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Use of Interactive Graphics To Analyze QUICK-Geometry

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INTRODUCTION

The QUICK-geometry system (ref. 1) is a method for defining configuration shapes in completely analytical form. It was developed for use where the analytical definition of an aircraft geometry is advantageous or necessary for the solution of the flow around it. The QUICK InterActive Graphics Analysis (QUIAGA) program was written to combine interactive computer processing and graphics-terminal display so that QUICK-geometry models can be rapidly checked for errors and analysis can be made to aid in corrections. The program, which was originally written in FORTRAN IV for use with the Control Data computer systems at Langley Research Center (LaRC), is fully described in the original part of this report entitled "Use of Interactive Graphics To Analyze QUICK-Geometry," published as NASA TM-83234 in December 1981. This paper is a supplement which describes the use of the QUIAGA program on the Prime minicomputer system at LaRC with which a higher baud rate speeds up the graphics display.

DESCRIPTION OF USAGE ON PRIME MINICOMPUTER SYSTEM

Requirements and Availability

The Quick InterActive Graphics Analysis (QUIAGA) program and its companion data reader (READAT) have been coded in FORTRAN 77 to run on the Prime minicomputer system and the Tektronix 4014 Computer Display (storage-tube graphics) Terminals at LaRC. The PLOT10 library is used for all graphics. Non-ANSI usages have been generally avoided in order to ease conversion to other systems with similar capabilities. The complete program is available from COSMIC (Computer Software Management and Information Center, 112 Barrow Hall, University of Georgia, Athens, GA 30602) as QUICK Interactive Graphics Analysis Program, LAR-12952. It is essentially equivalent to the version coded in FORTRAN IV for Control Data computers.

Changes in the graphical displays are small, the most notable changes being a different set of symbols for control-point locations and the addition of date and time notations as an aid in hard-copy identification. On the other hand, the Prime system requires a different means of accessing the file containing the QUICK intermediate deck. (See fig. 4 of the original report.) The optional capability to compare with original digitized data requires an additional file containing the cross-section data written in Prime mass storage format by the program READAT. An error file QERROR has been added. The programs are written assuming a 9600-band data link between the terminal and computer.

The command files used on the LaRC Prime minicomputer system to compile, load, and save the programs are shown in figure 1. Note that in addition to the program, the second procedure compiles and loads the subset of QUICK subroutines QKSUBS and CSMSET. This is the same group of subroutines, called SUBQUICK, which is used whenever the QUICK-geometry system is invoked, for example, by the finite-difference flow-field program STEIN (ref. 2). The V-mode PLOT10 graphics library VLBTEK is also loaded. These command files use the Prime utility SEG for segmented programs and save the absolute binaries as #READAT and #QUIAGA.

Usage of READAT

The program READAT, which is run as shown in figure 2, takes numerical cross-section data from file QINP and writes them on a direct-access file named by the user. The input file must be opened on Prime file unit 1 by typing "I QINP." The data on this file are in the same form as that used by the Control Data version READATA (appendix A of the original report). The outputs from READAT are a list of the cross-section numbers and associated axial locations displayed on the screen (fig. 2) and the cross-section data written to the direct-access file named by the user.

Usage of QUIAGA

The QUICK Interactive Graphics Analysis (QUIAGA) program is run in the interactive mode. An example of the initialization of an interaction session is given in figure 3. For QUIAGA the input file, containing the QUICK intermediate output, can be opened either before beginning execution or by giving the file name when asked for it. As shown in the figure, before reading the QUICK intermediate data from the input file, the program asks the user, "DO YOU NEED HELP?" The figure shows a negative response. If the response had not begun with an "N," the program would have listed the quantities which may be asked for in a session and appropriate responses (fig. 4). A flowchart of prompts and program actions is given in figure 5. The rest of this section enlarges on this information.

IS Q2650 OUTPUT ON A D/A FILE? Y/N: This question pertains to the availability of original numerical data for comparison plots such as those shown in figure 6. If a local file of such data, written in direct-access form by the companion program READAT, is available, answer "Y." The program will then ask for the name of the file and will list the X locations from it as in figure 3, confirming the desired file has been opened. If such data are not available, answer "N." (The program will continue running but comparison plots cannot be made.)

