

Technical Report Documentation Page

1. Report No. FHWA/TX-04/5-1291-01-1	2. Government Accession No.	3. Recipient's Catalog No.	
4. Title and Subtitle INTERACTIVE GRAPHICS INTERSECTION DESIGN SYSTEM (IGIDS) ENHANCEMENTS		5. Report Date October 2001	
		6. Performing Organization Code	
7. Author(s) Thomas W. Rioux, Robert F. Inman, and Randy B. Machemehl		8. Performing Organization Report No. 5-1291-01-1	
9. Performing Organization Name and Address Center for Transportation Research The University of Texas at Austin 3208 Red River, Suite 200 Austin, TX 78705-2650		10. Work Unit No. (TRAIS)	
		11. Contract or Grant No. 5-1291	
12. Sponsoring Agency Name and Address Texas Department of Transportation Research and Technology Implementation Office P.O. Box 5080 Austin, TX 78763-5080		13. Type of Report and Period Covered Research Report (9/1/00 – 8/31/01)	
		14. Sponsoring Agency Code	
15. Supplementary Notes Project conducted in cooperation with the U.S. Department of Transportation, the Federal Highway Administration, and the Texas Department of Transportation.			
16. Abstract The Interactive Graphics Intersection Design System (IGIDS) is a computer software program developed for TxDOT that assists engineers in the analysis and design of individual, at-grade intersections. IGIDS was initially developed under several RMC 3 – Geometric Design, Environmental, Hydraulics, and Right-of-Way projects. IGIDS is a MicroStation application which contains (1) geometric, traffic data, and signalization definition tools; (2) built-in analysis tools for vehicle turning templates; horizontal sight distance checking for stop sign, yield sign, and no control; and "Highway Capacity Manual" (HCM), Chapter 9 procedures; and (3) interfaces to external analysis programs for the TEXAS Model for Intersection Traffic (TEXAS), the TxDOT Automated Plan Preparation System (APP), and the Signal Operations and Analysis Package (SOAP). IGIDS can operate in English or metric units. IGIDS was recently enhanced by the addition of vertical sight distance checking within the horizontal sight triangle, the inclusion of pavement striping definition and tabulation, and the development of training materials. Most TxDOT engineers now use GEOPAK for the geometric design of intersections. TxDOT Traffic Operations personnel generally have access to the GEOPAK design files for an intersection. IGIDS was enhanced to directly read the intersection geometry from an existing GEOPAK design file. The addition of this feature makes IGIDS much easier to use and reduce duplicated effort. In addition, most TxDOT engineers now prefer to use PASSER II-90 for signal timing optimization rather than using SOAP. IGIDS was enhanced by the addition of a PASSER II-90 interface. The addition of this feature increases the engineers' ability to analyze and design an intersection for optimum operation. Since the last release of IGIDS, the HCM Chapter 9 procedures have been updated. IGIDS was modified to use the 1998 version of the HCM Chapter 9 procedures. Training modules for these enhancements were developed and added to the training course previously developed for IGIDS. In addition, each training module was updated to reflect recent experience using web-based training. Finally, a test training session was held to evaluate the training materials and procedures.			
17. Key Words Interactive Graphics, intersection design, street intersections, Interactive Graphics Intersection Design System (IGIDS), PASSER II, GEOPAK, Vehicle Turn Templates		18. Distribution Statement No restrictions. This document is available to the public through the National Technical Information Service, Springfield, Virginia 22161.	
19. Security Classif. (of report) Unclassified	20. Security Classif. (of this page) Unclassified	21. No. of pages 44	22. Price

Interactive Graphics Intersection Design System (IGIDS) Enhancements

by

Thomas W. Rioux,
Robert F. Inman
and
Randy B. Machemehl

Research Report Number 5-1291-01-1

Research Project 5-1291
*Interactive Graphics Intersection Design
System (IGIDS) Enhancements*

Conducted for the

TEXAS DEPARTMENT OF TRANSPORTATION

in cooperation with the

**U. S. Department of Transportation
Federal Highway Administration**

by the

CENTER FOR TRANSPORTATION RESEARCH
Bureau of Engineering Research
THE UNIVERSITY OF TEXAS AT AUSTIN

October 2001

ABSTRACT

The Interactive Graphics Intersection Design System (IGIDS) is a computer software program developed for TxDOT that assists engineers in the analysis and design of individual, at-grade intersections. IGIDS was initially developed under several RMC 3 – Geometric Design, Environmental, Hydraulics, and Right-of-Way projects. IGIDS is a MicroStation application which contains (1) geometric, traffic data, and signalization definition tools; (2) built-in analysis tools for vehicle turning templates; horizontal sight distance checking for stop sign, yield sign, and no control; and “Highway Capacity Manual” (HCM), Chapter 9 procedures; and (3) interfaces to external analysis programs for the TEXAS Model for Intersection Traffic (TEXAS), the TxDOT Automated Plan Preparation System (APP), and the Signal Operations and Analysis Package (SOAP). IGIDS can operate in English or metric units. IGIDS was recently enhanced by the addition of vertical sight distance checking within the horizontal sight triangle, the inclusion of pavement striping definition and tabulation, and the development of training materials.

Most TxDOT engineers now use GEOPAK for the geometric design of intersections. TxDOT Traffic Operations personnel generally have access to the GEOPAK design files for an intersection. IGIDS was enhanced to directly read the intersection geometry from an existing GEOPAK design file. The addition of this feature makes IGIDS much easier to use and reduce duplicated effort. In addition, most TxDOT engineers now prefer to use PASSER II-90 for signal timing optimization rather than using SOAP. IGIDS was enhanced by the addition of a PASSER II-90 interface. The addition of this feature increases the engineers’ ability to analyze and design an intersection for optimum operation. Since the last release of IGIDS, the HCM Chapter 9 procedures have been updated. IGIDS was modified to use the 1998 version of the HCM Chapter 9 procedures. Training modules for these enhancements were developed and added to the training course previously developed for IGIDS. In addition, each training module was updated to reflect recent experience using web-based training. Finally, a test training session was held to evaluate the training materials and procedures.

