TRACK TRAIN DYNAMICS
MATHEMATICAL MODEL

TRACK TRAIN DYNAMICS
AAR

NATIONAL GOVERNMENT-INDUSTRY RESEARCH PROGRAM ON TRACK-TRAIN DYNAMICS

Software Series

GIFWHL - User's Guide and Technical Documentation

R-367

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Technical Center
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13. ABSTRACT

This report describes an interface package which links GIFTS-4B (an interactive, graphics-oriented, finite-element software system) to WHEEL, a finite-element program. The package is designed to produce complete card-image input decks, which can then be used for three dimensional stress analyses of railroad car wheels, by means of the WHEEL program. The user's interaction is minimized by means of computer-coded flexibilities and conveniences, which saves time and eliminates errors in data preparation, checking, and display of results. A guide to the use of the package is included, and various features are illustrated. The United States Government assumes no liability for the contents of this report, or the use thereof.

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BACKGROUND INFORMATION

ON THE

TRACK-TRAIN DYNAMICS PROGRAM

The Track-Train Dynamics Program encompasses studies of the dynamic interaction of a train consist with track as affected by operating practices, terrain, and climatic conditions.

Trains cannot move without these dynamic interactions. Such interactions, however, frequently manifest themselves in ways climaxing in undesirable and costly results. While often differing and sometimes necessarily so, previous efforts to reasonably control these dynamic interactions have been reflected in the operating practices of each railroad and in the design and maintenance specifications for track and equipment.

Although the matter of track-train dynamics is by no means a new phenomenon, the increase in train lengths, car sizes, and loadings has emphasized the need to reduce wherever possible excessive dynamic train action. This, in turn, requires a greater effort to achieve more control over the stability of the train as speeds have increased and railroad operations become more systematized.

The Track-Train Dynamics Program is representative of many new programs in which the railroad industry is pooling its resources for joint study and action.

A major planning effort on track-train dynamics was initiated in July 1971 by the Southern Pacific Transportation Company under contract to the AAR and carried out with AAR staff support. Completed in early 1972, this plan clearly indicated that no individual railroad had both the resources and the incentive to undertake the entire program. Therefore, AAR was authorized by its Board to proceed with the Track-Train Dynamics Program.

In the same general period, the FRA signaled its interest in vehicle dynamics by development of plans for a major test facility. The design of a track loop for train dynamic testing and the support of related research programs were also pursued by FRA.

In organizing the effort, it was recognized that a substantial body of information and competence on this program resided in the railroad supply industry and that significant technical and financial resources were available in government.

Through the Railroad Progress Institute, the supply industry coordinated its support for this program and has made available men, equipment, data from earlier proprietary studies, and monetary contributions.

Through the FRA, contractor personnel and direct financial resources have been made available.

Through the Transport Canada Research and Development Centre (TDC), the Canadian Government has made a major commitment to work on this problem and to coordinate that work with the United States' effort.

Through the Office de Recherces et D'Essais, the research arm of the Union Internationale des Chemins de Fer, the basis for a full exchange of information with European groups active in this field has been arranged.

The Track-Train Dynamics Program is managed by the Research and Test Department of the Association of American Railroads under the direction of an industry-government steering committee. Railroad members are designated by elected members of the AAR's Operation-Transportation General Committee, supply industry members by the Railway Progress Institute, U. S. Government members by the Federal Railroad Administration, and Canadian Government members by the Transport Development Centre. Appropriate task forces and advisory groups are established by the Steering Committee on an ad hoc basis as necessary to pursue and resolve elements of the program.

The staff of the program comprises AAR employees, personnel contributed on a full- or part-time basis by railroads or members of the supply industry, and personnel under contract to the Federal Railroad Administration or the Transportation Development Agency.

The program plan as presented in 1972 comprises:

1) Phase I -- 1972-1974

   Analysis of an interim action regarding the present dynamic aspects of track, equipment, and operations to reduce excessive train action.

2) Phase II -- 1974-1977

   Development of improved track and equipment specifications and operating practices to increase dynamic stability.

3) Phase III -- 1977-1982

   Application of more advanced scientific principles to railroad track, equipment, and operations to improve dynamic stability.

Phase I officially ended in December of 1974. The major technical elements of Phase I included:

a) The establishment of the dynamic characteristics of track and equipment.

b) The development and validation of mathematical models to permit the rapid analysis of the effects on dynamic stability of modifications in design, maintenance, and use of equipment and track structures.

c) The development of interim guidelines for train handling, makeup, track structures, and engineer training to reduce excessive train action.

Reports on all elements of Phase I activities have been completed and are available through the AAR. A list of the Track Train Dynamics publications is available upon request.

The major technical elements of Phase II include:

a) The adaptation of Phase I analytical models to allow for conducting parameter investigations in the area of track, trucks, draft gear and cushion units, and vehicle behavior.

b) The development of fatigue analysis guidelines.

c) The development of a comprehensive program for identifying the loads to which track, vehicles, and vehicle components are subjected.

Phase III is now under way, and this report is an element of one of the tasks entitled, "Enhancement of Mathematical Models and Computer Programs for Structural Problems."

ACKNOWLEDGEMENT

The study reported herein is part of an effort within the International Government-Industry Research Program on Track Train Dynamics to enhance the accessibility of various finite-element structural programs by the railroad community. Funding for this portion of the program is provided through a contract with the Federal Railroad Administration. The Association of American Railroads furnished the manpower and computer facilities to complete this project.

Dr. G. J. Moyar, former Vice-President, Research and Development,Brenco, Incorporated, who served through early 1979 as Director of the Track-Train Dynamics Program, Phase III, played an important role in the definition and review of the project. Mr. Allen M. Hamilton, Manager, Task 2, TTD Phase III, played a key role in supporting the development and implementation of the project.

Mr. K. L. Hawthorne, Director, Track-Train Dynamics and Mr. E. F. Lind, former Technical Director - Association of American Railroads Technical Center, provided necessary administrative support and guidance throughout the project.

EXECUTIVE SUMMARY

This is the first report in a "Software Development Series," wherein an interface package has been developed which links GIFTS-4B, an interactive, graphics-oriented, finite-element program, developed by the University of Arizona, to WHEEL, a finite-element program, developed by Battelle-Columbus Laboratories. One significant reason for the development of this package has been the extensive detailed data input requirements for the WHEEL program, which involves considerable amounts of user time and effort. The potential usage of the WHEEL program, as, for example, in modelling a complex structure, such as a railroad vehicle wheel, has been limited by the amount of effort and cost involved in defining the details of the problem for use in the program.

Section 2 describes how the GIFTS program has been used to generate a 2-D basic model, and the information needed to create a complete input data deck for a 3-D stress analysis of a car wheel, using the WHEEL program. The guidelines for the use of the package are explained, and the various features illustrated by means of a sample problem in Section 4.

FOREWORD

This report is the result of a project undertaken in one of the four tasks of the Phase III portion of a ten year International Government-Industry Research Program on Track-Train Dynamics. Task 2, Advanced Design Methods, is one of the methodology development tasks in Phase III, which supports the adaptation and demonstration of existing computational techniques for design evaluation, with special emphasis on advanced pre-and post-processing techniques, so as to make them more attractive for use by the railroad industry.

The interface package, GIFWHL, has been designed to produce the card images used in the three-dimensional stress analysis of railroad vehicle wheels, using the WHEEL program. GIFWHL utilizes special data-handling techniques, that have been designed to lessen the amount of man effort and cost involved in defining the problem details for the WHEEL code. No fundamentally new methodology is revealed, nor is any claim made that the particular software that is illustrated is comprehensive, or even the best available. The package merely illustrates a technique by which data for a complex finite-element grid, for the three dimensional (3-D) stress analysis of a wheel, can be generated with less time, labor and computational costs than heretofore. An illustrative problem is presented to demonstrate the cost-beneficial conveniences of the data preparation. It is hoped that this presentation will provide an incentive to those in the industry, who have been previously hesistant in utilizing 3-D models, because of the excessive manual data-handling requirements, to now make use of this valuable tool.

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1. INTRODUCTION

Most of the current attempts [1-3]* to handle the generation of total engineering data and its proper communication to the existing commercial finite-element programs, rely mainly on human resources. However, as the problem size or number of finite elements increases, the volume of input data increases, and the resources required for maintaining data reliability and control increase dramatically [4].

The critical factors in data inputs to a finite-element program are:

(a) Problem Size: The volume of information which is being managed, controlled, transmitted or interpreted. The problem size refers not only to the number of nodes and elements, but also to the problem complexity.

(b) Reliability: The increasing volume of information generated at any particular stage should conform to the input requirements of the parent program, i.e., the scaling, formatting or units used should be consistent, and the generated data should be complete.

(c) Overhead Costs: The data preparation costs should be kept to a minimum. The major factors affecting the overhead costs are the efficiency of the data-handling routines or retrieval mechanism, the quality of the structure of the data base system (DBS) and the trade-off between the usage of incore data storage and the number of times the input/output

---

* The numbers inside the square brackets designate the References, listed in Section 6.

operations are required to carry out a particular task. The efficient utilization of the various available resources should reduce the overhead and operating costs significantly.

Computing systems usually provide efficient file access methods, that are used to manage both the files and records within the files. These systems support the storage and retrieval of data, that have been formatted for use in specific finite-element programs. The data structure or arrangement is known by the programmer, and is often defined within the system, programming or application manual for the subject program. There are several finite-element programs [5-8], which are based upon data base systems. In the present case, GIFTS [5] has been chosen to be the host program for the interface package.

IPAC is a general purpose interface package for finite-element programs that was developed for the definition, access and manipulation of the data elements within the data base management system (DBS) of GIFTS. The GIFTS-WHEEL interface package forms a subsystem of IPAC. The IPAC system supports the storage, generation, retrieval and display of data from the existing data base (UDB). It also provides queries for retrievals of missing data, mostly in a programming language (not found within the host program), or poses questions to clarify some of the incomplete or inconsistent information encountered during processing. IPAC can also be modified to generate the input data required for any commercially-available, finite-element programs.

2. DESCRIPTION OF THE GIFWHL INTERFACE PROGRAM

The WHEEL program [3] is a public domain, finite-element program for the static stress analysis of railroad vehicle wheels, developed and supplied by Battelle's Columbus Laboratories, under the joint sponsorship of the Track-Train Dynamics (TTD) Program and the Federal Railroad Administration (FRA). The program uses a 20-node, three dimensional, isoparametric solid element for wheel modelling. The present capability of GIFTS does not include solid elements, and they must be generated outside the GIFTS system. This is one of the functions of IPAC which is utilized in the GIFWHL interface. Since wheel cross-sections are geometrically axisymmetric, we could possibly construct a three-dimensional grid from a two-dimensional one by rotating it about an axis of symmetry. However, in order to construct a 20-node isoparametric element (see Figure 1), as needed in WHEEL, we would require a generation capability for a two-dimensional mesh, consisting of elements having eight nodes. Incidently, we also do not have at present in GIFTS-4B any eight-node planar elements; the closest 2-D element that could be generated by GIFTS is a nine-node element (QM9 or QB9) (see Figure 2). By using this element we would generate a 23-node (9+9+5) brick element, instead of a 20-node element.

In order to generate isoparametric elements for use in the GIFWHL interface, it is essential to use 9-node elements to form 8-node planar elements. This is done as follows:

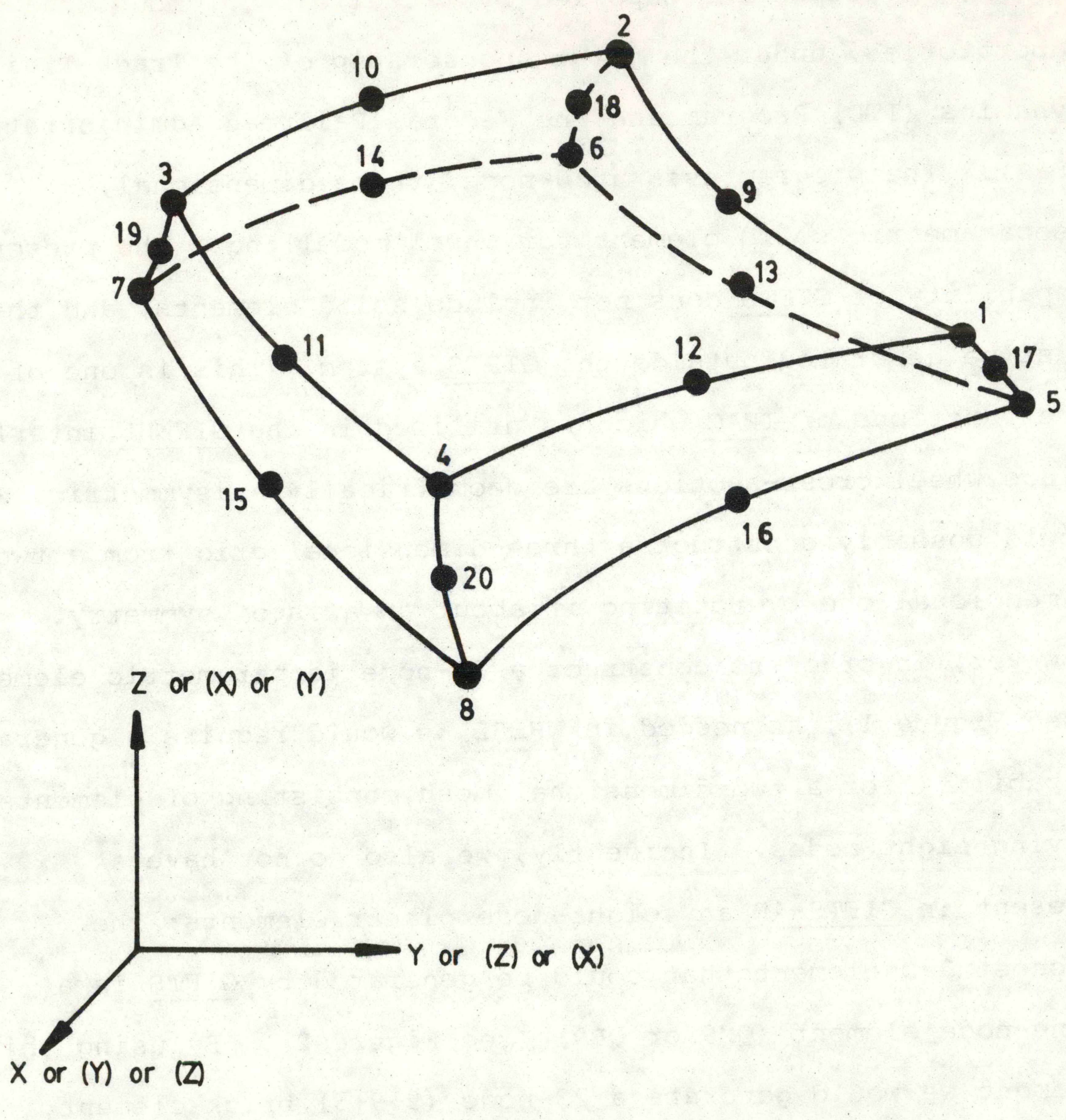

Figure 1. 20-Node, Isoparametric Element Used in the WHEEL Program, and Illustrating the Node Numbering Convention.