KEY: ITYPE, SCALE FACTOR: This prompt, which comes next, marks the beginning of the major program loop. After each series of plots is finished, the program will return to this point to begin a new series. The parameter ITYPE is a two-digit integer which determines the type of plots to be generated in the next series. If the first digit is zero, the plots will be single cross sections with original data for comparison (e.g., fig. 6); if it is 1, the one or more cross sections plotted will be aligned to form a front view (fig. 7(a)); if it is a 2, the cross sections plotted will be displaced in a row from upper left to lower right, somewhat like a lower oblique view (fig. 7(b)); if the first digit is 3, the cross sections will be in a row from lower left to upper right, somewhat like an upper oblique view (fig. 7(c)). If the second digit is a 1 or 3, only the right half of the cross sections will be plotted (e.g., fig. 7(b)); if it is a 2 or 4, both halves will be plotted (fig. 7(a)); if the second digit is 5, body lines will be plotted instead of cross sections (fig. 8). If ITYPE is positive, all lines will be plotted (figs. 7(a) and 7(b)), but if ITYPE is negative, hidden lines will be omitted (fig. 7(c)). The SCALE FACTOR, entered after ITYPE and a comma, is the decimal multiplication factor required to convert from geometry units to inches on the graphics terminal screen. The best choice depends on the configuration and type of plot; it can be found most easily by making a few trials. For a new configuration, dividing 15 by the length in inches should give a reasonable value. If 0.0 is used for SCALE FACTOR, the program will compute its own scale factor, which may be acceptable.

KEY: # PTS/SIDE, CONCENTR ANGL: This prompt appears next if the plots are to be of a cross-section type. The value of # PTS/SIDE is the integer number of points to be used in plotting each half cross section. The number must be between 3 and 180 (inclusive), chosen as a compromise between plotting speed and accuracy. The CONCENTR ANGL is a real number designating the angle about which there is to be a concentration of points around the cross section. The angle is measured from the horizontal through the QUICK map axis at each cross section. Concentrating near 0°, for example, helps to define the wing leading edge in plots such as those in figure 7. The range for concentrated points is from -90° to +90°. However, CONCENTR ANGL can be set outside this range (such as 99) to produce an even angular distribution of points.

KEY: X LOCATION # (0 TO END): If the type of plot is a single cross section with comparison data, this prompt appears next. This is the integer corresponding to the desired axial location of the plot as listed after the yes response to the question "IS Q2650 OUTPUT ON A D/A FILE?" (fig. 3). The program will then plot the original cross-section data for the indicated axial location and the QUICK-geometry cross section of the type indicated by the second digit of ITYPE (fig. 6). The program returns to this same prompt after plotting; a response of zero, when no more plots of this type are desired, sends the program on to the last prompt of the main loop.

KEY: XMIN, XMAX, DELX: For all other types of plot this prompt appears next. Respond with the decimal axial location for the first cross section to be plotted or the beginning of the body lines, with the axial location for the last cross section to be plotted or the end of the body lines, and with the increment in axial location for the cross sections or for the body-line points to be plotted. (For a single cross section give the axial location followed by a slash.) If cross sections are requested, the program will plot them according to the value of ITYPE. After completing the plot the program moves on to the last prompt.

KEY: # OF BL'S AND BL #'S: If body-line plots were requested (ITYPE = 5), the program issues this prompt after requesting the axial locations. Respond with the number of body-line models to be plotted (up to a total of 20) and their model numbers. These numbers are found in parentheses in the "Body Line Coordinate Index" printed as part of the QUICK output when the geometry model is generated. The program will then plot the requested body lines between the given beginning and ending axial locations with points computed at the specified increments. The lines will be labeled with their model numbers.

MORE BL'S? (Y/N): This prompt appears after the plot. A response of "Y" sends the program back to the prompt of the previous paragraph. An "N" response sends the program on to the last prompt.

HIT 0 TO STOP, 1 TO CHANGE PLOT TYPE, 2 FOR NEW X STATION: This is the last prompt of the main program loop. A response of 0 ends the program, 1 returns the program to the beginning of the major program loop (to the prompt "KEY: ITYPE, SCALE FACTOR"), and 2 returns the program to the request for new axial locations (to the prompt "KEY: XMIN, XMAX, DELX"). If the response is 2, the ensuing plots will be of the same type and scale factor as the plots just completed, and if they are cross-section plots the same number of points per cross section and the same concentration angle will be used. The program will continue cycling and producing plots as requested until the user responds with a 0 to this last prompt.