DISCLAIMERS

The contents of this report reflect the views of the authors, who are responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official views or policies of the Federal Highway Administration or the Texas Department of Transportation. This report does not constitute a standard, specification, or regulation.

There was no invention or discovery conceived or first reduced to practice in the course of or under this contract, including any art, method, process, machine, manufacture, design or composition of matter, or any new and useful improvement thereof, or any variety of plant, which is or may be patentable under the patent laws of the United States of America or any foreign country.

Research performed in cooperation with the Texas Department of Transportation and the U.S. Department of Transportation, Federal Highway Administration.

ACKNOWLEDGMENTS

The authors would like to sincerely thank TxDOT Project Director James Bailey and Program Coordinator Sally Wegmann for their support during this project.

NOT INTENDED FOR CONSTRUCTION, BIDDING, OR PERMIT PURPOSES

Tom Rioux (Texas No. 48008)
Research Supervisor

Table of Contents

CHAPTER 1. INTRODUCTION	1
CHAPTER 2. GEOPAK INTERFACE	5
CHAPTER 3. PASSER II-90 INTERFACE.....	19
CHAPTER 4. HIGHWAY CAPACITY MANUAL CHAPTER 9 PROCEDURES.....	21
CHAPTER 5. IGIDS TRAINING MATERIALS	29
CHAPTER 6. SUMMARY AND RECOMMENDATIONS	31
REFERENCES	33

List of Figures

Figure 2.1 IGIDS GEOPAK centerline attributes.....	4
Figure 4.1 HCM main dialog box	21
Figure 4.2 Typical HCM module dialog box.....	23
Figure 4.3 Volume Adjustment dialog box.....	24
Figure 4.4 Saturation Flow dialog box	24
Figure 4.5 Capacity Analysis dialog box	25
Figure 4.6 Level of Service dialog box.....	26
Figure 4.7 View Data dialog box.....	26

List of Tables

Table 4.1 Items in Volume Adjustment dialog box.....	24
Table 4.2 Items in Saturation Flow dialog box.....	25
Table 4.3 Items in Capacity Analysis dialog box	25
Table 4.4 Items in Level of Service dialog box	26

CHAPTER 1. INTRODUCTION

Intersection design is a complex process that involves a number of different disciplines in transportation engineering. Elements of transportation planning, traffic engineering, and geometric design contribute to the process of designing the best practicable facility for handling traffic at an intersection. Traditionally, the design engineer has relied upon the application of manual, or sometimes computer-aided, procedures to determine the most appropriate alternative that satisfies the objectives. Intersection design involves geometric layout, traffic analysis, channelization, selection and placement of traffic control devices, timing of traffic signals, lighting, drainage, fuel-consumption evaluation, pollution analysis, cost estimating and many other engineering functions which are eventually reduced to practice in a set of plans and specifications. Virtually all the engineering requirements and analysis procedures needed to complete the design process are well known and documented.

The ultimate objective of this study is the development of an Interactive Graphics Intersection Design System (IGIDS) which assists engineers in the analysis and design of isolated, at-grade intersections and which operates on personal computers and workstations. The role of IGIDS is to provide the Intersection Design Engineer with suitable tools to assist with each process stage. The available tools may be loosely divided into three groups.

First are the drawing tools. IGIDS uses MicroStation as a graphics engine to perform all graphics input and output. The user may select from a library one of several typical intersection designs to be created and then modify it as needed to define the particular intersection of interest. Alternately, the user may define the intersection geometry by pointing at selected elements in a reference file created by another source, such as a topographical map of the area (with optional use of a superimposed aerial photo). Finally, the user may create the key components of the intersection geometry on the scratch level using MicroStation commands (with optional use of a superimposed aerial photo) and then define the intersection geometry by pointing at these elements. After the centerline of the legs is defined, IGIDS has several commands to place lanes and curb returns and manipulate the intersection elements. The elements of the design may be specified by the most convenient method for the particular situation. The width of a lane may sometimes be specified by keyboard entry of a numerical value. Other times it may be more convenient to identify lane edge graphics that exist in a file that is being viewed concurrently with the IGIDS graphics file. Alternately, requesting that the lane edges be located by identifying existing landmarks on a superimposed aerial photo may be most convenient.

Next are the built-in analysis tools. Both graphical aids and computational analysis procedures are incorporated. Vehicle turning templates may be quickly drawn for the standard AASHTO design vehicles to a user-specified turn radius for the turn angle defined by the user-selected legs. These templates may be moved dynamically over the intersection geometry to evaluate pavement edge and channelization requirements. For checking sight distance restrictions, sight lines for stopped vehicles, yielding vehicles, or vehicles approaching an uncontrolled intersection may be drawn. The analysis detailed in Chapter 9 of the Highway Capacity Manual may be used to find

v/c ratios and delay values for intersections with pretimed controllers and are displayed in bar chart format for each leg.

Finally, there are data-manipulation tools that prepare data files for analyses that are executed outside IGIDS and retrieve the results back into the IGIDS-compatible context. The TEXAS Model for Intersection Traffic (TEXAS) and the Signal Operations Analysis Package (SOAP) are supported by IGIDS. The TEXAS Model provides simulation of vehicular traffic flow through a single intersection or a diamond interchange and generates both a statistical summary and animated graphics that show drawn-to-scale, color-coded vehicle types moving through the intersection geometry. Selected TEXAS Model statistics may be displayed in bar chart format for each leg and the total intersection. SOAP develops and assesses isolated intersections timing plans.

Data for both the built-in and external analysis are drawn from a common database that is maintained by IGIDS. Much of these data are extracted from the graphical intersection geometry definition that has been constructed by the user. Some non-graphical data, such as volumes, must be entered through the keyboard.

