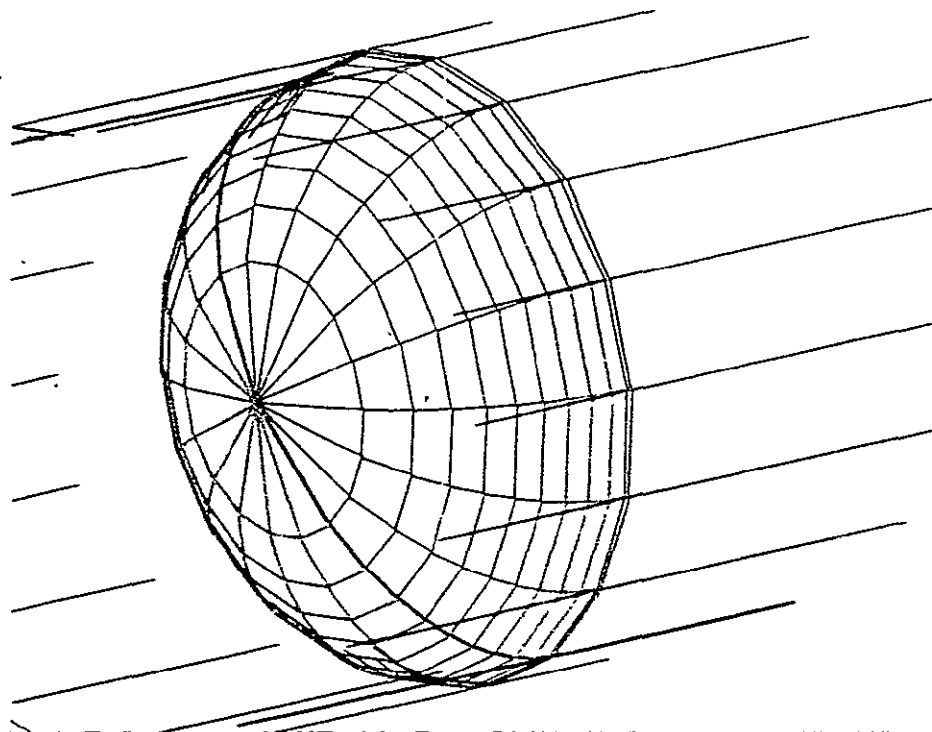
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FIGURE 5-A   ROTATED AND INCREASED SCALING.

FIGURE 5-B   SAME AS 5-A PLUS HARDWARE WINDOWING.

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NO	COMP NAME	DEL X	DEL Y	DEL Z	ON/OFF
1	BOOSTWNG	0.00	0.00	0.00	*
2	VERT1	0.00	0.00	0.00	*
3	CAN1	0.00	0.00	0.00	*
4	LOXT1	0.00	0.00	0.00	*
5	FUELT1	0.00	0.00	0.00	*
6	SKIRT1	0.00	0.00	0.00	*
7	NOSE1	0.00	0.00	0.00	*

OPTIONS

FSW 11 -- COMP DISPLAY
FSW 12 -- MOVE COMP
FSW 13 -- DUPLICATE COMP
FSW 14 -- ROTATE COMP
FSW 15 -- DISPLAY IMAGE

FIGURE 6   COMPONENT LIST FOR VEHICLE SHOWN IN FIGURE 2.

NO	COMP NAME	DEL X	DEL Y	DEL Z	ON/OFF
1	BOOSTWNG	0.00	0.00	0.00	*
2	VERT1	0.00	0.00	0.00	*
3	CAN1	0.00	0.00	0.00	*
4	LOXT1	0.00	0.00	0.00	*
5	FUELT1	0.00	0.00	0.00	*
6	SKIRT1	0.00	0.00	0.00	*
7	NOSE1	0.00	0.00	0.00	*
8	T TAIL	-80.00	-25.60	40.00	*