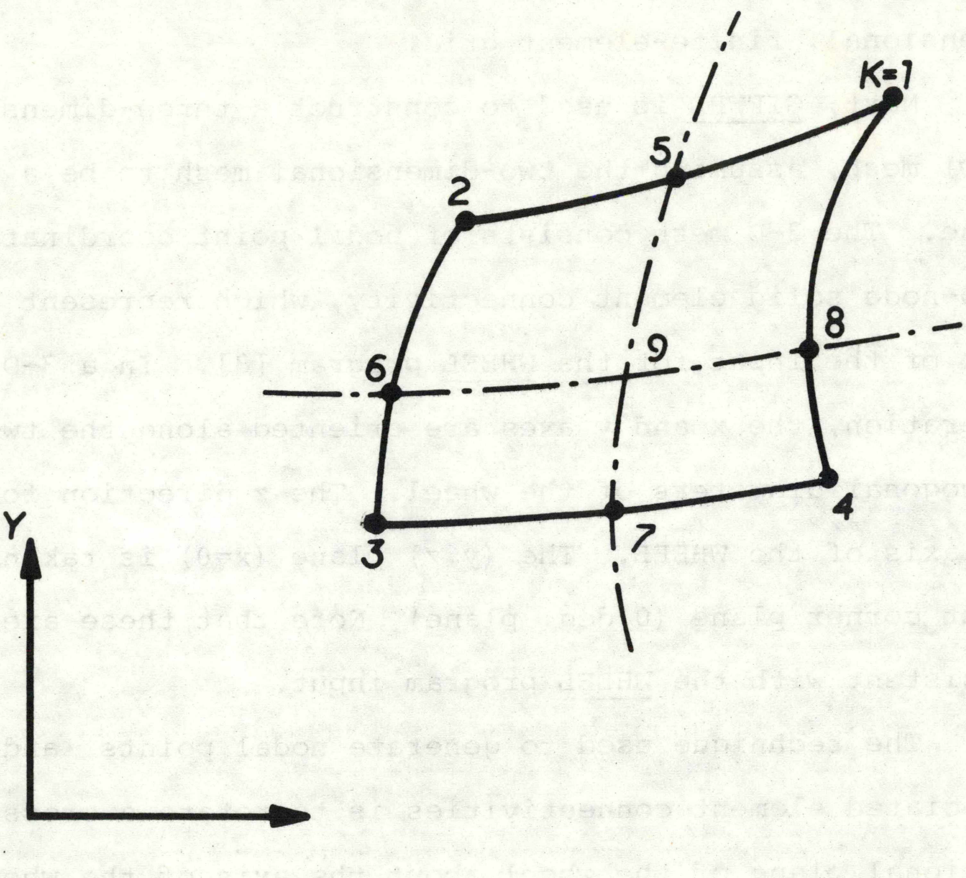

Figure 2. QM9 or QB9 Element Types Available with the GIFTS Program.

First, GIFTS is used to construct a 2-dimensional (2-D) grid, consisting of element types QM9 or QB9. Later, a separate routine,called BRICK, is run to transform the nine-node elements into eight-node element grids. The node numbers are then reordered, so that no essential node is missing. The bandwidth is also optimized for the modified, two-dimensional, finite-element grid.

Next, GIFWHL is used to construct a three-dimensional (3-D) mesh, assuming the two-dimensional mesh to be a base plane. The 3-D mesh consists of nodal point coordinates and a 20-node solid element connectivity, which represent the bulk of the input for the WHEEL program [3]. In a 3-D grid generation, the x and y axes are oriented along the two orthogonal diameters of the wheel. The z direction forms the axis of the WHEEL. The (y,z) plane (x=0) is taken as the first corner plane (0 deg. plane) Note that these axes are consistent with the WHEEL program input.

The technique used to generate nodal points and the associated element connectivities is to rotate a cross-sectional plane of the wheel about the axis of the wheel. The 2-dimensional grid generated during the first stage of interfacing is then used as the base plane (0 deg. plane) for rotation. The actual 3-D cross-section is divided into several pie-shaped 3-dimensional wedges. Each pie-shaped wedge is comprised of two corner planes and one midside plane. The user supplies the angular locations of the various corner or midside planes, indicated by the angles $\theta_c(I)$ and $\theta_m(I)$ (see also Figure 3), respectively.

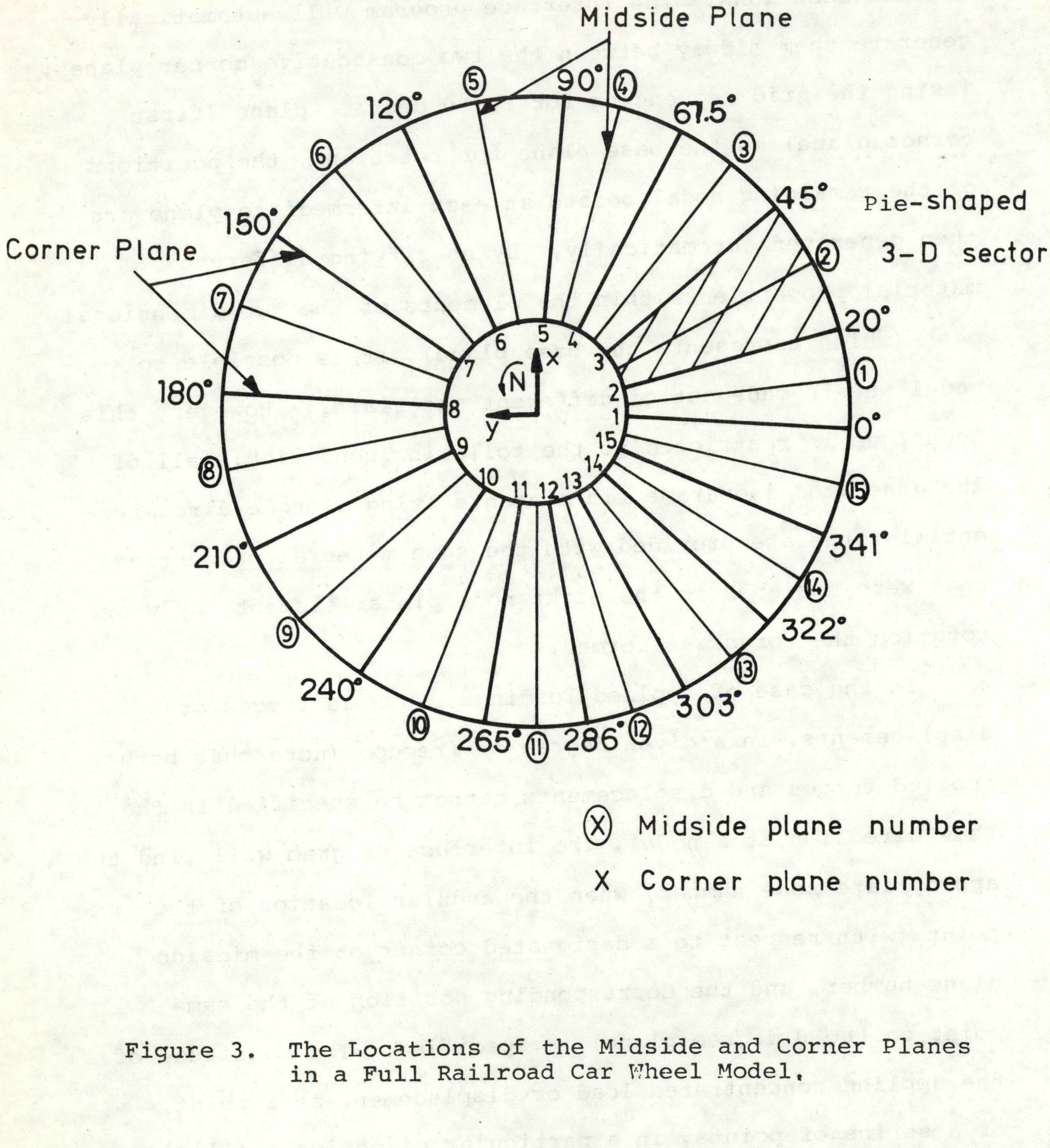

Figure 3. The Locations of the Midside and Corner Planes in a Full Railroad Car Wheel Model.

If the midside plane is chosen halfway (angularly) between the corner planes, the user can ignore the midside angular locations. The interface program will automatically generate them midway between the two consecutive corner planes. Taking the grid sequencing for the 0 degree plane (first corner plane) as the base plane for rotations, the positions of the remaining nodal points at each intermediate plane are then generated automatically. By specifying different material properties within the elements of the two-dimensional mesh (which represents the base plane), it is possible to model wheels made out of different materials. However, this technique is restricted to the following condition: all of the generated isoparametric elements lying along a circumferential torus are provided with the same material properties that were assigned to the eight node planar element, by whose rotation the torus was formed.

In the case of applied loadings, such as forces or displacements, in a given degree of freedom (note that both applied forces and displacements cannot be specified in the same direction at a node), the interface program will find the appropriate node number, when the angular location of the point (with respect to a designated corner or the midside plane number, and the corresponding position of the same point on the 0 degree plane) is specified. The magnitude of the applied concentrated load or displacement at a point, or a series of points, in a particular direction will also be applied automatically. The user, therefore, deals only with the 2-dimensional planar mesh initially formed by GIFTS-4.

The location of the loaded point and the associated node number in the 3-D mesh is determined by the GIFWHL program. The degrees of freedom 1, 2 and 3, along which the load is applied, correspond to the global x, y and z directions, respectively.

3. BASIC MODEL DEFINITION AND TWO-DIMENSIONAL MESH GENERATION

As described in Section 2, a two-dimensional model representing a zero degree plane (first corner plane of a 3-D model) must be constructed. The GIFTS-4 program has the capability of generating a 2-D mesh, using the principle of a minimum number of user points. This capability is very useful, and has been used in the present case to create a basic model of the wheel.

The configuration of a dummy type AA-36 wheel is shown in Figure 4, and Table 1 lists the basic data necessary to model the cross-section of the wheel. This data has been stored in a steering file, named AA36.SRC, which contains the coded instructions to generate a 2-dimensional basic model of the wheel. As shown in Table 1, the wheel cross-section is modeled using 44 key points (KPOINT), 24 straight lines (SLINES), 16 curved lines (CARC) and 13 subdivisions (GRID4). These instructions can be found in the GIFTS-4 User's Manual [5], however some of the salient points are discussed here. The first instruction KPOINT defines the locations of the key points used to model the cross-section of the wheel. The SLINE command defines the location of the intermediate lines connecting any two key points with a straight line. CARC has the same function, but the intermediate points are generated along a curve joining the key points. The GRID4 command describes each division of the wheel cross-section (specified by the four adjoining lines or curves) into several finite elements of the type and shape

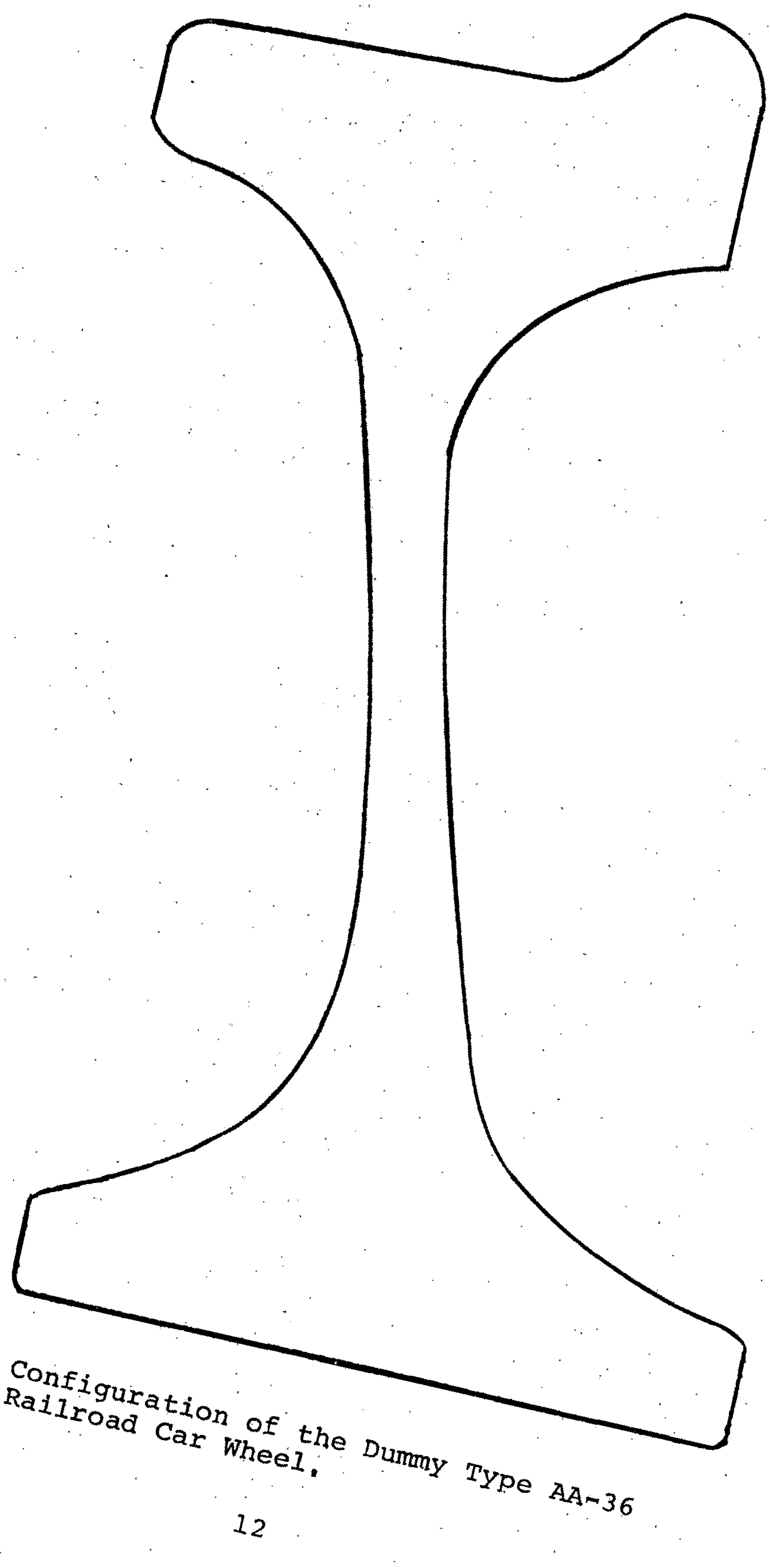

Figure 4. Configuration of the Dummy Type AA-36 Railroad Car Wheel.