The IGIDS was initially developed under the TxDOT research program by the Center for Transportation Research (CTR) at The University of Texas at Austin. The primary developers of IGIDS were Dr. Thomas W. Rioux and Mr. Bobby F. Inman with the support of Dr. Clyde E. Lee, Dr. Randy B. Machemehl, and several undergraduate and graduate students. The initial design and development of IGIDS using MicroStation Clix Version 4 was performed under Project 0-1139 from 9/1988 to 9/1991. Additional features were added using MicroStation Clix Version 4 under Project 0-1308 from 9/1991 to 9/1993. IGIDS was converted to MicroStation DOS Version 4 MDL (MicroStation Development Language) under Project 0-1308 Extension from 9/1993 to 9/1994. Metrication, vertical sight distance checking, striping, traffic control bill-of-materials, and development of training materials were performed under Project 0-1291 from 9/1995 to 9/1997.

Most TxDOT engineers now use GEOPAK for the geometric design of intersections. TxDOT Traffic Operations personnel generally have access to the GEOPAK design files for an intersection. IGIDS was enhanced to directly read the intersection geometry from an existing GEOPAK design file. The addition of this feature makes IGIDS much easier to use and reduce duplicated effort. In addition, most TxDOT engineers now prefer to use PASSER II-90 for signal timing optimization rather than using SOAP. IGIDS was enhanced by the addition of a PASSER II-90 interface. The addition of a PASSER II interface increases the engineers' ability to analyze and design an intersection for optimum operation. Since the last release of IGIDS, the HCM Chapter 9 procedures have been updated. IGIDS was modified to use the 1998 version of the HCM Chapter 9 procedures. Training modules for these enhancements were developed and added to the training course previously developed for IGIDS. In addition, each training module was updated to reflect recent experience using web-based training. Finally, a test training session was held to evaluate the training materials and procedures.

IGIDS is currently being implemented statewide within TxDOT. Both Division and District personnel of TxDOT as well as engineers in other governmental agencies may utilize IGIDS. Computer software developed in this project will be distributed throughout TxDOT and used to analyze and design isolated intersections. The training modules will be used to train TxDOT personnel in the use of IGIDS and the

enhancements. IGIDS software and training materials is available through the University of Texas at Austin Department of Civil Engineering's anonymous ftp site and web page.

CHAPTER 2 - GEOPAK INTERFACE

GEOPAK is a roadway design package used by most state departments of transportation and is the standard for TxDOT. Like IGIDS, GEOPAK is a MicroStation MDL Application that runs on top of MicroStation. The Design and Computation Manager within GEOPAK adds geometric elements to a MicroStation design file using specific class, color, level, style, and weight as defined by each agency for the type of feature selected. Most agencies define unique attributes for centerline, lane edge, and pavement edge features. The design file to be processed does not have to be created by GEOPAK; any design file where the centerline and lane or pavement edges have unique attributes may be processed by IGIDS. The design file to be processed does have to be attached as a reference file. The IGIDS interface to GEOPAK consists of 3 commands:

1. Load From GEOPAK Centerline,
2. Load From GEOPAK Lane Edges, and
3. Load From GEOPAK Pavement Edges.

The Load From GEOPAK Centerline command must be executed first then either the Load From GEOPAK Lane Edges or the Load From GEOPAK Pavement Edges command is performed. The Load From GEOPAK Lane Edges command is used when there are one or more graphical elements defining the inner edge and outer edge for each lane. This command is executed once for the entire intersection. The Load From GEOPAK Pavement Edges command is used when there are one or more graphical elements defining only the inner edge of the median lane (optional; the centerline may be used as the inner edge of the median lane) and the outer edge of the curb lane. This command is executed once for each leg of the intersection. All three commands function in a similar sequence:

1. Identifies and accepts a single element in a reference file (this action also identifies the reference file number),
2. Obtains the class, color, level, style, and weight from the element and displays the values in a dialog box for choosing selection criteria,
3. Scans the reference file for all arc, curve, line, and line string elements that meet the user's criteria, and
4. Identifies the intersection geometry from the scanned elements and adds the elements to IGIDS in a logical sequence.

The dialog box for choosing selection criteria for centerline attributes is shown below. When an attribute like "Level" has a check mark in the box immediately to the left of it, this indicates that each element selected must have the value of "Level" specified in the box immediately to the right of it. When there is no check mark then "Level" is not used in the selection criteria and all levels are allowed. The user may enter a number into the box immediately to the right of "Level" or use the option button immediately to its right to select a "Level". IGIDS initially sets each attribute to be selected and sets the value to the attribute to the value from the element identified and accepted in Step 1 above.

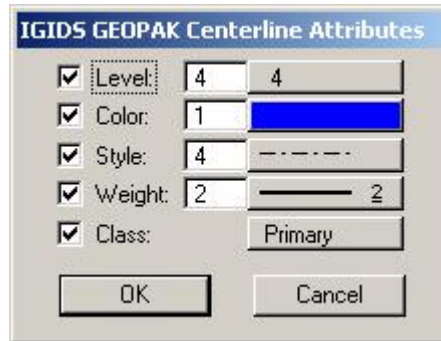


Figure 2.1 IGIDS GEOPAK Centerline Attributes

The Load From GEOPAK Centerline command must be executed first before either the Load From GEOPAK Lane Edges or the Load From GEOPAK Pavement Edges command is performed. The Load From GEOPAK Centerline command (a) adds the alternative, (b) adds each leg, and (c) adds the centerline segments for each leg by performing the following logic (3517 lines of MDL):

1. Prompts the user to keyin the alternative name,
2. Prompts the user to keyin the alternative number using the lowest unused alternative number as a default,
3. Prompts the user to identify and accept a centerline segment in a reference file,
4. Obtains the class, color, level, style, and weight from the element and displays the values in a dialog box for choosing selection criteria,
5. Scans the reference file for all arc, curve, line, and line string elements that meet the user's criteria,
 - a. Adds the element to a temporary list with curve and line string elements creating multiple line elements while determining the maximum x or y coordinate,
6. Checks for the physical intersection of all combinations of 2 centerline elements and if found
 - a. Breaks each element into 2 elements at the point of intersection if the resultant elements are greater than a small, non-zero value in length (0.1 feet or 0.0348 meters),
 - b. Uses the point of intersection as the center of the intersection for the physical intersection with the angle of intersection closest to 90 degrees, and
 - c. Starts the checking process over at the beginning of Step 6,
7. If the center of the intersection is not found
 - a. Checks for the physical touching of all combinations of 2 centerline elements and if found
 - i. Uses the point of intersection as the center of the intersection for the physical touching with the angle of intersection greater than 45 degrees and closest to 90 degrees,
8. If the center of the intersection is still not found
 - a. Checks for the physical intersection of the extension of all combinations of 2 centerline elements and if found