OPTIONS

FSW 11 -- COMP DISPLAY
FSW 12 -- MOVE COMP
FSW 13 -- DUPLICATE COMP
FSW 14 -- ROTATE COMP
FSW 15 -- DISPLAY IMAGE

FIGURE 7   MODIFIED COMPONENT LIST WITH DUPLICATED AND MOVED COMPONENT.
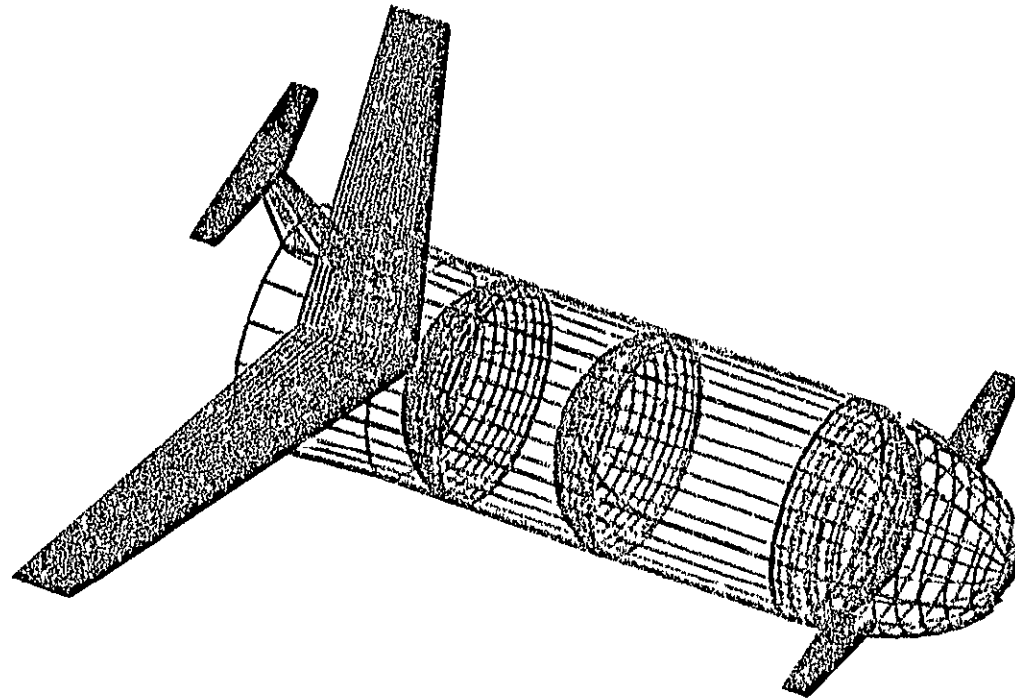
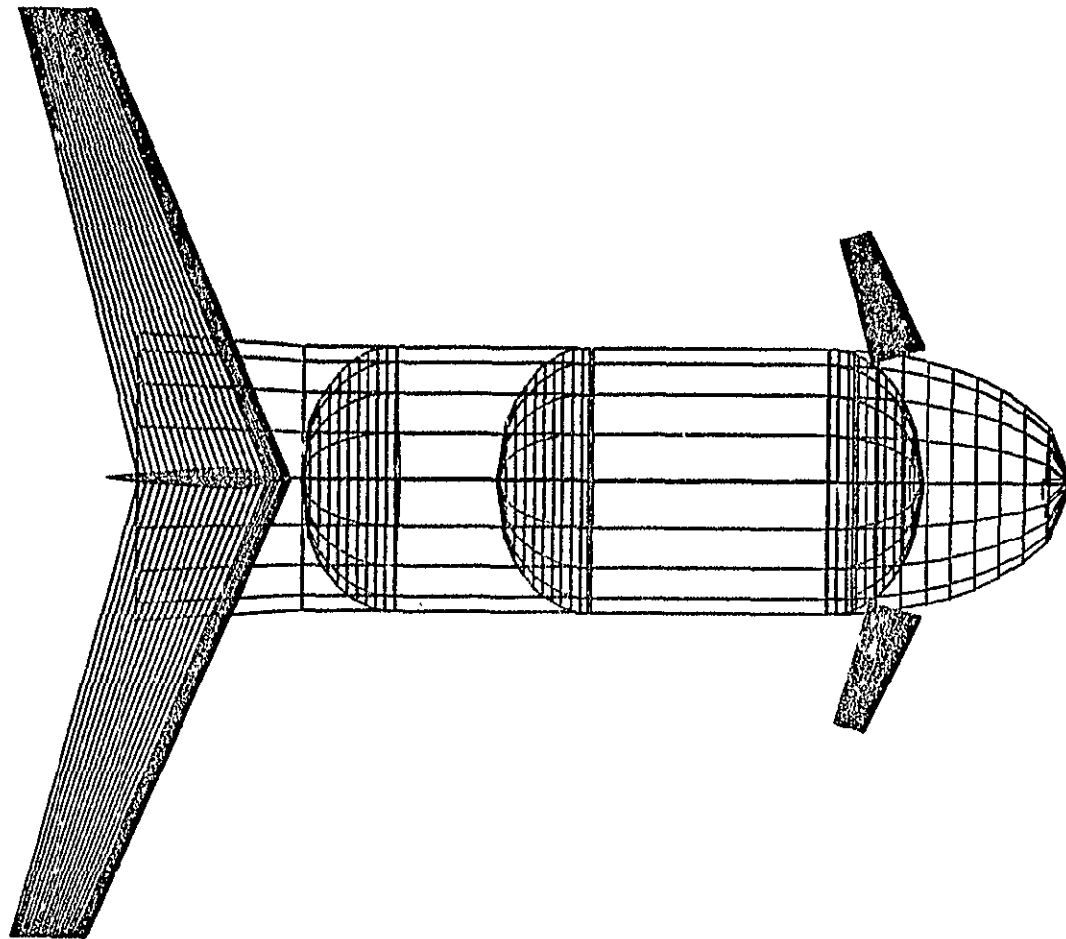FIGURE 8   DISPLAY DESCRIBED BY COMPONENT LIST IN FIGURE 7.