TABLE 1. GIFTS Steering File (AA36,SRC), Containing the Basic Data for the 2-Dimensional Wheel Model.

```
KPOINT    (1)
1
0.0,18.05,4.50
2
0.0,18.25,4.95
3
0.0,18.62,5.16
4
0.0,18.84,5.38
5
0.0,19.05,5.60
6
0.0,18.90,6.20
7
0.0,18.37,6.50
8
0.0,18.06,6.53
9
0.0,17.75,6.56
10
0.0,16.55,6.56
11
0.0,16.30,5.75
12
0.0,15.75,5.05
13
0.0,15.10,4.62
14
0.0,14.25,4.40
15
0.0,13.50,4.45
16
0.0,12.75,4.63
17
0.0,10.25,5.25
18
0.0,8.85,5.60
19
0.0,7.5,6.0
20
0.0,6.86,6.40
21
0.0,6.25,7.10
22
0.0,5.85,8.15
23
0.0,5.62,9.10
24
0.0,4.375,9.10
25
0.0,4.375,7.10
26
0.0,4.375,3.48
27
0.0,4.375,2.12
28
0.0,5.57,2.12
29
0.0,5.83,2.83
30
0.0,6.25,3.48
31
0.0,6.85,4.05
32
0.0,7.5,4.37
33
0.0,8.85,4.55
34
0.0,10.25,4.30
35
0.0,12.75,3.80
36
0.0,14.25,3.52
37
0.0,15.10,3.25
38
0.0,15.75,2.75
39
0.0,16.30,1.84
40
0.0,16.53,0.85
41
0.0,17.50,0.85
42
0.0,17.82,1.00
43
0.0,17.85,1.30
44
0.0,18.00,3.50

MSTEEL    (2)
1

ETH,1     (3)
1
1.0

SLINE     (4)
L1
3,9,5
L2
10,9,3
L3
1,10,5
L4
1,44,3
L5
44,12,5
L6
44,43,5
L7
43,38,5
L8
41,40,5
L9
38,12,5
L10
36,14,5
L11
36,35,3
L12
35,16,5
L13
16,17,3
L14
35,34,3
L15
34,17,5
L16
32,19,5
L17
30,21,5
L18
23,24,3
L19
21,25,3
L20
30,26,3
L21
28,27,3
L22
27,26,3
L23
26,25,5
L24
25,24,3

CARC  (5)
C1
3,2,1,3
C2
5,4,3,3
C3
7,6,5,5
C4
9,8,7,3
C5
10,11,12,3
C6
12,13,14,3
C7
14,15,16,3
C8
17,18,19,3
C9
19,20,21,3
C10
21,22,23,3
C11
28,29,30,3
C12
30,31,32,3
C13
32,33,34,3
C14
36,37,38,3
C15
38,39,40,3
C16
43,42,41,3

GETY     (6)
QM9
1,1

GRID4    (7)
G1
C2,C3,C4,L1
G2
C1,L1,L2,L3
G3
L4,L3,C5,L5
G4
L6,L5,L9,L7
G5
C16,L7,C15,L8
G6
L9,C6,L10,C14
G7
L10,C7,L12,L11
G8
L12,L13,L15,L14
G9
L15,C8,L16,C13
G10
L16,C9,L17,C12
G11
C10,L18,L24,L19
G12
L17,L19,L23,L20
G13
C11,L20,L22,L21

END
```

TABLE 1 (cont.d)

(1) KPOINT - Defines the nodes describing the geometry of the structure. The node number and its x, y and z coordinates are given.

(2) MSTEEL - Defines the material as mild steel. There is only one material, and default values of material properties are used, as follows:
Young's modulus = 29.5×10^6; Poission's ratio = 0.3;
Coefficient of thermal expansion = 0.65×10^{-5}.

(3) ETH - Defines the thickness of the elements in the 2-D structure. The thickness is given as 1.0.

(4) SLINE - Defines the data for each line list (24 lines in the example). Along with the line name, its starting and ending nodes are listed, and the number of points to be generated along the line, are prescribed. For example, line L1 starts at node 3 and ends at 9; the total nodes needed along L1 are 5.

(5) CARC - Defines the arcs (used to model the curved boundaries of the geometry) in the same manner as SLINE. The first three numbers define an arc. For example, Arc C1 is defined by nodes 3, 2 and 1; the last digit is total number of nodes along the arc; in this case it is 3.

(6) GETY - Specifies that all elements to be generated are of the QM9 type; material number one, and thickness number one.

Table 1 (cont'd.)

(7) GRID4 - Generates grids (G1 to G13 in the example) that are bounded by four sides. In the example, G1 is defined by arcs C2, C3 and C4 and line L1). For the WHEEL program, grids should be defined in a clockwise manner.

proclaimed by the GETY command. The key points, lines and grids, generated as the result of the above commands, are shown in Figures 5, 6 and 7. All of these plots are obtained and drawn by <u>GIFTS</u>, using their respective plotting commands. Note that the model generated thus far uses QM9 element types. This has to be converted into a QM8 element type, not available in <u>GIFTS</u>. The sequence of input steps to be followed for generating the correct 2-D model is given in Table 2. Table 3 contains the various input and output messages encountered while running the modules interactively and step-by-step. Figure 8 shows the final 2-dimensional model of the wheel, with the sequence numbers obtained from the <u>GIFTS</u> plotting commands. This completes the generation of a 2-dimensional wheel model. Next, the 3-dimensional model of the wheel will be generated, based upon the 2-D model.

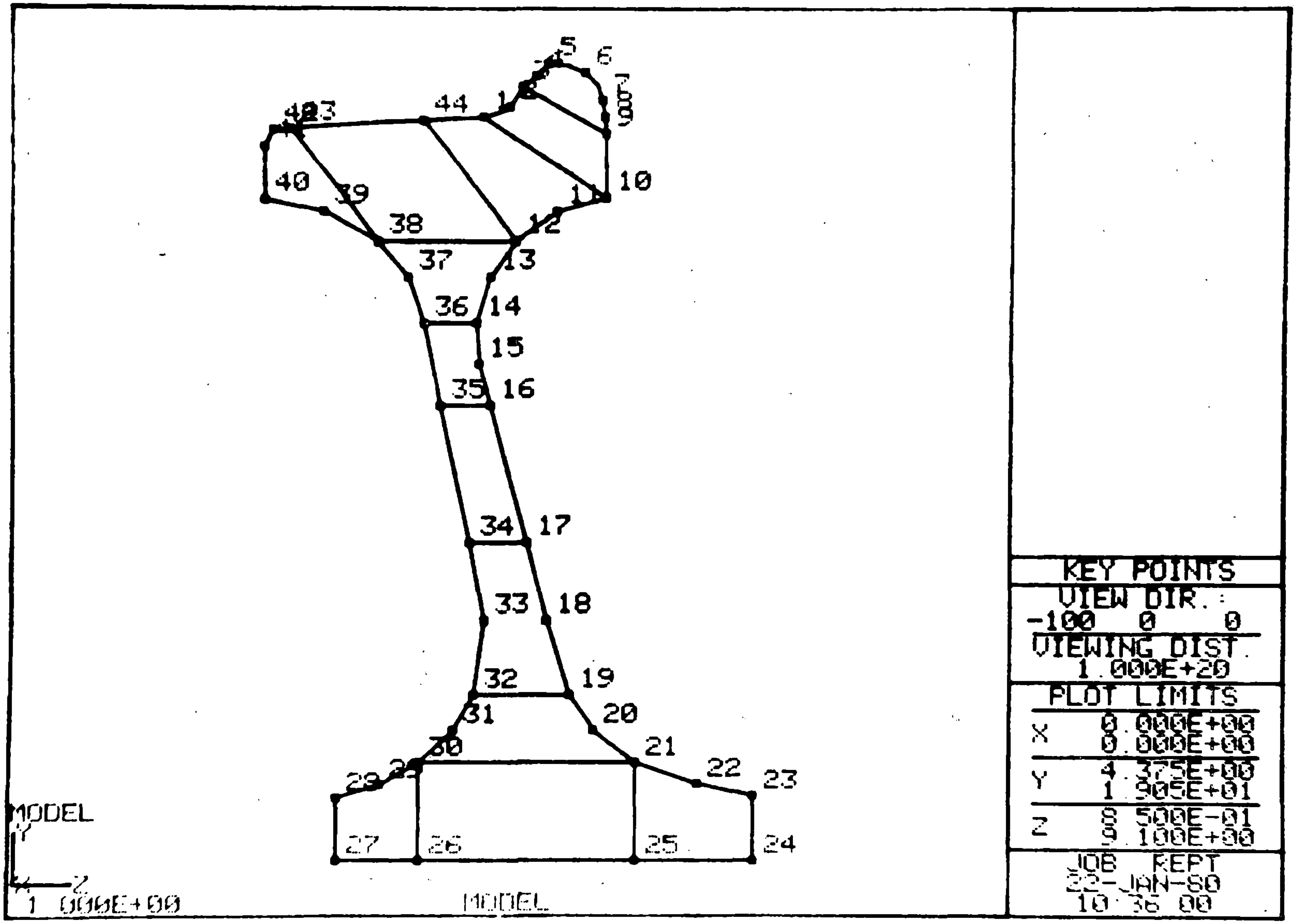

Figure 5. Basic 2-D Model of the Cross-section of a Wheel, Showing the Key Points.

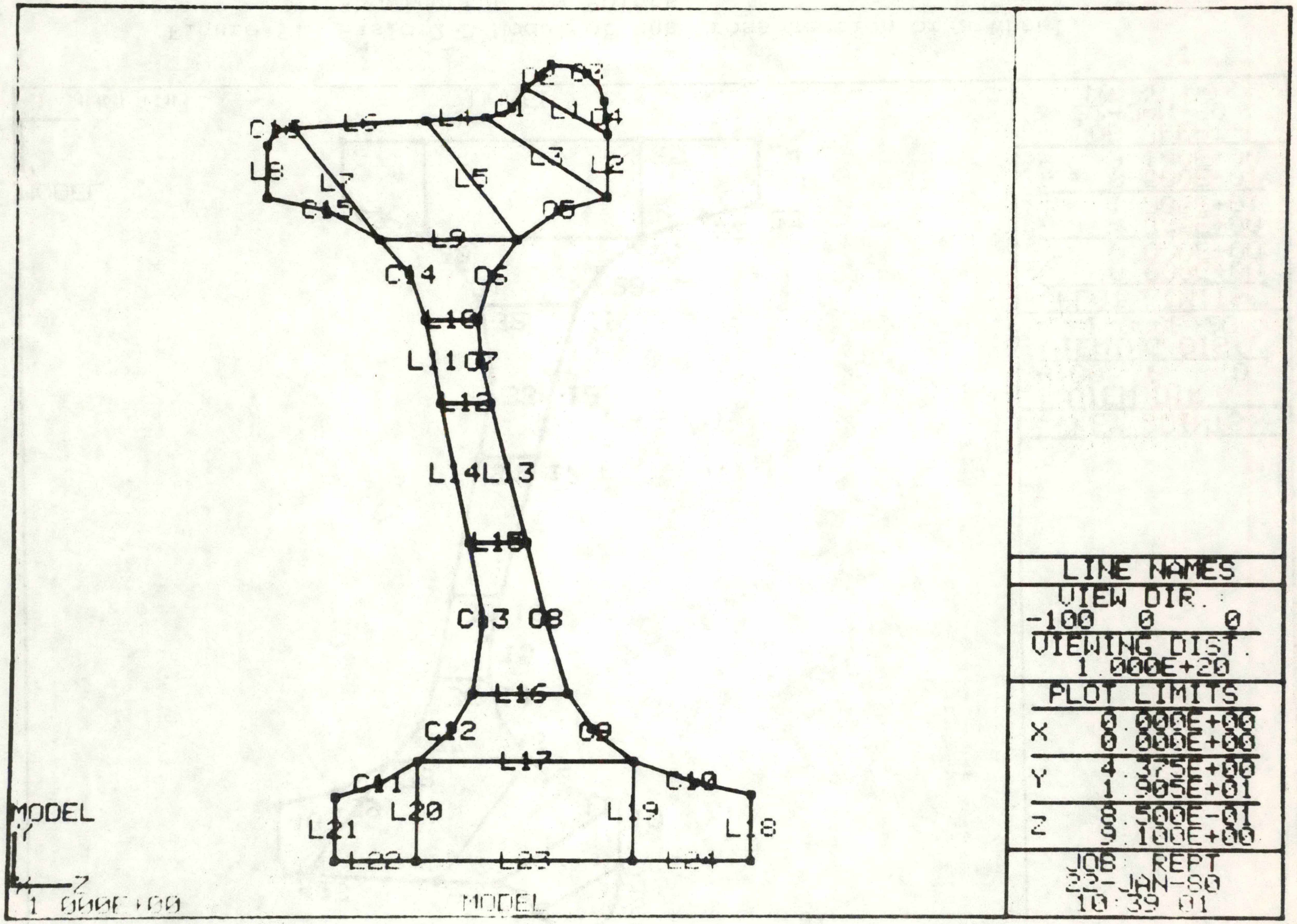

Figure 6. Basic 2-D Model of the Cross-section of a Wheel, Showing the Lines.