HIT <CR> TO CONTINUE: The program pauses after each plot is completed. A carriage return <CR> signals the program to clear the screen and continue when the user is ready.

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June 17, 1982

REFERENCES

1. Vachris, Alfred F., Jr.; and Yaeger, Larry S.: QUICK-GEOMETRY - A Rapid Response Method for Mathematically Modeling Configuration Geometry. Applications of Computer Graphics in Engineering, NASA SP-390, 1975, pp. 49-73.

2. Marconi, Frank; and Yaeger, Larry: Development of a Computer Code for Calculating the Steady Super/Hypersonic Inviscid Flow Around Real Configurations. Volume II - Code Description. NASA CR-2676, 1976.

```
. C_RDAT

F77 READAT -INTS -B B_RDAT -64V
FILMEM
SEG
VLOAD #READAT
LO B_RDAT
LI
MA 3
QU
CO TTY
OK,

. C_QIAG

F77 QUIAGA -INTS -B B_QIAG -L L_QIAG
F77 COMPAR -INTS -B B_COMP -L L_COMP
F77 CSMSET -INTS -B B_CSMS -L L_CSMS -NOOPT
F77 QKSUBS -INTS -B B_QSUB -L L_QSUB
FILMEM
SEG
VLOAD #QUIAGA
LO B_QIAG
LO B_COMP
LO B_CSMS
LO B_QSUB
LI VLBTEK
LI
MA 3
QU
CO TTY
OK,
```

Figure 1.- Command files to compile, load, and save absolute binaries of programs READAT and QUIAGA.

```
OK, I QINP
OK, SEG #READAT
   47 CROSS SECTIONS ON INPUT FILE
NAME OF D/A FILE TO WRITE:
QXDATA
              #   X LOCATION        #   X LOCATION        #   X LOCATION        #   X LOCATION
              1    0.00000          2    2.00000          3   12.00000          4   22.00000
              5   32.00000          6   42.00000          7   52.00000          8   62.00000
              9   62.00000         10   87.00000         11  112.00000         12  137.00000
             13  162.00000         14  182.00000         15  187.00000         16  202.00000
             17  222.00000         18  242.00000         19  262.00000         20  282.00000
             21  302.00000         22  322.00000         23  342.00000         24  362.00000
             25  402.00000         26  432.00000         27  462.00000         28  512.00000
             29  562.00000         30  612.00000         31  662.00000         32  712.00000
             33  762.00000         34  812.00000         35  862.00000         36  912.00000
             37  962.00000         38 1012.00000         39 1012.00000         40 1062.00000
             41 1073.00000         42 1082.00000         43 1112.00000         44 1162.00000
             45 1212.00000         46 1237.00000         47 1262.00000
**** STOP
```

Figure 2.- Example of run of READAT absolute binary on Prime minicomputer. User inputs are underlined.

OK, <u>I QOUTPT</u> OK, <u>SEG #QUIAGA</u> DO YOU NEED HELP?	Prime commands to open QUICK intermediate-output file as input file and to begin execution from absolute binary of QUIAGA.
<u>N</u>	If response does not begin with N, screen clears and HELP list is printed. (See fig. 4.)
[NAME OF INPUT FILE: <u>QOUTPT</u>]	Ask for input file only if it was not opened already.
QUICK GEOMETRY INPUTS	Identification from file QOUTPT.
IS Q2650 OUTPUT ON A D/A FILE? Y/N <u>Y</u>	Response beginning with N would skip this list and not allow comparisons with original data.
GIVE FILE NAME <u>QXDATA</u>	Name of direct-access file produced by program READAT.