- i. Uses the point of intersection as the center of the intersection for the physical intersection of the extension with the angle of intersection greater than 45 degrees and closest to 90 degrees,
9. If the center of the intersection is still not found
 - a. Calculates the length-weighted average x and y coordinate,
 - b. Checks for the physical intersection of the extension of all combinations of 2 centerline elements and if found
 - i. Uses the point of intersection as the center of the intersection for the physical intersection of the extension with the angle of intersection greater than 45 degrees and closest to 90 degrees and nearest to the length-weighted average x and y coordinate,
10. If the center of the intersection is still not found
 - a. Issues an error message and returns,
11. Checks the perpendicular projection of the center of the intersection on each centerline element and if the perpendicular projection is on the element
 - a. Breaks the element into 2 elements at the point of perpendicular projection if the resultant elements are greater than a small, non-zero value in length (0.1 feet or 0.0348 meters) and
 - b. Starts the checking process over at the beginning of Step 6,
12. Checks for duplicate elements and if found
 - a. Issues a warning message and
 - b. Skips the duplicate element in further processing,
13. Adds the alternative using specified name, specified number, and calculated center of the intersection,
14. If there are remaining elements to be processed
 - a. Finds the next unprocessed element that is closest to the center of the intersection,
 - b. Adds a leg to the alternative,
 - c. Adds the element to the leg as a centerline segment,
 - d. Sets the element as having been processed,
 - e. If there are remaining elements to be processed
 - i. Finds the next unprocessed element that is closest to the ending coordinate of the element just added and that is closest to the ending angle of the element just added,
 - ii. If the distance from the ending coordinate of the element just added to the beginning of this element is less than or equal a small, non-zero distance (0.1 feet or 0.0348 meters)
 1. Adds the element to the leg as a centerline segment,
 2. Sets the element as having been processed, and
 3. Continues processing at Step 14.e,
 - iii. If the distance from the ending coordinate of the element just added to the beginning of this element is greater than a small, non-zero distance (0.1 feet or 0.0348 meters)
 1. Continues processing at Step 14,
15. Fixes any small gaps between adjacent centerline segments,
16. Sorts the centerline segments for each leg, and

17. Sorts the legs.

The Load From GEOPAK Lane Edges command may be executed after the Load From GEOPAK Centerline command is performed. The Load From GEOPAK Lane Edges command is used when there are one or more graphical elements defining the inner edge and outer edge for each lane. This command is executed once for the entire intersection. The Load From GEOPAK Lane Edges command adds the inner edge, outer edge, stop line edge, median lane curb return, and curb lane curb return segments for each lane for each leg by performing the following logic (3806 lines of MDL):

1. If an alternative is not selected then issues an error message and returns,
2. If the alternative is not completed then issues an error message and returns,
3. If the alternative has no legs then issues an error message and returns,
4. Checks each leg and if there are already inbound or outbound lanes then issues an error message and returns,
5. Prompts the user to keyin the distance from the centerline to the closest lane edge using a default of 0.0 (median width) (any lane edge found within this distance from the centerline will be considered an inner edge otherwise it will be considered an outer edge) (this parameter allows medians),
6. Prompts the user to keyin the maximum curb return radius using a reasonable default (50 feet or 20 meters) (arcs with a radius less than or equal to this value will be considered as curb return elements otherwise they will be considered as inner edge or outer edge segments),
7. Prompts the user to identify and accept a lane edge segment in a reference file,
8. Obtains the class, color, level, style, and weight from the element and displays the values in a dialog box for choosing selection criteria,
9. Scans the reference file for all arc, curve, line, and line string elements that meet the user's criteria,
 - a. Adds the element to a temporary list with curve and line string elements creating multiple line elements while determining the maximum x or y coordinate,
10. Checks for the physical intersection of all combinations of 2 lane edge elements and if found
 - a. Breaks each element into 2 elements at the point of intersection if the resultant elements are greater than a small, non-zero value in length (0.1 feet or 0.0348 meters) and
 - b. Starts the checking process over at the beginning of Step 10,
11. Checks for duplicate elements and if found
 - a. Issues a warning message and
 - b. Skips the duplicate element in further processing,
12. For each element that is not a curb return element
 - a. For each leg of the alternative
 - i. Continues with the next leg if the station and offset for the beginning point and the ending point for the element can not be found for the leg,
 - ii. Continues with the next leg if the change in offset is greater than the change in station (the element should be roughly parallel to the centerline),

- iii. Finds the leg that the element has the minimum absolute offset value at the station farthest from the center of the intersection,
 - b. If no leg is found,
 - i. Checks the perpendicular projection of the center of the intersection on the element
 - ii. If the perpendicular projection is on the element
 - 1. Breaks the element into 2 elements at the point of perpendicular projection if the resultant elements are greater than a small, non-zero value in length (0.1 feet or 0.0348 meters) and
 - 2. Starts the checking process over at the beginning of Step 10,
 - iii. If the perpendicular projection is not on the element
 - 1. Draws the element on the scratch level in red and
 - 2. Issues a warning message and returns,
 - c. If a leg is found,
 - i. Determines the station and offset of the beginning and ending point of the element for the leg,
 - ii. Calculates a distance equal to the absolute value of the offset at the point nearest the center of the intersection plus 0.1 times the station at the point nearest the center of the intersection,
 - iii. Saves the station and offset at the point farthest from the center of the intersection,
 - iv. Determines the maximum station value,
- 13. For each leg of the alternative
 - a. Finds the element with the minimum value of distance equal to the absolute value of the offset at the point nearest the center of the intersection plus 0.1 times the station at the point nearest the center of the intersection that is not a curb return element,
 - b. If there is no element then skips to the next leg,
 - c. If the offset at the point farthest from the center of the intersection is close to zero then sets an inbound/outbound flag for both inbound and outbound lanes, else if the offset is negative then sets the inbound/outbound flag for an inbound lane, else sets the inbound/outbound flag for an outbound lane,
 - d. If the inbound/outbound flag is inbound or both
 - i. If the leg has exactly one inbound lane
 - 1. Saves the inbound lane number and
 - 2. If the inbound lane has no outer edge segments then sets the add lane flag to false else sets the add lane flag to true,
 - ii. If the leg does not have exactly one inbound lane
 - 1. Sets the add lane flag to true,
 - iii. If the add lane flag is true
 - 1. Adds an inbound lane and
 - 2. Saves the inbound lane number,
 - e. If the inbound/outbound flag is outbound or both
 - i. If the leg has exactly one outbound lane
 - 1. Saves the outbound lane number and