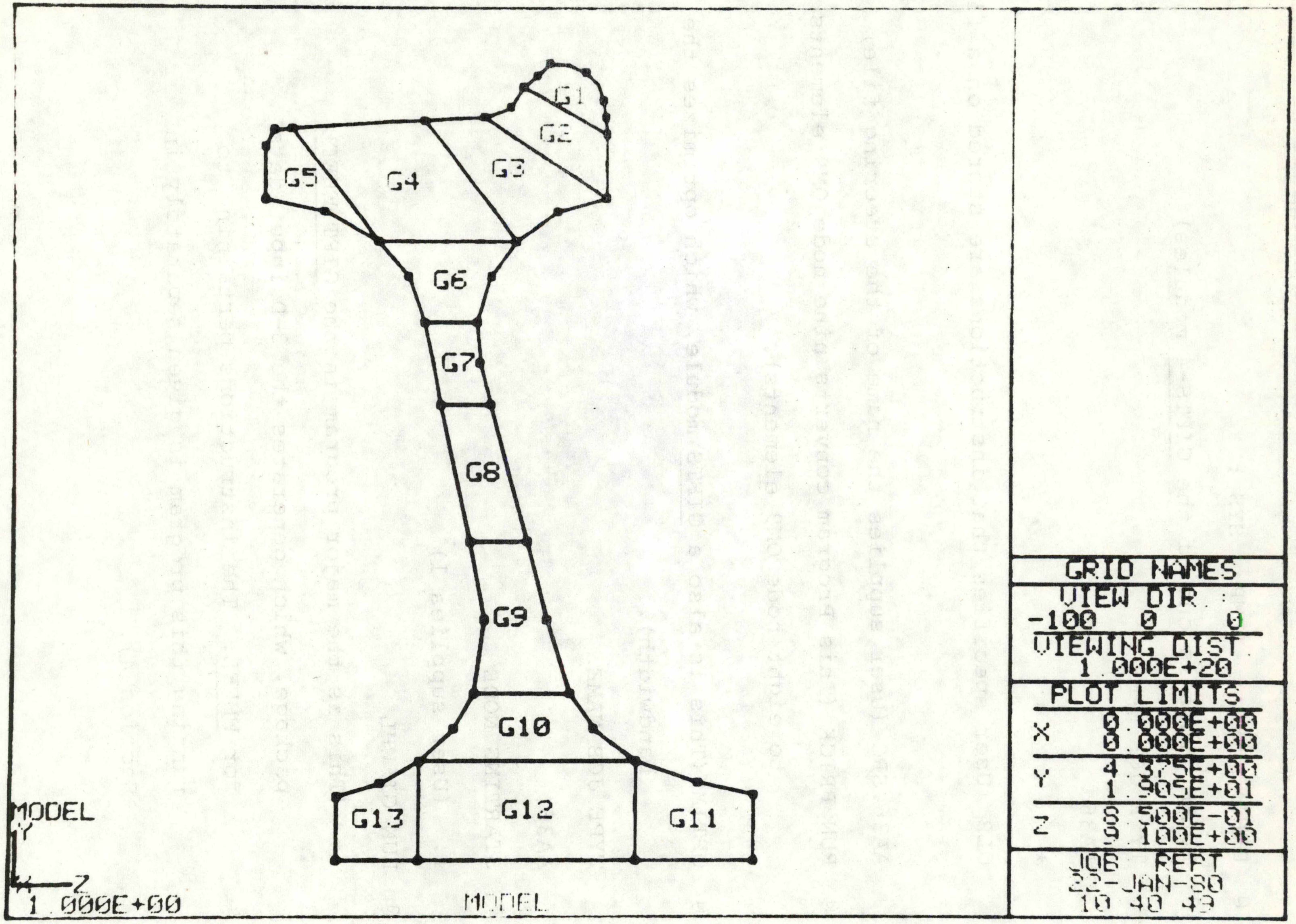

Figure 7. Basic 2-D Model of the Cross-section of a Wheel, Showing the Grids.

TABLE 2 Input Steps Required to Generate the Basic Wheel Model

@ DEFINE SYS : <TEMP>, SYS :

@ BULKM (This is one of the GIFTS-4 modules)

TYPE JOB NAME

AA36

*

OLB (User specifies that instructions are stored on a file)

>

AA36.SRC (User supplies the name of the steering file)

@ RUN BRICK (This Program converts nine node QM9 elements to eight node QM9 elements).

@ OPTIM (This is also a GIFTS module, which optimizes the bandwidth).

TYPE JOB NAME

AA36

STARTING NODE

1. (User supplies 1)

@ RUN GIFWHL

(This is the major program in the GIFT-WHEEL package, which generates the 3-D input data for WHEEL. The instructions pertaining to running this program is given separately in Section 4).

Table 3. Input and Output Steps Encountered During the Generation of the Basic 2-D Model of Wheel Cross-section.

```
@BULKM
7 @
   BULKM VD4B

TYPE JOB NAME
REPT

JOB REPT BEING CREATED
*
OLB

>
AA36

KPOINT
MSTEEL
ETH,1
SLINE
CARC
GETY

GRID4
END
*

QUIT

LINES BEING GENERATED:
L1
L2
L3
L4
L5
L6
L7
L8
L9
L10
L11
L12
L13
L14
L15
L16
L17
L18
L19
L20
L21
L22
L23
L24
C1
C2
C3
C4
C5
C6
C7
C8
C9
C10
C11
C12
C13
C14
C15
C16

GRIDS BEING GENERATED:
G1
G2
G3
G4
G5
G6
G7
G8
G9

G10
G11
G12
G13

ASSIGNING USER NUMBERS
STOP


END OF EXECUTION
CPU TIME: 16.50 ELAPSED TIME: 2:37.04
EXIT
```

TABLE 3 (Continued)

```
@RUN BRICK

          TYPE JNAME NAME - CORRESPONDING TO GIFTS 4-B

XXX

REPT

MAT        9     1     1     9      10
THS       17     1     1    17      10
PTS       16   112    10   160      16
ELT       20    38    10   200      10
LIN       22    28    10   220       5
GRD       25     9    10   250       5

END OF EXECUTION
CPU TIME: 10.76
EXIT


@OPTIM

OPTIM VD4B

TYPE JOB NAME
REPT

STARTING NODE
1

  153 NODES
   52 ELEMENTS

H.B.W. BEFORE AND AFTER
 HBW NEL
 912  25
 795  26
OPTIMIZATION TIME   5.662 SEC.
STOP

END OF EXECUTION
CPU TIME: 5.76
EXIT
@
```

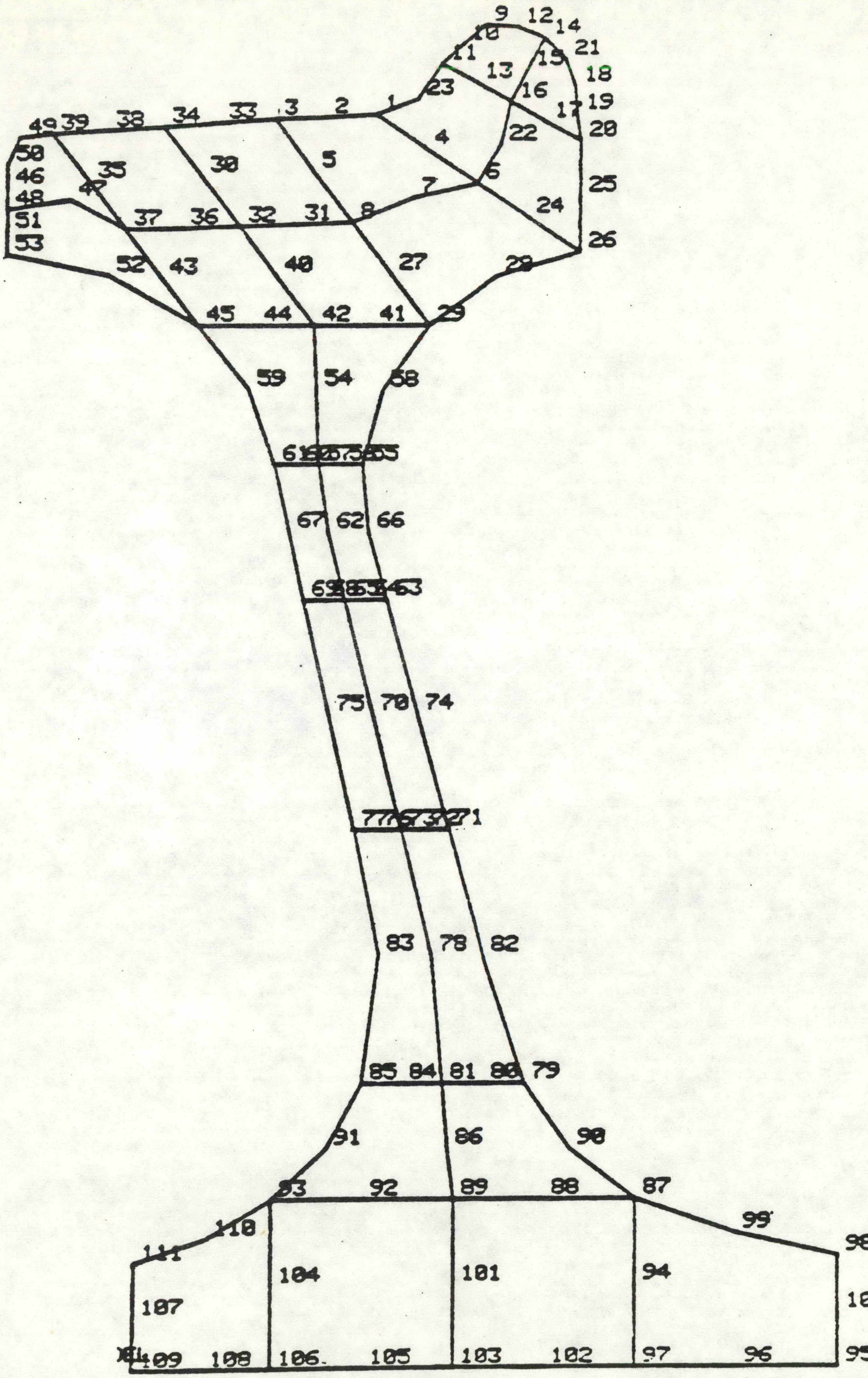

Figure 8. Final 2-D Model of the Wheel, with QM8 Elements.

4. CONSTRUCTION OF THE 3-D WHEEL MODEL

As stated earlier, the two dimensional model of the wheel is used as a base plane for constructing the 3-D model, and the theoretical aspects were discussed in Section 2. This Section describes the step-by-step procedure to run the GIFWHL program. First the various input and output prompts are listed in Section 4.1, in the way they are encountered while running the package in an interactive mode. These prompts are explained in Section 4.2 in connection with the wheel problems, for which the 2-D model was generated.

Figure 9 shows the angular locations of the midside and corner planes, needed as an input to the GIFWHL package. The output of this program represents the card images necessary to run the WHEEL program. They are stored in a file, (file name specified by the user) at the end of the run. The complete computer listing of this file is given in Appendix B.

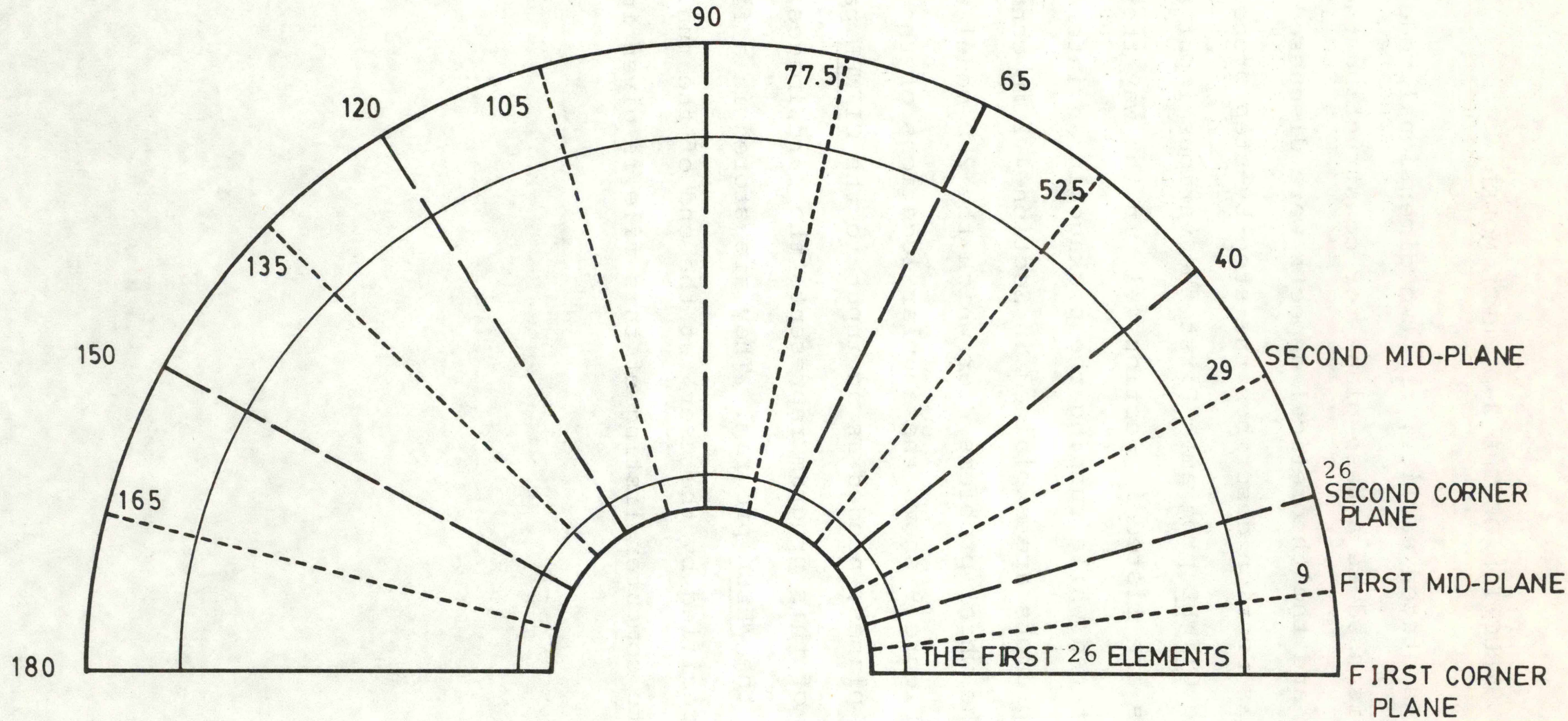

Figure 9. The Angular Locations of the Corner and Mid-Side Planes of the AA36 Wheel.

4.1 Interactive Running Mode of the GIFWHL Program

Computer Prompt Identifications

CONNECT (TO DIRECTORY) <BGIFTS>
Password:
@RUN IPAC

a. SUPPLY JOB NAME - CORRESPONDING TO GIFTS-4B : XXXX (4 CHARACTERS ONLY)
AA36

b. SUPPLY WHEEL HEADING (TITLE) CARD INFORMATION. THIS CARD IS USED TO DESCRIBE THE PARTICULAR PROBLEM

c. ANALYSIS OF A DUMMY WHEEL, AA36

SUPPLY NO. OF CORNER PLANES DESIRED BY THE USER TO BE GENERATED IN THE 3-D GRID (I2)
8

d. SUPPLY NO. OF MIDSIDE PLANES DESIRED BY THE USER TO BE GENERATED IN THE 3-D GRID (I2)
7

e. WHETHER THE ORIGIN OF THE (Y-Z) PLANE IS ON THE AXIS, OR ON THE BASE OF THE WHEEL:
IF ON THE AXIS, SUPPLY 0
IF ON THE BASE, SUPPLY 1
1

f. SUPPLY THE DISTANCE FROM THE AXIS TO THE BASE OF THE WHEEL (INCHES): F10.5.
4.5

INFORM WHETHER CORNER PLANES ARE EQUALLY SPACED CIRCUMFERENCIALLY: ENTER 1 FOR YES
ENTER 0 FOR NO
0

g. SUPPLY ANGULAR LOCATION OF CORNER PLANES, IN DEGREES:

FOR THE # 1 CORNER PLANE (F10.5)

0

FOR THE # 2 CORNER PLANE (F10.5)

18

FOR THE # 3 CORNER PLANE (F10.5)

40.