47 CROSS SECTIONS READ FROM FILE QXDATA

LOCATION #	X	LOCATION #	X	LOCATION #	X
1	0.0000	17	222.0000	33	762.0000
2	2.0000	18	242.0000	34	812.0000
3	12.0000	19	262.0000	35	862.0000
4	22.0000	20	282.0000	36	912.0000
5	32.0000	21	302.0000	37	962.0000
6	42.0000	22	322.0000	38	1012.0000
7	52.0000	23	342.0000	39	1012.0000
8	62.0000	24	362.0000	40	1062.0000
9	62.0000	25	402.0000	41	1073.0000
10	87.0000	26	432.0000	42	1082.0000
11	112.0000	27	462.0000	43	1112.0000
12	137.0000	28	512.0000	44	1162.0000
13	162.0000	29	562.0000	45	1212.0000
14	182.0000	30	612.0000	46	1237.0000
15	187.0000	31	662.0000	47	1262.0000
16	202.0000	32	712.0000	48	0.0000

Figure 3.- Initialization of interactive session using QUIAGA. User inputs are underlined.

```
                 QUICK  INTERACTIVE GRAPHICS ANALYSIS

          HELPS YOU CHECK  QUICK  OUTPUT (USE PRIMOS'  I pathname)

     WHEN ASKED FOR:   GIVE A:     EXPLANATION:

     ITYPE        2-DIGIT INTEGER <0  HIDDEN LINES OUT
                                  >0  ALL LINES

                     1ST DIGIT = 0  COMPARISON WITH ORIGINAL DATA
                                 1  FRONT VIEW
                                 2  BOTTOM OBLIQUE
                                 3  TOP OBLIQUE

                     2ND DIGIT = 1  HALF CROSS SECTIONS
                                 2  WHOLE CROSS SECTIONS
                                 3  HALF CROSS SECTIONS WITH CONTROL POINTS
                                 4  WHOLE CROSS SECTIONS WITH CONTROL POINTS
                                 5  BODY LINES

     SCALE FACTOR      REAL        SCREEN INCH/MODEL INCH (AUTO IF 0.)

     # PTS/SIDE        INTEGER     NUMBER OF POINTS AROUND HALF CROSS SECTIONS (<=180)
     CONCENTR ANGL     REAL        ANGLE FOR CONCENTRATED POINTS (-90. TO 90.)
                                   EVEN ANGULAR DISTRIBUTION IF NOT IN RANGE

     # OF BL'S         INTEGER     NUMBER OF BODY LINES TO PLOT  (NBLS<=10)
     BL #'S        NBLS INTEGERS   BODY LINE COORDINATE INDEX NUMBERS FROM  QUICK


     XMIN              REAL        BEGIN AT THIS AXIAL STATION
     XMAX              REAL        END   AT THIS AXIAL STATION
     DELX              REAL        INCREMENT IN  AXIAL STATION

     X LOCATION #      INTEGER     NUMBER FROM LOCATION LIST

          ERROR MESSAGES ON FILE QERROR
```

Figure 4.- Help output from QUIAGA program.