2. If the outbound lane has no outer edge segments then sets the add lane flag to false else sets the add lane flag to true,
- ii. If the leg does not have exactly one outbound lane
 1. Sets the add lane flag to true,
- iii. If the add lane flag is true
 1. Adds an outbound lane and
 2. Saves the outbound lane number,
- f. For inbound and outbound directions,
 - i. If inbound direction and the inbound/outbound flag is inbound or both then uses the saved inbound lane number else if outbound direction and the inbound/outbound flag is outbound or both then uses the saved outbound lane number else continues to next direction,
 - ii. If the lane is the median lane and the offset at the point farthest from the center of the intersection is less than or equal to the median width then sets inner edge segment else sets outer edge segment,
 - iii. Adds the element for the lane as an inner or outer edge segment,
 - iv. Sets the element as having been processed,
 - v. Determines the lane width maximum,
 - vi. If the lane width at the point farthest from the center of the intersection for the last segment on the lane edge is less than or equal to the lane width maximum
 1. Finds the element that is not a curb return element, that has not been processed, that has the closest point on the element to the end of the last segment on the lane edge being nearest the end of the last segment on the lane edge, that has the minimum offset, that does not cause a reversal of direction, and that the distance from the closest point on the element to the end of the last segment on the lane edge is less than or equal to a small, non-zero distance (0.1 feet or 0.0348 meters)
 - a. If an element is found
 - i. Adds the element to the lane edge,
 - ii. Sets the element as having been processed, and
 - iii. Continues processing at Step 13.f.vi,
 - vii. Fixes any small gaps between adjacent lane edge segments,
14. For each leg of the alternative
 - a. For each inbound and outbound lane of the leg
 - i. Issues a warning message if there are no outer edge segments,
15. For each leg of the alternative
 - a. For each inbound and outbound lane of the leg that does not have an inner edge
 - i. If the lane is the median lane
 1. Copies the centerline to the inner edge for the lane potentially shifting the centerline to create a median, potentially trimming the centerline at the beginning to accommodate T intersections, potentially trimming the centerline at the beginning to not exceed the outer edge beginning station, and potentially trimming the centerline at the ending to not exceed the outer edge ending station,

- ii. If the lane is not the median lane
 - 1. Copies the adjacent left lane outer edge to the inner edge for the lane potentially trimming the adjacent left lane outer edge at the beginning to accommodate T intersections, potentially trimming the adjacent left lane outer edge at the beginning to not exceed the outer edge beginning station, and potentially trimming the adjacent left lane outer edge at the ending to not exceed the outer edge ending station,
- 16. For each leg of the alternative
 - a. For each inbound and outbound lane of the leg
 - i. Fixes edges as needed for turn bays
- 17. For each leg of the alternative
 - a. For each inbound and outbound lane of the leg
 - i. Sorts the inner and outer edge segments,
- 18. For each leg of the alternative
 - a. Sorts each inbound and outbound lane of the leg,
- 19. Sorts each leg of the alternative,
- 20. For each leg of the alternative
 - a. For each inbound lane for the leg
 - i. Adds a stop line segment perpendicular to the centerline between the inner edge and outer edge at the station nearest the center of the intersection where both the inner edge and outer edge exist,
 - ii. Calculates the lane length,
 - iii. Calculates the lane width,
 - b. For each outbound lane for the leg
 - i. Calculates the lane length,
 - ii. Calculates the lane width,
- 21. For each element that is a curb return element and has not been processed
 - a. Finds the leg that has the minimum distance from the beginning or ending point of the curb return element to the inbound median lane inner edge beginning point,
 - b. Finds the leg that has the minimum distance from the beginning or ending point of the curb return element to the inbound curb lane outer edge beginning point,
 - c. If the minimum distance from the beginning or ending point of the curb return element to the inbound median lane inner edge beginning point is less than the minimum distance from the beginning or ending point of the curb return element to the inbound curb lane outer edge beginning point
 - i. Adds a median lane curb return using the radius of the curb return element for the identified leg and
 - ii. Sets the element as having been processed,
 - d. If the minimum distance from the beginning or ending point of the curb return element to the inbound median lane inner edge beginning point is greater than or equal to the minimum distance from the beginning or ending point of the curb return element to the inbound curb lane outer edge beginning point
 - i. Adds a curb lane curb return using the radius of the curb return element for the identified leg and

- ii. Sets the element as having been processed,
- 22. For each leg of the alternative that is completed
 - a. Finds the offset for the inbound median lane inner edge beginning point,
 - b. Finds the offset for the outbound median lane inner edge beginning point,
 - c. If one-half of the sum of the two offsets is greater than the curb return radius minimum (0.25 feet or 0.1 meters)
 - i. Adds a median lane curb return using the radius of one-half of the sum of the two offsets for the leg,
- 23. For any element that has not been processed
 - a. Draws the element on the scratch level in red and
 - b. Issues a warning message.