FOR THE # 4 CORNER PLANE (F10.5)

65.

FOR THE # 5 CORNER PLANE (F10.5)

90.

FOR THE # 6 CORNER PLANE (F10.5)

Computer
Prompt
Identifi-
cations (cont'd.)

120.

FOR THE # 7 CORNER PLANE (F10.5)

150.

FOR THE # 8 CORNER PLANE (F10.5)

180.

INFORM WHETHER MID-PLANES ARE HALFWAY BETWEEN TWO
CONSECUTIVE CORNER PLANES: ENTER 1 FOR YES
ENTER 0 FOR NO

0

h. SUPPLY ANGULAR LOCATION OF MIDSIDE PLANES, IN DEGREES:

FOR THE # 1 MIDSIDE PLANE (F10.5)

9.

FOR THE #2 MIDSIDE PLANE (F10.5)

29.

FOR THE # 3 MIDSIDE PLANE (F10.5)

52.5

FOR THE # 4 MIDSIDE PLANE (F10.5)

77.5

FOR THE #5 MIDSIDE PLANE (F10.5)

105.

FOR THE #6 MIDSIDE PLANE (F10.5)

135.

FOR THE #7 MIDSIDE PLANE (F10.5)

165.

i. SUPPLY OUTPUT FILE NAME FOR STORING THE GENERATED
INPUT INFORMATION FOR PROGRAM WHEEL (10 CHARACTERS)

WHEEL. INP

Computer
Prompt
Identifi-
cations (Cont'd.)

j. IP: THE PARAMETER THAT CONTROLS THE STRESS AND STRAIN QUANTITIES THAT APPEAR IN THE OUTPUT: FOR VARIOUS OPTIONS OF IP, SEE PAGE 14 OF WHEEL MANUAL*

ENTER IP:
1

k. IN: THE NUMBER OF INTEGRATION POINTS IN EACH OF THE THREE DIRECTIONS; SEE PAGES 16-17 OF THE WHEEL MANUAL**

ENTER IN:
0

l. ANALYSIS OF A DUMMY WHEEL, AA-36

INFORM WHETHER CORNER & MID PLANES ARE NUMBERED IN PROPER ORDER: ENTER 1 FOR YES
ENTER 0 FOR NO

1

m. SUPPLY THE ALPHANUMERIC TITLE BY WHICH THIS MODEL IS IDENTIFIED (20 CHARACTERS, MAXIMUM):
84 NODE WHEEL MODEL

n. SUPPLY THE PARAMETER WHICH CONTROLS THE GENERATION DECOMPOSITION & STORAGE OF THE MASTER STIFFNESS MATRIX

0

---

* IP=0: stresses/strains printed at the element centroid;
IP=1: stresses/strains printed at the element centroid and element nodes;
IP=2: stresses/strains printed at the element centroid, node points and Gaussian points;
IP=3: stresses/strains printed at the element centroid and Gaussian points.

** Can be 2, 3 or 4. When a 0 is entered, the built-in default value of 3 is selected. The value of 3 is recommended for any structure with curved boundaries.

Computer
Prompt
Identifi-
cations (Cont'd.)

o. ENTER THE NO.OF PRESCRIBED (NON-ZERO) DISPLACEMENTS ASSOCIATED WITH DISPLACEMENT LOADINGS AT UNCONSTRAINED POINTS

0

p. SUPPLY THE NO. OF COORDINATE ROTATIONAL MATRICES USED WITHIN THE FINITE-ELEMENT MODEL (SEE PAGES 4 & 8 OF THE WHEEL MANUAL.

0

q. SUPPLY NO.OF LOAD CASES (NMFOR) IN THE MODEL, FOR WHICH THE SOLUTION IS TO BE OBTAINED

1

r. SUPPLY THE NO.OF NODAL TEMP."IT" THAT ARE PART OF THIS LOAD CASE (SEE PAGE 19 OF THE WHEEL MANUAL) IF YOU SUPPLY AN EXTERNAL FILE AS INPUT, SET IT=1

0

s. SUPPLY THE NO. OF PRESSURES (NP) THAT ARE PART OF THIS LOAD CASE (SEE PAGE 19 OF THE WHEEL MANUAL)

0

t. SUPPLY THE OUTPUT MASS STORAGE OPTION (IQ) IF=0, NO STORAGE IS PROVIDED

0

u. SUPPLY THE LOAD CASE TITLE TO BE PRINTED WITH THE OUTPUT TO IDENTIFY THE LOAD CASE

CONCENTRATED LOAD AT NODE 7 CORNER PLANE #5

v. IN THE FOLLOWING QUERIES, SUPPLY THOSE FORCE OR DISPLACEMENTS WHICH ARE SPECIFIED ON A CORNER PLANE

SUPPLY THE ASSOCIATED CORNER PLANE # AT WHICH LOAD POINTS (FORCE OR DISP.) ARE LOCATED. IF NONE, ENTER ZERO

1

SUPPLY THE NODE # WHICH CORRESPONDS TO THE SAME POINT, BUT IN THE 2-D (0 DEG.) PLANE CONFIGURATION.

3

SUPPLY THE DIRECTION (DEGREE OF FREEDOM) IN WHICH THE LOAD IS APPLIED (ONE DIRECTION AT A TIME)

2

Computer
Prompt
Identifi-
cations (Cont'd.)

```
SUPPLY THE MAGNITUDE OF THE FORCE OR THE DISP.
APPLIED IN THAT DIRECTION, (F10.5)

      -32875.0

SUPPLY THE ASSOCIATED CORNER PLANE # AT WHICH
LOAD POINTS (FORCE OR DISP.) ARE LOCATED. IF
NONE, ENTER ZERO

      0

IN THE FOLLOWING QUERIES, SUPPLY THOSE FORCES OR
DISPLACEMENTS WHICH ARE SPECIFIED ON A MIDSIDE
PLANE

SUPPLY THE ASSOCIATED MID-PLANE # AT WHICH LOAD
POINTS (FORCE OR DISP.) ARE LOCATED. IF NONE,
ENTER ZERO

      0

      END OF WHEEL INTERFACE

      END OF EXECUTION
      CPU TIME: 14.19
```

4.2 Notes on the Computer Prompts in Section 4.1

Section 4.1 gives all of the computer prompts, which are marked alphabetically in small letters (a,b,c,---). This Section explains these prompts in more detail, and lists some of the options which can be used. The illustrated answers to the prompts given in Section 4.1 simply demonstrate the use of the GIFWHL package in a typical case. A different set of prompts should be expected, if the user chooses options that are different than those shown in Section 4.1. The possible replies to such prompts are discussed here, and alternatives to be followed are suggested.

a. This is the job name assigned to generate the basic model in GIFTS-4. The job name is used in the IPAC-GIFTS system as part of the file identifier. Typically, a file name is made up of two parts. The first part is identical to the job name, and the second part (called the extension) describes the quality of the data.

b. This is the title card. Up to eighty alphanumeric characters can be used to describe the problem being solved.

c. The technique used to generate the three-dimensional grid is to rotate a cross-sectional plane of the wheel about the axis of the wheel. The user-supplied 2-D grid is considered to be the first corner plane for a 3-D system, which is repeated at several angular locations, specified by the angles (in degrees). Several corner planes are therefore indicated, which create the half (180°) or full wheel (360°) model of the wheel. Two adjacent corner planes form a pie-shaped, 3-D sector, as shown in Figure 3. A midside plane is later defined as being located anywhere between two adjacent corner planes.

In the case of a half-wheel model, the number of midside planes are one less than the number of corner planes. In the case of a full-wheel model, they are equal.

d. See Part c.

e. In constructing the 2-D model, which represents the 0^{o} corner plane, the user has two options: (i) to use a coordinate system whose orgin is at the axis of the wheel. In this case, the query in (f) will not be asked; or (ii) to use a coordinate system whose origin lies along the line, coinciding with the inner diameter of the wheel. In this case, the query in (f) will be asked.

f. If the second option in Part (e) is used, the user should specify the distance between the axis and the inner diameter (i.e., base) of the wheel, in inches.

g. As mentioned in Part (c), the angular location of each corner plane has to be specified, in degrees. They are read in, sequentially, in this step.

h. In this section, the user is asked to supply the angular locations of the midside planes. If the user desires that the midside plane be located midway between the two adjacent corner planes, he should hit the "Return" key after each of the computer prompts. The <u>IPAC</u> will automatically generate the required angular locations.

i. At this point, the user supplies the file name (maximum of ten characters) for storing the generated information (card images) for the WHEEL program.

j. For details, see page 14 of the WHEEL manual.

k. For details, see pages 16-17 of the WHEEL manual.

l. The midside and corner planes are to be numbered (for purposes of identification) in a cyclic order, starting with the mid-plane, closest to the first corner plane. The user is, however, not restricted to following the above system, in which case the midside plane numbers, for each pie-shaped sector, should then be specified individually. The proper ordering scheme has the advantage of eliminating some of the user inputs.

m. This is the alphanumeric title (maximum of 20 characters) by which the model is identified within this program, the output is stored and the files saved for later use.

n. The parameter 'ISAVE" controls the generation, decomposition and storage of the master stiffness matrix for the structure.

If 'ISAVE' = 0, the stiffness is generated and decomposed, and the particular load case(s), which are to be read in, are solved.

If 'ISAVE' = 1, the stiffness is generated, decomposed and stored on tape, and the particular load case(s), which are to be read in, are solved. In this particular case, an output device, called 'ITAPE,' needs to be requested among the Job Control Cards. The decomposed stiffness is stored on 'TAPE 1'.

If 'ISAVE' = 2, the stiffness matrix is generated, decomposed, and stored. It is anticipated that the load case(s) will be supplied during a later run, therefore, no load-related data is furnished within this run. Here again, 'TAPE 1' needs to be requested among the Job Control Cards, since the decomposed stiffness matrix is stored in "TAPE 1.'

If 'ISAVE' = 1, the decomposed stiffness matrix that was stored on 'TAPE 1' during a previous run is utilized to solve the load case(s) to be read in during this run. In this case, 'TAPE 1' needs to be attached, and the Job Control Cards should contain such instructions. Also for this particular case, none of the cards between this card and the LOAD DATA SIZING card [3] should be read in. The ID on this run must be the same as in the run that generated the stiffness matrix. If this option of 'ISAVE' is selected, the rest of the input variables on this card are ignored.

o. The number "NGDISP' for the given (non-zero) displacement conditions are usually associated with prescribed displacements at the nodes. This card can be supplied at any node for any direction, provided the degree of freedom in that direction is not constrained. The method of enumeration is governed by the total number of directions (degrees-of-freedom), along which the displacements are specified. For example, if displacements at node 15 are specified in the x and z directions, these conditions will count towards the 'NGDISP' number. If the displacement at node 15 is specified in the z direction only, then the contribution of node 15 towards the count for 'NGDISP' will be only 1.

p. The number of coordinate rotational matrices 'NRM,' used within the finite-element model, are supplied in this section. The rotational matrices are necessary, if a point is to be constrained in (a) direction(s) other than the global axis direction(s).

q. This input specifies the number of load cases to be applied to the model during the analysis. The load(s) can be either mechanical, thermal, or both.

r. The number of nodal temperatures that are part of this load case are defined here. 'IT' is a parameter which controls the various options available with the WHEEL program.

- IT=0: means that the loading does not involve any temperature forces.
- IT < Number of Nodes: means that not all the nodes in the finite-element mesh are subjected to temperatures, different from the ambient temperature.
- IT = Number of Nodal Points: means that all of the nodal points in the finite-element grid are subjected to a temperature rise of differing magnitudes.
- IT = -1: means that all of the nodes in the mesh are subjected to a constant temperature rise.
- IT = 1: indicates that nodal temperature data are to be read from another file. On the next prompt from IPAC, the user supplies the name of that file. The data on the temperature file should be arranged in the order shown below:

Columns;

Node N_1	Temperature Change T_1	Node N_2	Temperature Change T_2

If the parameter 'IT' is specified as a negative number, no numbers need be punched for N, and only a single entry is required for T_1 to indicate the uniform temperature change. If the parameter 'IT' is equal to the number of nodal points (NNODE) in the model, the entries for the nodal points in this card set are not required; however, the nodal temperature changes have to be strictly sequential and in the ascending order of the nodal numbers, in an 8E10.3 format per card.

s. The number of pressures 'NP' that are a part of this load case, are inputted here. Each pressure value on a single face of an element counts as 1 towards the NP number. The face has to correspond to one of the faces defined by the WHEEL program.

t. The output mass storage options 'IQ' are identified here. The identifier is used to indicate that the output quantities, in addition to being printed, have to be stored on a magnetic tape or permanent file device, whichever is requested in the Job Control Card Stream. The storage device has to be declared as 'TAPE 4.' Any value of 'IQ' different from 0 will cause the program to try to store the output quantities on 'TAPE 4.' If IQ = 0, no storage will be attempted. Storage of the output on a file is usually required, if it is to be further processed, e.g., to obtain graphical plots. If the output is stored on 'TAPE 4,' it is identified by the ID appearing on Item (m).

u. This is title (comment) information, that is printed within the program's output to identify the loading case. The title that is printed is exactly the same as it appears on this card. A maximum of 60 alphanumeric characters (15A4) are allowed.

v. In the case of mechanical loadings, situations arise when loads are applied in a direction different from the global x, y and z directions, and at a point which might correspond to an interior node of 20-node isoparametric elements. Since nodes of an isoparametric element are generated by rotating a 2-D zero degree plane, it is possible in the interface package to identify a node in the 3-D system by its image on the 2-D plane, and the associated plane number (midside or corner). The process of applying the loadings follows this concept: the user is asked to supply the image location of the load on the 2-D (1st corner plane), and if the point is situated on a mid-side plane, the user is asked to supply the image location of the corresponding point on the first midside plane.