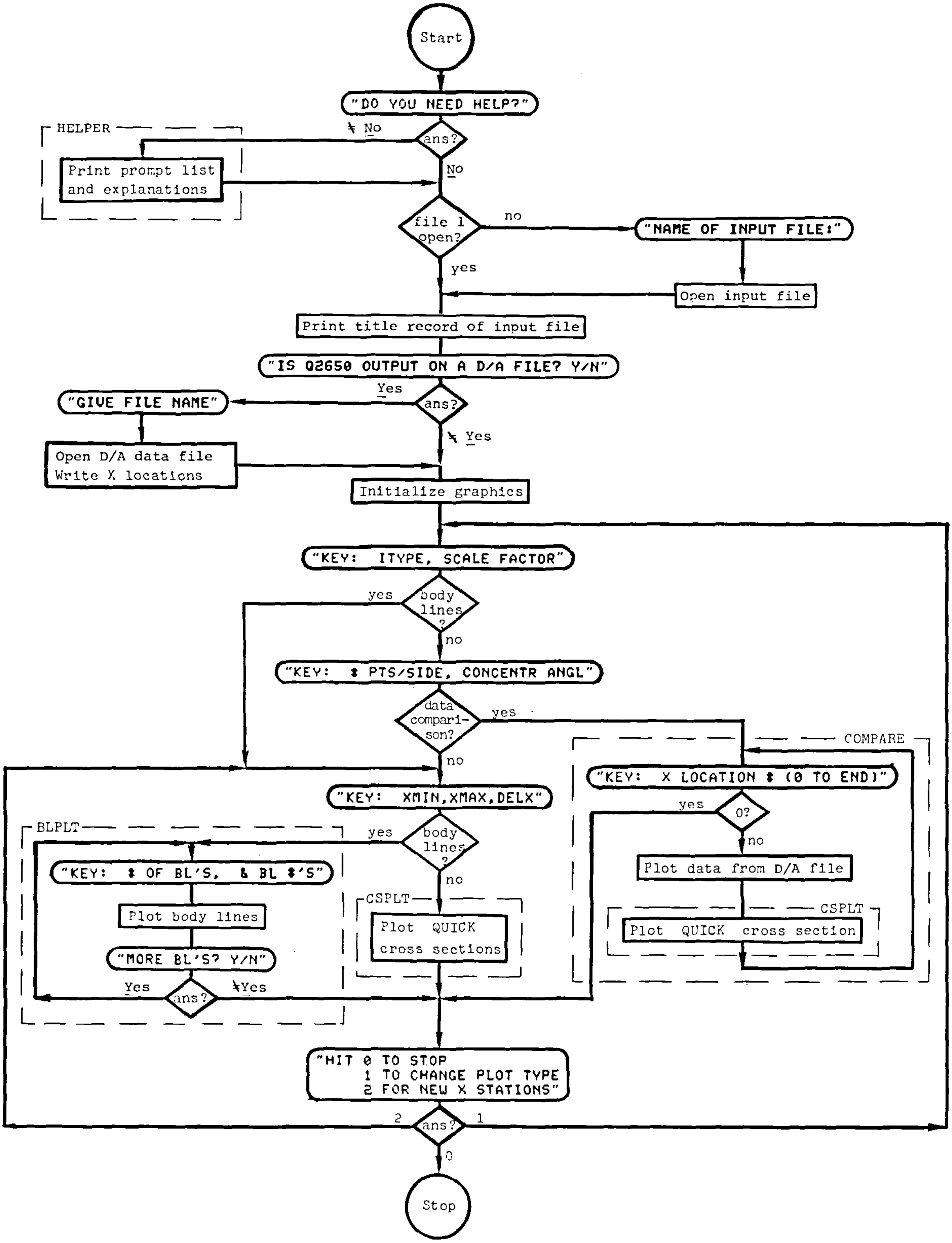


Figure 5.- Simplified flowchart of QUIAGA program. Items in quotes are prompts requiring keyboard response; dashed outlines denote subroutines.