FIGURE 9   CONFIGURATION WITH ROTATED COMPONENT (CANARDS).

NO"	COMP NAME	DEL X	DEL Y	DEL Z	ON/OFF
1	BOOSTWNG	0.00	0.00	0.00	
2	VERT1	0.00	0.00	0 00	*
3	CAN1	0.00	0.00	0.00	*
4	LOXT1	0.00	0.00	0.00	*
5	FUELT1	0.00	0.00	0.00	*
6	SKIRT1	0.00	0.00	0.00	*
7	NOSE1	0 00	0.00	0.00	*

OPTIONS

FSW 11 -- COMP DISPLAY
FSW 12 -- MOVE COMP
FSW 13 -- DUPLICATE COMP
FSW 14 -- ROTATE COMP
FSW 15 -- DISPLAY IMAGE

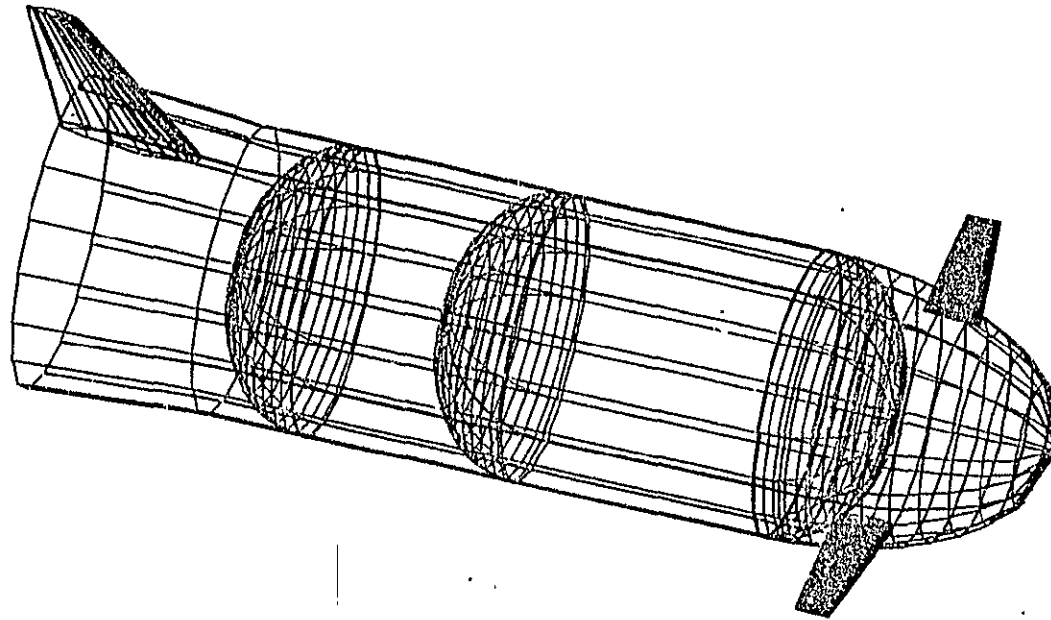FIGURE 10   DISPLAY LIST WITH COMPONENT 1 DISPLAY STATUS TURNED OFF.

FIGURE 11   DISPLAY RESULTING FROM COMPONENT LIST OF FIGURE 10.