The Load From GEOPAK Pavement Edges command may be executed after the Load From GEOPAK Centerline command is performed. The Load From GEOPAK Pavement Edges command is used when there are one or more graphical elements defining only the inner edge of the median lane (optional; the centerline may be used as the inner edge of the median lane) and the outer edge of the curb lane. This command is executed once for each leg of the intersection. The Load From GEOPAK Pavement Edges command adds the inner edge, outer edge, stop line edge, median lane curb return, and curb lane curb return segments for each lane for a single specified leg by performing the following logic (4307 lines of MDL):

1. If an alternative is not selected then issues an error message and returns,
2. If the alternative has no legs then issues an error message and returns,
3. Checks each leg and if there are already inbound or outbound lanes for all legs then issues an error message and returns,
4. Prompts the user to keyin the distance from the centerline to the closest lane edge using a default of 0.0 (median width) (any pavement edge found within this distance from the centerline will be considered an inner edge otherwise it will be considered an outer edge) (this parameter allows medians),
5. Prompts the user to keyin the maximum curb return radius using a reasonable default (50 feet or 20 meters) (arcs with a radius less than or equal to this value will be considered as curb return elements otherwise they will be considered as inner edge or outer edge segments),
6. Prompts the user to keyin the lane width type ("L" for number of lanes or "W" for lane width)
7. If the lane width type is "L" for number of lanes
 - a. Prompts the user to enter the number of lanes for a leg using a default of 1 with a minimum of 1 and a maximum of 6,
8. If the lane width type is "W" for lane width
 - a. Prompts the user to enter the lane width for a leg using a default of 12 feet or 3.6 meters with a minimum of 8 feet or 2.4 meters and a maximum of 15 feet or 4.5 meters,
9. Prompts the user to identify and accept a pavement edge segment in a reference file for a specific leg,
10. Obtains the class, color, level, style, and weight from the element and displays the values in a dialog box for choosing selection criteria,

11. Scans the reference file for all arc, curve, line, and line string elements that meet the user's criteria,
 - a. Adds the element to a temporary list with curve and line string elements creating multiple line elements while determining the maximum x or y coordinate and
 - b. Saves the element number if the element is the original element identified in Step 9 (identifies the leg to be processed)
12. Checks for the physical intersection of all combinations of 2 pavement edge elements and if found
 - a. Breaks each element into 2 elements at the point of intersection if the resultant elements are greater than a small, non-zero value in length (0.1 feet or 0.0348 meters) and
 - b. Starts the checking process over at the beginning of Step 12,
13. Checks for duplicate elements and if found
 - a. Issues a warning message and
 - b. Skips the duplicate element in further processing,
14. For each element that is not a curb return element
 - a. For each leg of the alternative
 - i. Continues with the next leg if the station and offset for the beginning point and the ending point for the element can not be found for the leg,
 - ii. Continues with the next leg if the change in offset is greater than the change in station (the element should be roughly parallel to the centerline),
 - iii. Finds the leg that the element has the minimum absolute offset value at the station farthest from the center of the intersection,
 - b. If no leg is found,
 - i. Checks the perpendicular projection of the center of the intersection on the element
 - ii. If the perpendicular projection is on the element
 1. Breaks the element into 2 elements at the point of perpendicular projection if the resultant elements are greater than a small, non-zero value in length (0.1 feet or 0.0348 meters) and
 2. Starts the checking process over at the beginning of Step 12,
 - iii. If the perpendicular projection is not on the element
 1. Draws the element on the scratch level in red and
 2. Issues a warning message and returns,
 - c. If a leg is found,
 - i. Saves the leg number to be processed if the element is the original element identified in Step 9 (identifies the leg to be processed),
 - ii. Determines the station and offset of the beginning and ending point of the element for the leg,
 - iii. Calculates a distance equal to the absolute value of the offset at the point nearest the center of the intersection plus 0.1 times the station at the point nearest the center of the intersection,
 - iv. Saves the station and offset at the point farthest from the center of the intersection,
 - v. Determines the maximum station value,

15. Issues a warning message and returns if no leg number to be processed is found,
16. For each leg of the alternative
 - a. Skips to the next leg if the leg is not the leg number to be processed,
 - b. Finds the element with the minimum value of distance equal to the absolute value of the offset at the point nearest the center of the intersection plus 0.1 times the station at the point nearest the center of the intersection that is not a curb return element,
 - c. Skips to the next leg if there is no element,
 - d. If the offset at the point farthest from the center of the intersection is close to zero then sets an inbound/outbound flag for both inbound and outbound lanes, else if the offset is negative then sets the inbound/outbound flag for an inbound lane, else sets the inbound/outbound flag for an outbound lane,
 - e. If the inbound/outbound flag is inbound or both
 - i. If the leg has exactly one inbound lane
 1. Saves the inbound lane number and
 2. If the inbound lane has no outer edge segments then sets the add lane flag to false else sets the add lane flag to true,
 - ii. If the leg does not have exactly one inbound lane
 1. Sets the add lane flag to true,
 - iii. If the add lane flag is true
 1. Adds an inbound lane and
 2. Saves the inbound lane number,
 - f. If the inbound/outbound flag is outbound or both
 - i. If the leg has exactly one outbound lane
 1. Saves the outbound lane number and
 2. If the outbound lane has no outer edge segments then sets the add lane flag to false else sets the add lane flag to true,
 - ii. If the leg does not have exactly one outbound lane
 1. Sets the add lane flag to true,
 - iii. If the add lane flag is true
 1. Adds an outbound lane and
 2. Saves the outbound lane number,
 - g. For inbound and outbound directions,
 - i. If inbound direction and the inbound/outbound flag is inbound or both then uses the saved inbound lane number else if outbound direction and the inbound/outbound flag is outbound or both then uses the saved outbound lane number else continues to next direction,
 - ii. If the lane is the median lane and the offset at the point farthest from the center of the intersection is less than or equal to the median width then sets inner edge segment else sets outer edge segment,
 - iii. Adds the element for the lane as an inner or outer edge segment,
 - iv. Sets the element as having been processed,
 - v. Determines the lane width maximum,
 - vi. If the lane width at the point farthest from the center of the intersection for the last segment on the lane edge is less than or equal to the lane width maximum