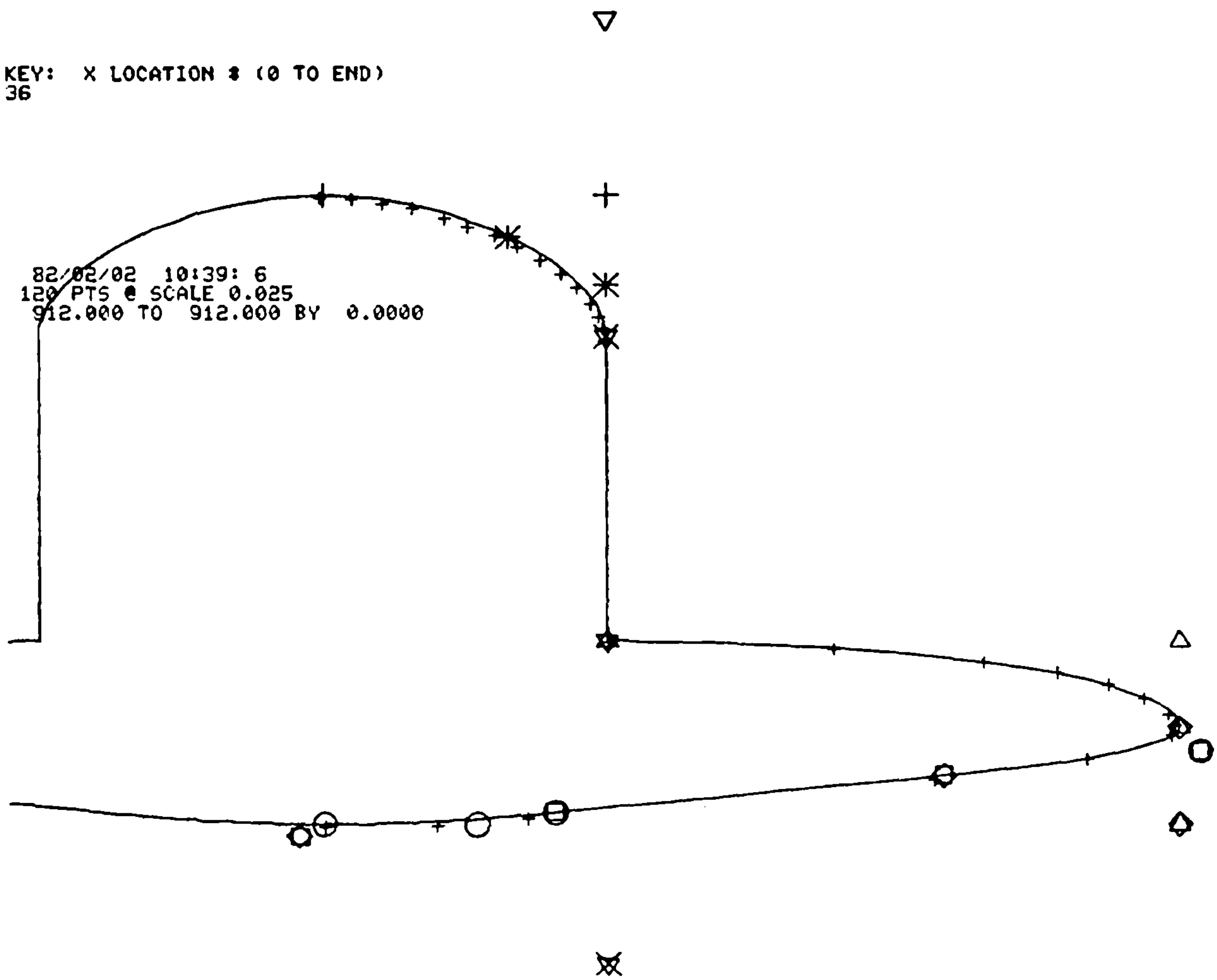
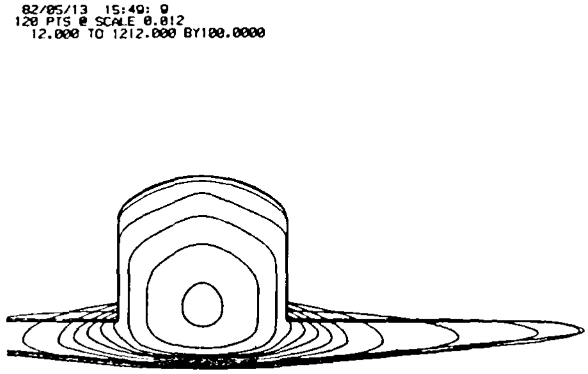
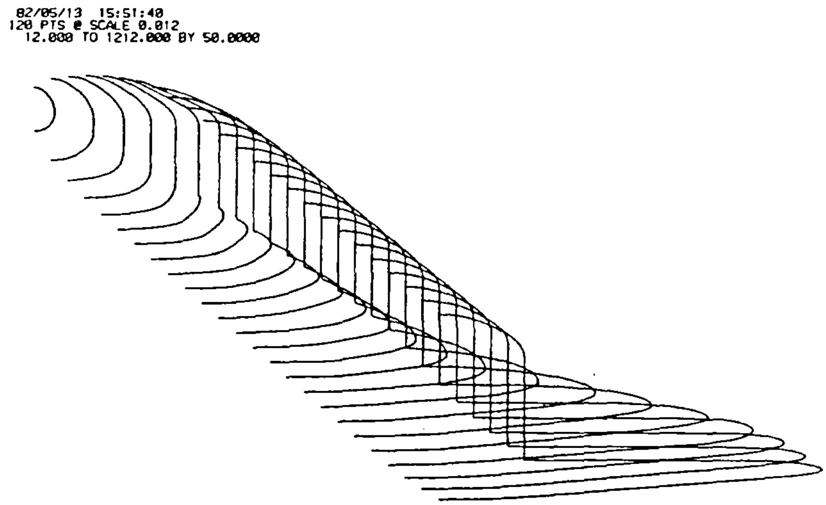