Relevant information, like the associated plane number and direction (degrees-of-freedom), in which the load is applied, and its magnitude (lbs.), are also to be specified.

w. The considerations shown in (v) are repeated here for the case of midside plane loads. It is to be noted that if no load exists, or if no more load inputs are desired, the inputting process for load generations can be terminated by hitting the "RETURN" key <u>once</u>.

5. CONCLUDING REMARKS

The GIFTS-WHEEL interface program is suitable for cost-effective generation of input data for the WHEEL finite-element program in a production environment. Its use in the earliest stages of the generation of railroad car wheel models, and with structures involving isoparametric elements, has resulted in input data generations for complex structural models in a variety of applications. Efficient computer processing, data management and user-oriented features have reduced the cost and flowtime for creating inputs to finite-element programs. Continuing developments and wider applications would help to define the requirements for extending IPAC's capabilities and the associated user interface into a more complete, unified utility package, for performing accurate and timely model-development tasks.

6. REFERENCES

1. Bathe, K.J., Wilson, E.L., and Peterson, F.E., "SAPV - A Structural Analysis Program for Static and Dynamic Response of Linear Systems," Report No. EERC 73-11, University of California, Berkeley, April 1974 (Revised).

2. Dunder, V., and Ridlon, S., "Practical Applications of Finite Element Method," J. of Structural Division, ASCE, January 1978, pp. 9-22.

3. Sampath, S.G., "WHEEL-Users Manual," Battelle-Columbus Laboratories, Columbus, Ohio, October 1977.

4. Felippa, C.A., "Data Base Management in Scientific Computing-I, General Description," Computers and Structures, Vol. 10, 1978, pp. 53-61.

5. Kamel, H.A., and McCabe, M.W., "GIFTS-4 User's Manual-Graphics Oriented Interactive Finite Element Time Sharing System," University of Arizona, Tuscon, 1976.

6. Swanson, J.A., "Present Trends in Computerized Structural Analysis," Computers and Structures, Vol. 10, 1978, pp. 33-37.

7. Dreisbach, R.L., and Giles, G.L., "The ATLAS Integrated Structural Analysis and Design Software System," NASA Conference Publication 2059, 1978.

8. Giles, G.L., and Haftka, R.T., "SPAR Data Handling Utilities," NASA Report TM 78701, September, 1978,

APPENDIX

GENERATED INPUT DATA FROM GIFWHL

INTERFACE PACKAGE

```
AA36 DUMMY WHEEL
AA  36                     1 1189  182  311     0     1     0
    1     1     2     1     3     1     4     1     5     1     6     1     7     1     8     1
    9     1    10     1    11     1    12     1    13     1    14     1    15     1    16     1
   17     1    18     1    19     1    20     1    21     1    22     1    23     1    24     1
   25     1    26     1    27     1    28     1    29     1    30     1    31     1    32     1
   33     1    34     1    35     1    36     1    37     1    38     1    39     1    40     1
   41     1    42     1    43     1    44     1    45     1    46     1    47     1    48     1
   49     1    50     1    51     1    52     1    53     1    54     1    55     1    56     1
   57     1    58     1    59     1    60     1    61     1    62     1    63     1    64     1
   65     1    66     1    67     1    68     1    69     1    70     1    71     1    72     1
   73     1    74     1    75     1    76     1    77     1    78     1    79     1    80     1
   81     1    82     1    83     1    84     1    85     1    86     1    87     1    88     1
   89     1    90     1    91     1    92     1    93     1    94     1    98     1    99     1
  100     1   101     1   104     1   107     1   110     1   111     1    95     0    96     0
   97     0   102     0   103     0   105     0   106     0   108     0   109     0   148     0
  149     0   151     0   152     0   153     0   249     0   250     0   251     0   256     0
  257     0   259     0   260     0   262     0   263     0   302     0   303     0   305     0
  306     0   307     0   403     0   404     0   405     0   410     0   411     0   413     0
  414     0   416     0   417     0   456     0   457     0   459     0   460     0   461     0
  557     0   558     0   559     0   564     0   565     0   567     0   568     0   570     0
  571     0   610     0   611     0   613     0   614     0   615     0   711     0   712     0
  713     0   718     0   719     0   721     0   722     0   724     0   725     0   764     0
  765     0   767     0   768     0   769     0   865     0   866     0   867     0   872     0
  873     0   875     0   876     0   878     0   879     0   918     0   919     0   921     0
  922     0   923     0  1019     0  1020     0  1021     0  1026     0  1027     0  1029     0
 1030     0  1032     0  1033     0  1072     0  1073     0  1075     0  1076     0  1077     0
 1173     0  1174     0  1175     0  1180     0  1181     0  1183     0  1184     0  1186     0
 1187     0  1079     1  1080     1  1081     1  1082     1  1083     1  1084     1  1085     1
 1086     1  1087     1  1088     1  1089     1  1090     1  1091     1  1092     1  1093     1
 1094     1  1095     1  1096     1  1097     1  1098     1  1099     1  1100     1  1101     1
 1102     1  1103     1  1104     1  1105     1  1106     1  1107     1  1108     1  1109     1
 1110     1  1111     1  1112     1  1113     1  1114     1  1115     1  1116     1  1117     1
 1118     1  1119     1  1120     1  1121     1  1122     1  1123     1  1124     1  1125     1
 1126     1  1127     1  1128     1  1129     1  1130     1  1131     1  1132     1  1133     1
 1134     1  1135     1  1136     1  1137     1  1138     1  1139     1  1140     1  1141     1
 1142     1  1143     1  1144     1  1145     1  1146     1  1147     1  1148     1  1149     1
 1150     1  1151     1  1152     1  1153     1  1154     1  1155     1  1156     1  1157     1
 1158     1  1159     1  1160     1  1161     1  1162     1  1163     1  1164     1  1165     1
 1166     1  1167     1  1168     1  1169     1  1170     1  1171     1  1172     1  1176     1
 1177     1  1178     1  1179     1  1182     1  1185     1  1188     1  1189     1
    1.29000E+08.30000E+00.67000E-05
    1    0.00000   18.05000    4.50000
    2    0.00000   18.02500    4.00000
    3    0.00000   18.00000    3.50000
    4    0.00000   17.67500    5.01500
    5    0.00000   17.43750    3.88750
    6    0.00000   17.30000    5.53000
    7    0.00000   17.14566    4.88280
    8    0.00000   16.87500    4.27500
    9    0.00000   19.05000    5.60000
```

10	0.00000	18.83756	5.37750
11	0.00000	18.62000	5.16000
12	0.00000	19.03779	5.91305
13	0.00000	18.40250	5.51000
14	0.00000	18.90311	6.19591
15	0.00000	18.54496	6.02580
16	0.00000	18.18500	5.86000
17	0.00000	17.96750	6.21000
18	0.00000	18.37000	6.50000
19	0.00000	18.05984	6.52997
20	0.00000	17.75000	6.56000
21	0.00000	18.66780	6.40273
22	0.00000	17.71533	5.76787
23	0.00000	18.22631	4.92387
24	0.00000	16.92500	6.04500
25	0.00000	17.15000	6.56000
26	0.00000	16.55000	6.56000
27	0.00000	16.31250	4.66250
28	0.00000	16.28996	5.73085
29	0.00000	15.75000	5.05000
30	0.00000	17.38125	2.77500
31	0.00000	16.85625	3.71250
32	0.00000	16.83750	3.15000
33	0.00000	17.96250	2.95000
34	0.00000	17.92500	2.40000
35	0.00000	17.32500	1.66250
36	0.00000	16.81875	2.58750
37	0.00000	16.80000	2.02500
38	0.00000	17.88750	1.85000
39	0.00000	17.85000	1.30000
40	0.00000	16.29375	3.52500
41	0.00000	15.75000	4.47500
42	0.00000	15.75000	3.90000
43	0.00000	16.27500	2.38750
44	0.00000	15.75000	3.32500
45	0.00000	15.75000	2.75000
46	0.00000	17.25750	0.85000
47	0.00000	17.12100	1.47657
48	0.00000	17.01500	0.85000
49	0.00000	17.80275	0.97564
50	0.00000	17.50000	0.85000
51	0.00000	16.77250	0.85000
52	0.00000	16.29106	1.86201
53	0.00000	16.53000	0.85000
54	0.00000	15.06101	3.93327
55	0.00000	14.25000	4.40000
56	0.00000	14.25000	4.18000
57	0.00000	14.25000	3.96000
58	0.00000	15.05431	4.59966
59	0.00000	15.06770	3.26688
60	0.00000	14.25000	3.74000
61	0.00000	14.25000	3.52000

62	0.00000	13.49513	4.05574
63	0.00000	12.75000	4.63000
64	0.00000	12.75000	4.42250
65	0.00000	12.75000	4.21500
66	0.00000	13.49026	4.45148
67	0.00000	13.50000	3.66000
68	0.00000	12.75000	4.00750
69	0.00000	12.75000	3.80000
70	0.00000	11.50000	4.49500
71	0.00000	10.25000	5.25000
72	0.00000	10.25000	5.01250
73	0.00000	10.25000	4.77500
74	0.00000	11.50000	4.94000
75	0.00000	11.50000	4.05000
76	0.00000	10.25000	4.53750
77	0.00000	10.25000	4.30000
78	0.00000	8.87369	5.07235
79	0.00000	7.50000	6.00000
80	0.00000	7.50000	5.59250
81	0.00000	7.50000	5.18500
82	0.00000	8.86693	5.59538
83	0.00000	8.88046	4.54933
84	0.00000	7.50000	4.77750
85	0.00000	7.50000	4.37000
86	0.00000	6.80020	5.23860
87	0.00000	6.25000	7.10000
88	0.00000	6.25000	6.19500
89	0.00000	6.25000	5.29000
90	0.00000	6.79317	6.45701
91	0.00000	6.80722	4.02019
92	0.00000	6.25000	4.38500
93	0.00000	6.25000	3.48000
94	0.00000	5.31250	7.10000
95	0.00000	4.37500	9.10000
96	0.00000	4.37500	8.10000
97	0.00000	4.37500	7.10000
98	0.00000	5.62000	9.10000
99	0.00000	5.87169	8.08006
100	0.00000	4.99750	9.10000
101	0.00000	5.31250	5.29000
102	0.00000	4.37500	6.19500
103	0.00000	4.37500	5.29000
104	0.00000	5.31250	3.48000
105	0.00000	4.37500	4.38500
106	0.00000	4.37500	3.48000
107	0.00000	4.97250	2.12000
108	0.00000	4.37500	2.80000
109	0.00000	4.37500	2.12000
110	0.00000	5.83399	2.83800
111	0.00000	5.57000	2.12000
112	3.90674	17.62214	4.50000
113	3.89591	17.57333	3.50000

114	3.74441	16.88992	5.53000
115	3.65242	16.47500	4.27500
116	4.12317	18.59844	5.60000
117	4.03011	18.17863	5.16000
118	4.09138	18.45503	6.19591
119	3.93595	17.75394	5.86000
120	3.97600	17.93456	6.50000
121	3.84180	17.32925	6.56000
122	3.58208	16.15770	6.56000
123	3.40892	15.37666	5.05000
124	3.64430	16.43838	3.15000
125	3.87968	17.50011	2.40000
126	3.63619	16.40177	2.02500
127	3.86345	17.42688	1.30000
128	3.40892	15.37666	3.90000
129	3.40892	15.37666	2.75000
130	3.68272	16.61168	0.85000
131	3.78769	17.08518	0.85000
132	3.57775	16.13817	0.85000
133	3.08426	13.91222	4.40000
134	3.08426	13.91222	3.96000
135	3.08426	13.91222	3.52000
136	2.75961	12.44777	4.63000
137	2.75961	12.44777	4.21500
138	2.75961	12.44777	3.80000
139	2.21851	10.00703	5.25000
140	2.21851	10.00703	4.77500
141	2.21851	10.00703	4.30000
142	1.62330	7.32222	6.00000
143	1.62330	7.32222	5.18500
144	1.62330	7.32222	4.37000
145	1.35275	6.10185	7.10000
146	1.35275	6.10185	5.29000
147	1.35275	6.10185	3.48000
148	0.94692	4.27130	9.10000
149	0.94692	4.27130	7.10000
150	1.21639	5.48678	9.10000
151	0.94692	4.27130	5.29000
152	0.94692	4.27130	3.48000
153	0.94692	4.27130	2.12000
154	1.20557	5.43797	2.12000
155	7.62826	16.35886	4.50000
156	7.61769	16.33620	4.00000
157	7.60713	16.31354	3.50000
158	7.46978	16.01899	5.01500
159	7.36941	15.80374	3.88750
160	7.31130	15.67912	5.53000
161	7.24607	15.53925	4.88280
162	7.13168	15.29394	4.27500
163	8.05088	17.26516	5.60000
164	7.96110	17.07263	5.37750
165	7.86915	16.87545	5.16000

166	8.04572	17.25410	5.91305
167	7.77723	16.67833	5.51000
168	7.98880	17.13204	6.19591
169	7.83744	16.80744	6.02580
170	7.68531	16.48121	5.86000
171	7.59339	16.28409	6.21000
172	7.76350	16.64887	6.50000
173	7.63242	16.36777	6.52997
174	7.50147	16.08696	6.56000
175	7.88935	16.91878	6.40273
176	7.48682	16.05554	5.76787
177	7.70277	16.51865	4.92387
178	7.15281	15.33926	6.04500
179	7.24790	15.54318	6.56000
180	6.99433	14.99939	6.56000
181	6.89396	14.78415	4.66250
182	6.88444	14.76372	5.73085
183	6.65624	14.27435	5.05000
184	7.34563	15.75276	2.77500
185	7.12376	15.27695	3.71250
186	7.11584	15.25996	3.15000
187	7.59128	16.27955	2.95000
188	7.57543	16.24557	2.40000
189	7.32186	15.70178	1.66250
190	7.10791	15.24296	2.58750
191	7.09999	15.22597	2.02500
192	7.55958	16.21158	1.85000
193	7.54374	16.17759	1.30000
194	6.88604	14.76715	3.52500
195	6.65624	14.27435	4.47500
196	6.65624	14.27435	3.90000
197	6.87811	14.75016	2.38750
198	6.65624	14.27435	3.32500
199	6.65624	14.27435	2.75000
200	7.29333	15.64061	0.85000
201	7.23565	15.51689	1.47657
202	7.19085	15.42083	0.85000
203	7.52377	16.13477	0.97564
204	7.39582	15.86039	0.85000
205	7.08836	15.20105	0.85000
206	6.88490	14.76471	1.86201
207	6.98588	14.98127	0.85000
208	6.36506	13.64991	3.93327
209	6.02231	12.91489	4.40000
210	6.02231	12.91489	4.18000
211	6.02231	12.91489	3.96000
212	6.36223	13.64384	4.59966
213	6.36788	13.65597	3.26688
214	6.02231	12.91489	3.74000
215	6.02231	12.91489	3.52000
216	5.70329	12.23074	4.05574
217	5.38838	11.55542	4.63000