1. Finds the element that is not a curb return element, that has not been processed, that has the closest point on the element to the end of the last segment on the lane edge being nearest the end of the last segment on the lane edge, that has the minimum offset, that does not cause a reversal of direction, and that the distance from the closest point on the element to the end of the last segment on the lane edge is less than or equal to a small, non-zero distance (0.1 feet or 0.0348 meters)
 - a. If an element is found
 - i. Adds the element to the lane edge,
 - ii. Sets the element as having been processed, and
 - iii. Continues processing at Step 16.g.vi,
 - vii. Fixes any small gaps between adjacent lane edge segments,
17. For each leg of the alternative
 - a. Skips to the next leg if the leg is not the leg number to be processed,
 - b. For each inbound and outbound lane of the leg
 - i. Issues a warning message if there are no outer edge segments,
18. For each leg of the alternative
 - a. Skips to the next leg if the leg is not the leg number to be processed,
 - b. For each inbound and outbound lane of the leg that does not have an inner edge
 - i. If the lane is the median lane
 1. Copies the centerline to the inner edge for the lane potentially shifting the centerline to create a median, potentially trimming the centerline at the beginning to accommodate T intersections, potentially trimming the centerline at the beginning to not exceed the outer edge beginning station, and potentially trimming the centerline at the ending to not exceed the outer edge ending station,
 - ii. If the lane is not the median lane
 1. Issues a warning message and returns,
 - c. Determines the lateral distance between the inner edge and outer edge of the lane where the stop line would be positioned
 - d. If the lane width type is “L” for number of lanes
 - i. Calculates the lane width as the lateral distance divided by the number of lanes specified in Step 7.a,
 - e. If the lane width type is “W” for lane width
 - i. Calculates the number of lanes as the lateral distance divided by the lane width specified in Step 8.a and rounded to the nearest integer number of lanes with a minimum of 1 lane
 - ii. Issues a warning message and returns if the number of lanes is greater than 6,
 - iii. Calculates the lane width as the lateral distance divided by the number of lanes calculated in Step 18.e.i,
 - f. If the calculated lane width is less than the minimum of 8 feet or 2.4 meters or greater than the maximum of 15 feet or 4.5 meters then issues a warning message and returns,

- g. Adds additional lanes as needed to satisfy the number of lanes specified in Step 7.a or the number of lanes calculated in Step 18.e.i
 - i. Moves the previous lane outer edge segments to the new lane outer edge segments without changing their physical location,
 - ii. Copies the previous lane inner edge segments to the previous lane outer edge segments shifting the segments by the lane width calculated in Step 18.d.i or Step 18.e.iii,
 - iii. Copies the previous lane inner edge segments to the new lane inner edge segments shifting the segments by the lane width calculated in Step 18.d.i or Step 18.e.iii,
- 19. For each leg of the alternative
 - a. Skips to the next leg if the leg is not the leg number to be processed,
 - b. For each inbound and outbound lane of the leg
 - i. Fixes edges as needed for turn bays
- 20. For each leg of the alternative
 - a. Skips to the next leg if the leg is not the leg number to be processed,
 - b. For each inbound and outbound lane of the leg
 - i. Sorts the inner and outer edge segments,
- 21. For each leg of the alternative
 - a. Skips to the next leg if the leg is not the leg number to be processed,
 - b. Sorts each inbound and outbound lane of the leg,
- 22. Sorts the leg to be processed for the alternative,
- 23. For each leg of the alternative
 - a. Skips to the next leg if the leg is not the leg number to be processed,
 - b. For each inbound lane for the leg
 - i. Adds a stop line segment perpendicular to the centerline between the inner edge and outer edge at the station nearest the center of the intersection where both the inner edge and outer edge exist
 - ii. Calculates the lane length,
 - iii. Calculates the lane width,
 - c. For each outbound lane for the leg
 - i. Calculates the lane length,
 - ii. Calculates the lane width,
- 24. For each element that is a curb return element and has not been processed
 - a. Finds the leg that has the minimum distance from the beginning or ending point of the curb return element to the inbound median lane inner edge beginning point,
 - b. Finds the leg that has the minimum distance from the beginning or ending point of the curb return element to the inbound curb lane outer edge beginning point,
 - c. If the minimum distance from the beginning or ending point of the curb return element to the inbound median lane inner edge beginning point is less than the minimum distance from the beginning or ending point of the curb return element to the inbound curb lane outer edge beginning point
 - i. Adds a median lane curb return using the radius of the curb return element for the identified leg and

- ii. Sets the element as having been processed,
- d. If the minimum distance from the beginning or ending point of the curb return element to the inbound median lane inner edge beginning point is greater than or equal to the minimum distance from the beginning or ending point of the curb return element to the inbound curb lane outer edge beginning point
 - i. Adds a curb lane curb return using the radius of the curb return element for the identified leg and
 - ii. Sets the element as having been processed,
- 25. For each leg of the alternative that is completed
 - a. Skips to the next leg if the leg is not the leg number to be processed,
 - b. Finds the offset for the inbound median lane inner edge beginning point,
 - c. Finds the offset for the outbound median lane inner edge beginning point,
 - d. If one-half of the sum of the two offsets is greater than the curb return radius minimum (0.25 feet or 0.1 meters)
 - i. Adds a median lane curb return using the radius of one-half of the sum of the two offsets for the leg,
- 26. For any element that has not been processed for the leg number to be processed
 - a. Draws the element on the scratch level in red and
 - b. Issues a warning message,
- 27. Continues processing at Step 9.

CHAPTER 3 – PASSER II-90 INTERFACE

PASSER II was developed by the Texas Transportation Institute (TTI) at Texas A&M University. Most TxDOT engineers now prefer to use PASSER II for signal timing optimization. PASSER II has a user-friendly input processor that creates an input file. PASSER II reads the input file and creates an output file. PASSER II has an output processor that reads the output file and displays the results. The documentation for PASSER II describes the format of the input and output files. The IGIDS interface to PASSER II-90 consists of 1 command: Save To PASSER II-90.