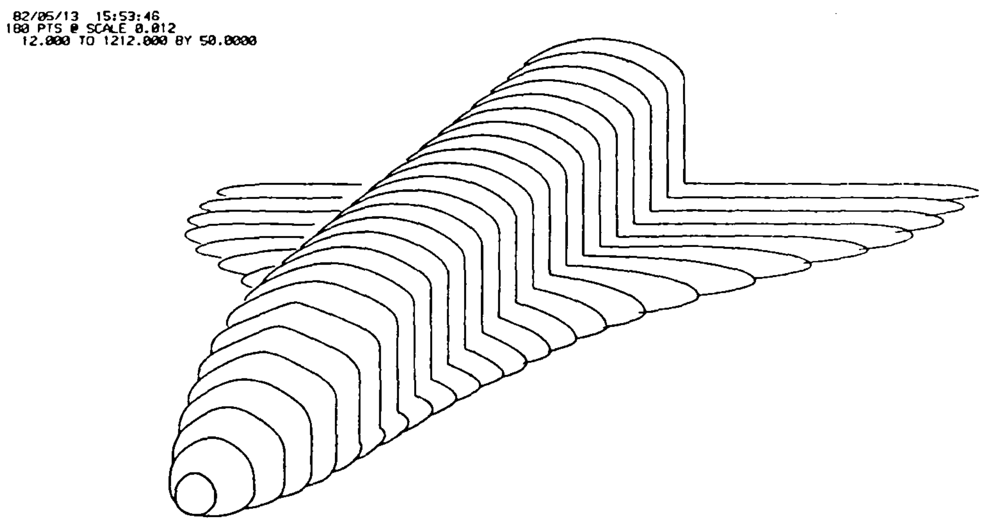
Figure 6.- Comparison of QUICK cross-section model including control points with original data digitized from a drawing. Large symbols are control points; small pluses are comparison data.



(a) Symmetric front view with all lines shown.