218	5.38838	11.55542	4.42250
219	5.38838	11.55542	4.21500
220	5.70123	12.22633	4.45148
221	5.70535	12.23516	3.66000
222	5.38838	11.55542	4.00750
223	5.38838	11.55542	3.80000
224	4.86011	10.42254	4.49500
225	4.33184	9.28965	5.25000
226	4.33184	9.28965	5.01250
227	4.33184	9.28965	4.77500
228	4.86011	10.42254	4.94000
229	4.86011	10.42254	4.05000
230	4.33184	9.28965	4.53750
231	4.33184	9.28965	4.30000
232	3.75018	8.04229	5.07235
233	3.16964	6.79731	6.00000
234	3.16964	6.79731	5.59250
235	3.16964	6.79731	5.18500
236	3.74733	8.03616	5.59538
237	3.75304	8.04843	4.54933
238	3.16964	6.79731	4.77750
239	3.16964	6.79731	4.37000
240	2.87389	6.16307	5.23860
241	2.64136	5.66442	7.10000
242	2.64136	5.66442	6.19500
243	2.64136	5.66442	5.29000
244	2.87092	6.15670	6.45701
245	2.87686	6.16944	4.02019
246	2.64136	5.66442	4.38500
247	2.64136	5.66442	3.48000
248	2.24516	4.81476	7.10000
249	1.84895	3.96510	9.10000
250	1.84895	3.96510	8.10000
251	1.84895	3.96510	7.10000
252	2.37511	5.09345	9.10000
253	2.48148	5.32156	8.08006
254	2.11203	4.52927	9.10000
255	2.24516	4.81476	5.29000
256	1.84895	3.96510	6.19500
257	1.84895	3.96510	5.29000
258	2.24516	4.81476	3.48000
259	1.84895	3.96510	4.38500
260	1.84895	3.96510	3.48000
261	2.10147	4.50662	2.12000
262	1.84895	3.96510	2.80000
263	1.84895	3.96510	2.12000
264	2.46555	5.28739	2.83800
265	2.35398	5.04813	2.12000
266	10.98814	14.32003	4.50000
267	10.95771	14.28036	3.50000
268	10.53157	13.72501	5.53000
269	10.27285	13.38784	4.27500

270	11.59691	15.11338	5.60000
271	11.33514	14.77224	5.16000
272	11.50749	14.99685	6.19591
273	11.07033	14.42713	5.86000
274	11.18295	14.57390	6.50000
275	10.80552	14.08202	6.56000
276	10.07500	13.13000	6.56000
277	9.58799	12.49532	5.05000
278	10.25002	13.35809	3.15000
279	10.91205	14.22086	2.40000
280	10.22719	13.32834	2.02500
281	10.86639	14.16136	1.30000
282	9.58799	12.49532	3.90000
283	9.58799	12.49532	2.75000
284	10.35808	13.49891	0.85000
285	10.65332	13.88368	0.85000
286	10.06283	13.11413	0.85000
287	8.67485	11.30529	4.40000
288	8.67485	11.30529	3.96000
289	8.67485	11.30529	3.52000
290	7.76171	10.11526	4.63000
291	7.76171	10.11526	4.21500
292	7.76171	10.11526	3.80000
293	6.23980	8.13187	5.25000
294	6.23980	8.13187	4.77500
295	6.23980	8.13187	4.30000
296	4.56571	5.95015	6.00000
297	4.56571	5.95015	5.18500
298	4.56571	5.95015	4.37000
299	3.80476	4.95846	7.10000
300	3.80476	4.95846	5.29000
301	3.80476	4.95846	3.48000
302	2.66333	3.47092	9.10000
303	2.66333	3.47092	7.10000
304	3.42124	4.45865	9.10000
305	2.66333	3.47092	5.29000
306	2.66333	3.47092	3.48000
307	2.66333	3.47092	2.12000
308	3.39080	4.41898	2.12000
309	13.82710	11.60232	4.50000
310	13.80795	11.58625	4.00000
311	13.78880	11.57018	3.50000
312	13.53984	11.36127	5.01500
313	13.35790	11.20861	3.88750
314	13.25257	11.12023	5.53000
315	13.13434	11.02102	4.88280
316	12.92700	10.84704	4.27500
317	14.59315	12.24510	5.60000
318	14.43041	12.10855	5.37750
319	14.26375	11.96871	5.16000
320	14.58379	12.23725	5.91305
321	14.09713	11.82890	5.51000

322	14.48062	12.15069	6.19591
323	14.20626	11.92047	6.02580
324	13.93052	11.68909	5.86000
325	13.76390	11.54929	6.21000
326	14.07224	11.80801	6.50000
327	13.83464	11.60864	6.52997
328	13.59729	11.40948	6.56000
329	14.30037	11.99943	6.40273
330	13.57073	11.38719	5.76787
331	13.96216	11.71565	4.92387
332	12.96530	10.87918	6.04500
333	13.13766	11.02381	6.56000
334	12.67804	10.63814	6.56000
335	12.49610	10.48547	4.66250
336	12.47884	10.47099	5.73085
337	12.06520	10.12391	5.05000
338	13.31481	11.17245	2.77500
339	12.91264	10.83499	3.71250
340	12.89827	10.82294	3.15000
341	13.76007	11.54607	2.95000
342	13.73135	11.52197	2.40000
343	13.27172	11.13630	1.66250
344	12.88391	10.81088	2.58750
345	12.86955	10.79883	2.02500
346	13.70262	11.49786	1.85000
347	13.67389	11.47376	1.30000
348	12.48174	10.47342	3.52500
349	12.06520	10.12391	4.47500
350	12.06520	10.12391	3.90000
351	12.46737	10.46137	2.38750
352	12.06520	10.12391	3.32500
353	12.06520	10.12391	2.75000
354	13.22001	11.09291	0.85000
355	13.11544	11.00516	1.47657
356	13.03425	10.93703	0.85000
357	13.63770	11.44339	0.97564
358	13.40578	11.24878	0.85000
359	12.84848	10.78116	0.85000
360	12.47967	10.47169	1.86201
361	12.66271	10.62528	0.85000
362	11.53740	9.68103	3.93327
363	10.91613	9.15972	4.40000
364	10.91613	9.15972	4.18000
365	10.91613	9.15972	3.96000
366	11.53227	9.67673	4.59966
367	11.54253	9.68533	3.26688
368	10.91613	9.15972	3.74000
369	10.91613	9.15972	3.52000
370	10.33787	8.67450	4.05574
371	9.76707	8.19554	4.63000
372	9.76707	8.19554	4.42250
373	9.76707	8.19554	4.21500

374	10.33414	8.67137	4.45148
375	10.34160	8.67763	3.66000
376	9.76707	8.19554	4.00750
377	9.76707	8.19554	3.80000
378	8.80951	7.39206	4.49500
379	7.85196	6.58857	5.25000
380	7.85196	6.58857	5.01250
381	7.85196	6.58857	4.77500
382	8.80951	7.39206	4.94000
383	8.80951	7.39206	4.05000
384	7.85196	6.58857	4.53750
385	7.85196	6.58857	4.30000
386	6.79764	5.70390	5.07235
387	5.74533	4.82091	6.00000
388	5.74533	4.82091	5.59250
389	5.74533	4.82091	5.18500
390	6.79246	5.69955	5.59538
391	6.80282	5.70825	4.54933
392	5.74533	4.82091	4.77750
393	5.74533	4.82091	4.37000
394	5.20925	4.37108	5.23860
395	4.78778	4.01742	7.10000
396	4.78778	4.01742	6.19500
397	4.78778	4.01742	5.29000
398	5.20387	4.36657	6.45701
399	5.21464	4.37560	4.02019
400	4.78778	4.01742	4.38500
401	4.78778	4.01742	3.48000
402	4.06961	3.41481	7.10000
403	3.35144	2.81220	9.10000
404	3.35144	2.81220	8.10000
405	3.35144	2.81220	7.10000
406	4.30517	3.61247	9.10000
407	4.49798	3.77425	8.08006
408	3.82831	3.21233	9.10000
409	4.06961	3.41481	5.29000
410	3.35144	2.81220	6.19500
411	3.35144	2.81220	5.29000
412	4.06961	3.41481	3.48000
413	3.35144	2.81220	4.38500
414	3.35144	2.81220	3.48000
415	3.80916	3.19626	2.12000
416	3.35144	2.81220	2.80000
417	3.35144	2.81220	2.12000
418	4.46910	3.75002	2.83800
419	4.26687	3.58033	2.12000
420	16.01055	8.33456	4.50000
421	15.96619	8.31148	3.50000
422	15.34529	7.98825	5.53000
423	14.96831	7.79201	4.27500
424	16.89756	8.79631	5.60000
425	16.51614	8.59776	5.16000

426	16.76727	8.72849	6.19591
427	16.13029	8.39690	5.86000
428	16.29439	8.48232	6.50000
429	15.74444	8.19604	6.56000
430	14.68003	7.64194	6.56000
431	13.97042	7.27254	5.05000
432	14.93505	7.77469	3.15000
433	15.89967	8.27684	2.40000
434	14.90178	7.75738	2.02500
435	15.83314	8.24221	1.30000
436	13.97042	7.27254	3.90000
437	13.97042	7.27254	2.75000
438	15.09249	7.85665	0.85000
439	15.52269	8.08060	0.85000
440	14.66229	7.63270	0.85000
441	12.63990	6.57992	4.40000
442	12.63990	6.57992	3.96000
443	12.63990	6.57992	3.52000
444	11.30939	5.88729	4.63000
445	11.30939	5.88729	4.21500
446	11.30939	5.88729	3.80000
447	9.09186	4.73292	5.25000
448	9.09186	4.73292	4.77500
449	9.09186	4.73292	4.30000
450	6.65258	3.46311	6.00000
451	6.65258	3.46311	5.18500
452	6.65258	3.46311	4.37000
453	5.54382	2.88593	7.10000
454	5.54382	2.88593	5.29000
455	5.54382	2.88593	3.48000
456	3.88067	2.02015	9.10000
457	3.88067	2.02015	7.10000
458	4.98500	2.59503	9.10000
459	3.88067	2.02015	5.29000
460	3.88067	2.02015	3.48000
461	3.88067	2.02015	2.12000
462	4.94065	2.57194	2.12000
463	17.43496	4.67168	4.50000
464	17.41081	4.66521	4.00000
465	17.38666	4.65874	3.50000
466	17.07274	4.57463	5.01500
467	16.84333	4.51316	3.88750
468	16.71052	4.47757	5.53000
469	16.56144	4.43762	4.88280
470	16.30000	4.36757	4.27500
471	18.40089	4.93050	5.60000
472	18.19568	4.87552	5.37750
473	17.98554	4.81921	5.16000
474	18.38909	4.92734	5.91305
475	17.77545	4.76292	5.51000
476	18.25901	4.89249	6.19591
477	17.91305	4.79979	6.02580

478	17.56536	4.70662	5.86000
479	17.35527	4.65033	6.21000
480	17.74406	4.75451	6.50000
481	17.44446	4.67423	6.52997
482	17.14518	4.59404	6.56000
483	18.03171	4.83158	6.40273
484	17.11169	4.58506	5.76787
485	17.60526	4.71732	4.92387
486	16.34829	4.38051	6.04500
487	16.56563	4.43875	6.56000
488	15.98607	4.28346	6.56000
489	15.75666	4.22199	4.66250
490	15.73490	4.21615	5.73085
491	15.21333	4.07640	5.05000
492	16.78900	4.49860	2.77500
493	16.28189	4.36272	3.71250
494	16.26378	4.35787	3.15000
495	17.35044	4.64904	2.95000
496	17.31422	4.63933	2.40000
497	16.73466	4.48404	1.66250
498	16.24567	4.35301	2.58750
499	16.22755	4.34816	2.02500
500	17.27800	4.62963	1.85000
501	17.24178	4.61992	1.30000
502	15.73855	4.21713	3.52500
503	15.21333	4.07640	4.47500
504	15.21333	4.07640	3.90000
505	15.72044	4.21228	2.38750
506	15.21333	4.07640	3.32500
507	15.21333	4.07640	2.75000
508	16.66946	4.46657	0.85000
509	16.53761	4.43124	1.47657
510	16.43523	4.40381	0.85000
511	17.19614	4.60769	0.97564
512	16.90370	4.52933	0.85000
513	16.20099	4.34104	0.85000
514	15.73595	4.21644	1.86201
515	15.96675	4.27828	0.85000
516	14.54782	3.89808	3.93327
517	13.76444	3.68817	4.40000
518	13.76444	3.68817	4.18000
519	13.76444	3.68817	3.96000
520	14.54135	3.89634	4.59966
521	14.55428	3.89981	3.26688
522	13.76444	3.68817	3.74000
523	13.76444	3.68817	3.52000
524	13.03530	3.49280	4.05574
525	12.31555	3.29994	4.63000
526	12.31555	3.29994	4.42250
527	12.31555	3.29994	4.21500
528	13.03059	3.49154	4.45148
529	13.04000	3.49406	3.66000

530	12.31555	3.29994	4.00750
531	12.31555	3.29994	3.80000
532	11.10815	2.97642	4.49500
533	9.90074	2.65290	5.25000
534	9.90074	2.65290	5.01250
535	9.90074	2.65290	4.77500
536	11.10815	2.97642	4.94000
537	11.10815	2.97642	4.05000
538	9.90074	2.65290	4.53750
539	9.90074	2.65290	4.30000
540	8.57133	2.29668	5.07235
541	7.24444	1.94114	6.00000
542	7.24444	1.94114	5.59250
543	7.24444	1.94114	5.18500
544	8.56479	2.29493	5.59538
545	8.57786	2.29843	4.54933
546	7.24444	1.94114	4.77750
547	7.24444	1.94114	4.37000
548	6.56849	1.76002	5.23860
549	6.03704	1.61762	7.10000
550	6.03704	1.61762	6.19500
551	6.03704	1.61762	5.29000
552	6.56170	1.75820	6.45701
553	6.57527	1.76184	4.02019
554	6.03704	1.61762	4.38500
555	6.03704	1.61762	3.48000
556	5.13148	1.37498	7.10000
557	4.22593	1.13233	9.10000
558	4.22593	1.13233	8.10000
559	4.22593	1.13233	7.10000
560	5.42850	1.45456	9.10000
561	5.67162	1.51971	8.08006
562	4.82721	1.29345	9.10000
563	5.13148	1.37498	5.29000
564	4.22593	1.13233	6.19500
565	4.22593	1.13233	5.29000
566	5.13148	1.37498	3.48000
567	4.22593	1.13233	4.38500
568	4.22593	1.13233	3.48000
569	4.80307	1.28698	2.12000
570	4.22593	1.13233	2.80000
571	4.22593	1.13233	2.12000
572	5.63520	1.50995	2.83800
573	5.38021	1.44162	2.12000
574	18.03282	0.78733	4.50000
575	17.98287	0.78515	3.50000
576	17.28353	0.75462	5.53000
577	16.85894	0.73608	4.27500
578	19.03187	0.83095	5.60000
579	18.60228	0.81219	5.16000
580	18.88512	0.82454	6.19591
581	18.16769	0.79322	5.86000