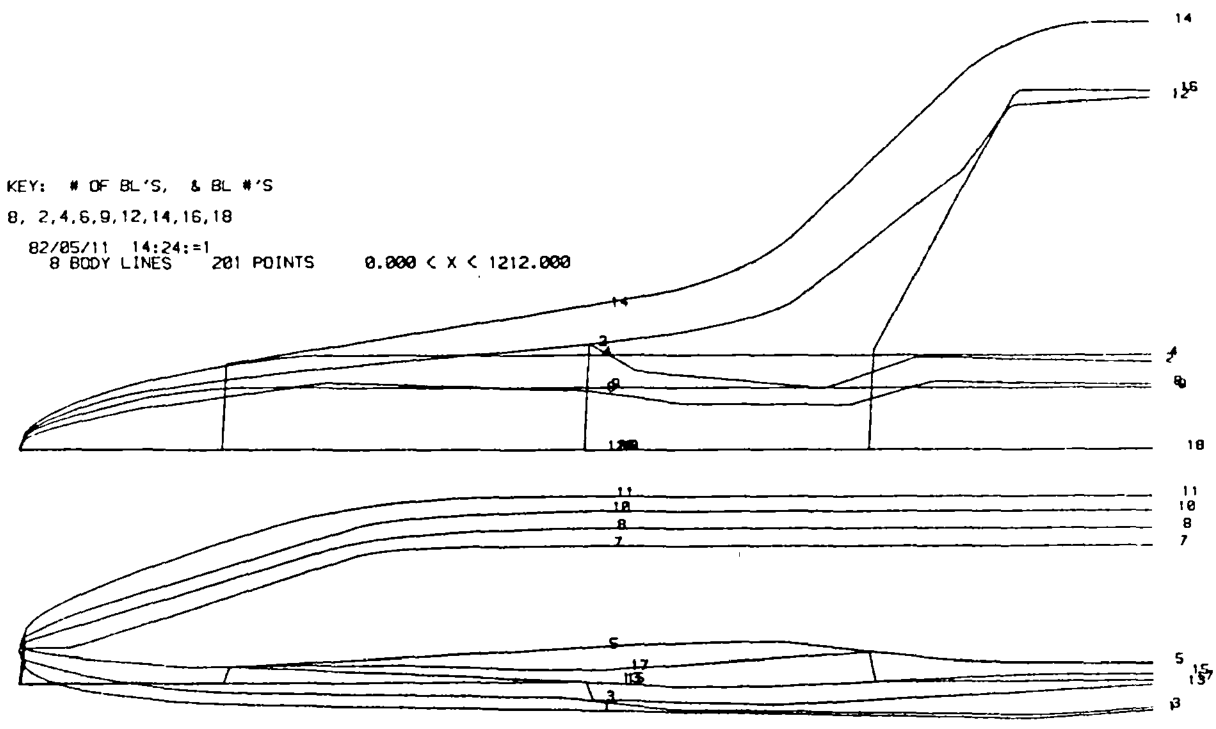


(b) One-sided lower pseudo-oblique view with all lines shown.

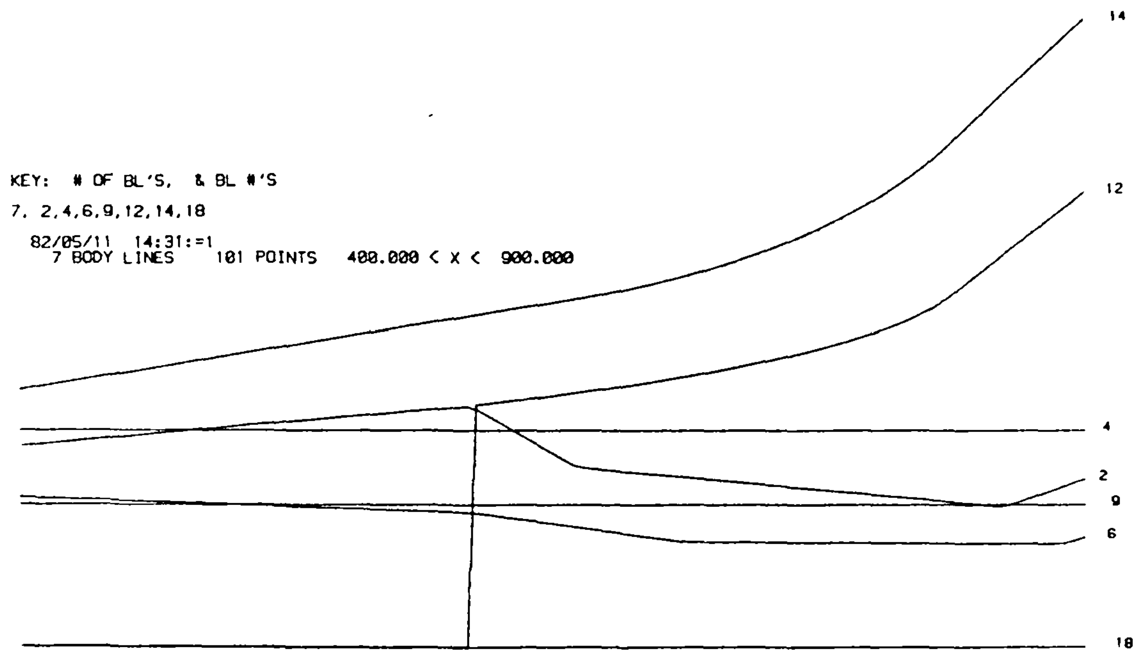


(c) Two-sided upper oblique view with hidden-line removal.

Figure 7.- Examples of overall views with many cross sections.



(a) Top view and side view body lines over whole modeled length.



(b) Several top view body lines over shorter range.

Figure 8.- Examples of body-line plots.

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15. Supplementary Notes

This supplement contains a description of the QUIGA program usage on the Langley Research Center Prime minicomputer system.

16. Abstract

The advantages of using interactive computer graphics to display aircraft geometry to aid in detection and analysis of errors are described. The QUICK-geometry system is reviewed and the Quick Interactive Graphics Analysis (QUIAGA) program is described. This QUIAGA program was developed to exercise the QUICK-geometry subroutines to examine the analytic definition of a configuration by plotting overall and detailed views in several modes on a graphics terminal. Its use in the detection and analysis of errors in the QUICK-geometry definition can be of great assistance in speedily arriving at a correct analytical geometry description for flow-field computation. Experience with the program in developing a QUICK-geometry model of the NASA Space Shuttle Orbiter is used to show some of its features. Appendixes giving details of program usage and an example session are included.

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