582	18.35252	0.80129	6.50000
583	17.73311	0.77424	6.56000
584	16.53425	0.72190	6.56000
585	15.73501	0.68701	5.05000
586	16.82147	0.73444	3.15000
587	17.90794	0.78188	2.40000
588	16.78401	0.73281	2.02500
589	17.83301	0.77861	1.30000
590	15.73501	0.68701	3.90000
591	15.73501	0.68701	2.75000
592	16.99881	0.74218	0.85000
593	17.48334	0.76334	0.85000
594	16.51427	0.72103	0.85000
595	14.23644	0.62158	4.40000
596	14.23644	0.62158	3.96000
597	14.23644	0.62158	3.52000
598	12.73786	0.55615	4.63000
599	12.73786	0.55615	4.21500
600	12.73786	0.55615	3.80000
601	10.24024	0.44710	5.25000
602	10.24024	0.44710	4.77500
603	10.24024	0.44710	4.30000
604	7.49286	0.32715	6.00000
605	7.49286	0.32715	5.18500
606	7.49286	0.32715	4.37000
607	6.24405	0.27262	7.10000
608	6.24405	0.27262	5.29000
609	6.24405	0.27262	3.48000
610	4.37084	0.19083	9.10000
611	4.37084	0.19083	7.10000
612	5.61465	0.24514	9.10000
613	4.37084	0.19083	5.29000
614	4.37084	0.19083	3.48000
615	4.37084	0.19083	2.12000
616	5.56470	0.24296	2.12000
617	17.77578	-3.13435	4.50000
618	17.75116	-3.13001	4.00000
619	17.72654	-3.12567	3.50000
620	17.40648	-3.06923	5.01500
621	17.17259	-3.02799	3.88750
622	17.03717	-3.00411	5.53000
623	16.88518	-2.97731	4.88280
624	16.61863	-2.93031	4.27500
625	18.76059	-3.30800	5.60000
626	18.55137	-3.27111	5.37750
627	18.33712	-3.23333	5.16000
628	18.74856	-3.30588	5.91305
629	18.12292	-3.19556	5.51000
630	18.61593	-3.28249	6.19591
631	18.26322	-3.22030	6.02580
632	17.90873	-3.15779	5.86000
633	17.69453	-3.12002	6.21000

634	18.09092	-3.18992	6.50000
635	17.78547	-3.13606	6.52997
636	17.48034	-3.08225	6.56000
637	18.38420	-3.24163	6.40273
638	17.44619	-3.07623	5.76787
639	17.94941	-3.16497	4.92387
640	16.66787	-2.93900	6.04500
641	16.88945	-2.97807	6.56000
642	16.29857	-2.87388	6.56000
643	16.06468	-2.83264	4.66250
644	16.04248	-2.82872	5.73085
645	15.51072	-2.73496	5.05000
646	17.11719	-3.01822	2.77500
647	16.60017	-2.92706	3.71250
648	16.58170	-2.92380	3.15000
649	17.68961	-3.11916	2.95000
650	17.65268	-3.11264	2.40000
651	17.06179	-3.00845	1.66250
652	16.56324	-2.92055	2.58750
653	16.54477	-2.91729	2.02500
654	17.61575	-3.10613	1.85000
655	17.57882	-3.09962	1.30000
656	16.04621	-2.82938	3.52500
657	15.51072	-2.73496	4.47500
658	15.51072	-2.73496	3.90000
659	16.02775	-2.82612	2.38750
660	15.51072	-2.73496	3.32500
661	15.51072	-2.73496	2.75000
662	16.99532	-2.99673	0.85000
663	16.86089	-2.97303	1.47657
664	16.75650	-2.95462	0.85000
665	17.53229	-3.09142	0.97564
666	17.23414	-3.03884	0.85000
667	16.51769	-2.91251	0.85000
668	16.04356	-2.82891	1.86201
669	16.27887	-2.87040	0.85000
670	14.83220	-2.61532	3.93327
671	14.03351	-2.47449	4.40000
672	14.03351	-2.47449	4.18000
673	14.03351	-2.47449	3.96000
674	14.82561	-2.61415	4.59966
675	14.83879	-2.61648	3.26688
676	14.03351	-2.47449	3.74000
677	14.03351	-2.47449	3.52000
678	13.29011	-2.34340	4.05574
679	12.55630	-2.21401	4.63000
680	12.55630	-2.21401	4.42250
681	12.55630	-2.21401	4.21500
682	13.28531	-2.34256	4.45148
683	13.29490	-2.34425	3.66000
684	12.55630	-2.21401	4.00750
685	12.55630	-2.21401	3.80000

686	11.32529	-1.99695	4.49500
687	10.09428	-1.77989	5.25000
688	10.09428	-1.77989	5.01250
689	10.09428	-1.77989	4.77500
690	11.32529	-1.99695	4.94000
691	11.32529	-1.99695	4.05000
692	10.09428	-1.77989	4.53750
693	10.09428	-1.77989	4.30000
694	8.73888	-1.54090	5.07235
695	7.38606	-1.30236	6.00000
696	7.38606	-1.30236	5.59250
697	7.38606	-1.30236	5.18500
698	8.73222	-1.53973	5.59538
699	8.74554	-1.54207	4.54933
700	7.38606	-1.30236	4.77750
701	7.38606	-1.30236	4.37000
702	6.69689	-1.18084	5.23860
703	6.15505	-1.08530	7.10000
704	6.15505	-1.08530	6.19500
705	6.15505	-1.08530	5.29000
706	6.68997	-1.17962	6.45701
707	6.70381	-1.18206	4.02019
708	6.15505	-1.08530	4.38500
709	6.15505	-1.08530	3.48000
710	5.23179	-0.92251	7.10000
711	4.30853	-0.75971	9.10000
712	4.30853	-0.75971	8.10000
713	4.30853	-0.75971	7.10000
714	5.53462	-0.97590	9.10000
715	5.78249	-1.01961	8.08006
716	4.92158	-0.86781	9.10000
717	5.23179	-0.92251	5.29000
718	4.30853	-0.75971	6.19500
719	4.30853	-0.75971	5.29000
720	5.23179	-0.92251	3.48000
721	4.30853	-0.75971	4.38500
722	4.30853	-0.75971	3.48000
723	4.89696	-0.86347	2.12000
724	4.30853	-0.75971	2.80000
725	4.30853	-0.75971	2.12000
726	5.74536	-1.01306	2.83800
727	5.48538	-0.96722	2.12000
728	16.67603	-6.90744	4.50000
729	16.62983	-6.88830	3.50000
730	15.98312	-6.62042	5.53000
731	15.59047	-6.45778	4.27500
732	17.59991	-7.29012	5.60000
733	17.20264	-7.12556	5.16000
734	17.46420	-7.23391	6.19591
735	16.80075	-6.95910	5.86000
736	16.97167	-7.02989	6.50000
737	16.39886	-6.79263	6.56000

738	15.29021	-6.33341	6.56000
739	14.55110	-6.02726	5.05000
740	15.55582	-6.44343	3.15000
741	16.56054	-6.85960	2.40000
742	15.52118	-6.42908	2.02500
743	16.49125	-6.83090	1.30000
744	14.55110	-6.02726	3.90000
745	14.55110	-6.02726	2.75000
746	15.71981	-6.51136	0.85000
747	16.16789	-6.69696	0.85000
748	15.27173	-6.32576	0.85000
749	13.16528	-5.45324	4.40000
750	13.16528	-5.45324	3.96000
751	13.16528	-5.45324	3.52000
752	11.77946	-4.87921	4.63000
753	11.77946	-4.87921	4.21500
754	11.77946	-4.87921	3.80000
755	9.46977	-3.92250	5.25000
756	9.46977	-3.92250	4.77500
757	9.46977	-3.92250	4.30000
758	6.92910	-2.87013	6.00000
759	6.92910	-2.87013	5.18500
760	6.92910	-2.87013	4.37000
761	5.77425	-2.39177	7.10000
762	5.77425	-2.39177	5.29000
763	5.77425	-2.39177	3.48000
764	4.04197	-1.67424	9.10000
765	4.04197	-1.67424	7.10000
766	5.19220	-2.15068	9.10000
767	4.04197	-1.67424	5.29000
768	4.04197	-1.67424	3.48000
769	4.04197	-1.67424	2.12000
770	5.14601	-2.13155	2.12000
771	14.78569	-10.35305	4.50000
772	14.76522	-10.33871	4.00000
773	14.74474	-10.32438	3.50000
774	14.47851	-10.13796	5.01500
775	14.28396	-10.00174	3.88750
776	14.17133	-9.92287	5.53000
777	14.04491	-9.83435	4.88280
778	13.82319	-9.67910	4.27500
779	15.60485	-10.92663	5.60000
780	15.43083	-10.80478	5.37750
781	15.25261	-10.67999	5.16000
782	15.59484	-10.91963	5.91305
783	15.07445	-10.55524	5.51000
784	15.48452	-10.84238	6.19591
785	15.19114	-10.63695	6.02580
786	14.89628	-10.43049	5.85000
787	14.71811	-10.30573	6.21000
788	15.04782	-10.53660	6.50000
789	14.79375	-10.35870	6.52997

790	14.53995	-10.18098	6.56000
791	15.29177	-10.70741	6.40273
792	14.51155	-10.16109	5.76787
793	14.93012	-10.45418	4.92387
794	13.86415	-9.70778	6.04500
795	14.04846	-9.83684	6.56000
796	13.55697	-9.49269	6.56000
797	13.36242	-9.35647	4.66250
798	13.34396	-9.34354	5.73085
799	12.90164	-9.03383	5.05000
800	14.23789	-9.96948	2.77500
801	13.80783	-9.66835	3.71250
802	13.79247	-9.65759	3.15000
803	14.71402	-10.30287	2.95000
804	14.68330	-10.28136	2.40000
805	14.19181	-9.93721	1.66250
806	13.77711	-9.64684	2.58750
807	13.76175	-9.63608	2.02500
808	14.65258	-10.25985	1.85000
809	14.62186	-10.23834	1.30000
810	13.34706	-9.34571	3.52500
811	12.90164	-9.03383	4.47500
812	12.90164	-9.03383	3.90000
813	13.33170	-9.33496	2.38750
814	12.90164	-9.03383	3.32500
815	12.90164	-9.03383	2.75000
816	14.13652	-9.89849	0.85000
817	14.02470	-9.82020	1.47657
818	13.93787	-9.75940	0.85000
819	14.58316	-10.21124	0.97564
820	14.33516	-10.03759	0.85000
821	13.73923	-9.62031	0.85000
822	13.34485	-9.34417	1.86201
823	13.54058	-9.48122	0.85000
824	12.33725	-8.63864	3.93327
825	11.67292	-8.17346	4.40000
826	11.67292	-8.17346	4.18000
827	11.67292	-8.17346	3.96000
828	12.33177	-8.63480	4.59966
829	12.34274	-8.64248	3.26688
830	11.67292	-8.17346	3.74000
831	11.67292	-8.17346	3.52000
832	11.05456	-7.74049	4.05574
833	10.44419	-7.31310	4.63000
834	10.44419	-7.31310	4.42250
835	10.44419	-7.31310	4.21500
836	11.05058	-7.73770	4.45148
837	11.05855	-7.74328	3.66000
838	10.44419	-7.31310	4.00750
839	10.44419	-7.31310	3.80000
840	9.42025	-6.59613	4.49500
841	8.39631	-5.87916	5.25000

842	8.39631	-5.87916	5.01250
843	8.39631	-5.87916	4.77500
844	9.42025	-6.59613	4.94000
845	9.42025	-6.59613	4.05000
846	8.39631	-5.87916	4.53750
847	8.39631	-5.87916	4.30000
848	7.26890	-5.08974	5.07235
849	6.14364	-4.30182	6.00000
850	6.14364	-4.30182	5.59250
851	6.14364	-4.30182	5.18500
852	7.26336	-5.08586	5.59538
853	7.27444	-5.09362	4.54933
854	6.14364	-4.30182	4.77750
855	6.14364	-4.30182	4.37000
856	5.57040	-3.90043	5.23860
857	5.11970	-3.58485	7.10000
858	5.11970	-3.58485	6.19500
859	5.11970	-3.58485	5.29000
860	5.56464	-3.89640	6.45701
861	5.57615	-3.90446	4.02019
862	5.11970	-3.58485	4.38500
863	5.11970	-3.58485	3.48000
864	4.35175	-3.04712	7.10000
865	3.58379	-2.50940	9.10000
866	3.58379	-2.50940	8.10000
867	3.58379	-2.50940	7.10000
868	4.60363	-3.22350	9.10000
869	4.80981	-3.36786	8.08006
870	4.09371	-2.86645	9.10000
871	4.35175	-3.04712	5.29000
872	3.58379	-2.50940	6.19500
873	3.58379	-2.50940	5.29000
874	4.35175	-3.04712	3.48000
875	3.58379	-2.50940	4.38500
876	3.58379	-2.50940	3.48000
877	4.07323	-2.85211	2.12000
878	3.58379	-2.50940	2.80000
879	3.58379	-2.50940	2.12000
880	4.77892	-3.34624	2.83800
881	4.56268	-3.19482	2.12000
882	12.19440	-13.30786	4.50000
883	12.16062	-13.27099	3.50000
884	11.68771	-12.75490	5.53000
885	11.40059	-12.44155	4.27500
886	12.86999	-14.04513	5.60000
887	12.57949	-13.72810	5.16000
888	12.77076	-13.93684	6.19591
889	12.28561	-13.40739	5.86000
890	12.41059	-13.54378	6.50000
891	11.99173	-13.08667	6.56000
892	11.18102	-12.20194	6.56000
893	10.64055	-11.61212	5.05000

894	11.37525	-12.41391	3.15000
895	12.10996	-13.21570	2.40000
896	11.34992	-12.38626	2.02500
897	12.05929	-13.16040	1.30000
898	10.64055	-11.61212	3.90000
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Software Series: GIFWHL- User's Guide and Technique Documentation, 1980
B Prasad, MT Chen, VK Garg