The Save To PASSER II-90 command accesses geometry, traffic, and traffic signal data stored in the IGIDS database, performs the portion of the Highway Capacity Manual Chapter 9 (HCM CH9) procedures to calculate volume and saturation flow rate by lane groups (the user should modify any HCM CH9 values before executing the Save to PASSER II-90 command), and write the input data file for PASSER II-90 by performing the following logic (1989 lines of MDL):

1. Prompts the user to identify and accept an alternative if there is more than one alternative,
2. If the alternative does not have 4 legs then issues an error message and returns,
3. If the number of traffic signal controller phases is invalid then issues an error message and returns,
4. Opens a dialog box for the user to select an IGIDS PASSER II-90 file name using the default “c:\p290\P290DATA”,
5. If the alternative is not completed then issues an error message and returns,
6. Extracts and stores the TEXAS Model for Intersection Traffic Geometry and Driver-Vehicle Processor data from the IGIDS database,
7. Extracts and stores the TEXAS Model for Intersection Traffic Simulation Processor data from the IGIDS database,
8. If the type of intersection control is invalid then issues an error message and returns,
9. If the traffic signal controller is not Pretimed or single-ring NEMA then issues an error message and returns,
10. If the number of traffic signal controller phases is invalid then issues an error message and returns,
11. Performs the portion of the Highway Capacity Manual Chapter 9 procedures to calculate volume and saturation flow rate by lane groups,
12. Sums the saturation flow rate, volume, and minimum phase length by NEMA movement using the northbound leg as the NEMA 2 movement,
13. Sets the pretimed/actuated flag from the IGIDS traffic signal controller data,
14. For each leg of the alternative,
 - a. If the left turn saturation flow rate is zero
 - i. Adds the left turn volume to the straight volume,
 - ii. Sets the left turn volume to zero, and
 - iii. Sets the left turn minimum phase length to zero,
 - b. If the minimum phase length for the left turn movement is greater than 7 seconds then sets the minimum phase length for the left turn movement to 7 seconds,

- c. If the minimum phase length for the straight movement is greater than 10 seconds then sets the minimum phase length for the straight movement to 10 seconds,
- 15. Formats the PASSER II-90 input cards,
- 16. Writes the PASSER II-90 input cards to the specified output file.

The user would then execute PASSER II-90 outside of IGIDS and MicroStation/J by performing the following steps:

- 1. Start PASSER II-90 in the normal fashion.
- 2. From the PASSER II-90 Main Menu, choose option 2 Read old data from disk and specify the PASSER II-90 input file created by IGIDS.
- 3. From the PASSER II-90 Main Menu, choose option 3 Edit Data. From the Edit Menu, choose option 3 Edit intersection phasing data and review and modify the phasing patterns as needed.
- 4. From the PASSER II-90 Main Menu, choose option 6 Run PASSER II-90. From the Output Menu, choose options as necessary.
- 5. From the PASSER II-90 Main Menu, choose option 8 Quit.
- 6. From the IGIDS Side Bar Menu, select TOOLS->Traffic->Controller->Timing and modify the traffic controller timing based upon PASSER II-90 recommendations and your judgment.

CHAPTER 4 – HIGHWAY CAPACITY MANUAL CHAPTER 9 PROCEDURES

The Highway Capacity Manual Chapter 9 procedures were developed as an internal analysis process to IGIDS. IGIDS was modified to use the Operational Analysis calculation methods described in Chapter 9 Signalized Intersections of the Highway Capacity Manual, Special Report 209, Third Edition, Transportation Research Board, National Research Council, Washington, D.C., 1998.

Before using the HCM function, the intersection geometry, lane channelization, traffic control device characteristics, traffic turning movement volumes, and peak hour factors must be entered into the IGIDS database. This is to be done by using the suitable IGIDS functions.

Data may be entered into an HCM dialog box in three ways. Data may be entered into a text box with a white background (Figure 4.1). A text box with a gray background (Figure 4.2-a) will display data, but cannot be used for data entry. There is usually an upper and lower limit on the value of numeric data that can be entered into a text box. An option button (Figure 4.1) can be used to choose from a set of appropriate data. To use an option button, click on the option button to see the options and then click on the item of choice, which will then be shown in the option button. A check box may be checked (Figure 4.2-c) or not checked (Figure 4.2-a) to enable or disable an option.

Section A		Section B			
Text box		Option button			
1	St.Lst.Tm./Mvmt: 2.0	AreaType: <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Eff.Gr.Ext./Mvmt: 2.0	CBD	NB Leg 3	SB Leg 1	EB Leg 4 WB Leg 2
	Percent Heavy Vehicles	8	8	5	5
	Grade, %	0	0	0	0
	Parking Manuvers/Hour	No P	No P	No P	No P
2	BUSES Stopping/Hour	0	0	0	0
	Conflicting Peds/Hour	100	100	100	100
	Lane Saturation Flow	1900	1900	1900	1900
	Use Lane Util. Fact	YES	YES	YES	YES
	Arrival Type	3	3	4	2
3	<input type="button" value="Adj. Vol."/> <input type="button" value="Sat. Flow"/> <input type="button" value="Capacity"/> <input type="button" value="LOS"/> <input type="button" value="View Data"/>				
4	<input type="button" value="Calculate and Plot"/> <input type="button" value="V/C"/> <input type="button" value="Delay"/> <input type="button" value="Calculate"/> <input type="button" value="Del Gra"/> <input type="button" value="Done"/> <input type="button" value="Cancel"/>				

Figure 4.1 HCM main dialog box

The HCM main dialog box is shown in Figure 4.1. It may be used for entry of data that is specific to HCM calculations and for reviewing the calculated data.

Zone A-1 in Figure 4.1 has 2 text boxes and 1 option button for data that applies to the entire intersection:

- St.Lst.Tm./Mvmt. - (starting lost time per movement) Time lost at the beginning of a movement when the first several vehicles in the queue are moving at less than the saturation flow rate (0.0 to 5.0 sec.).
- Eff.Gr.Ext/Mvmt. - (effective green extension per movement) Time during the clearance interval when vehicles continue to enter the intersection (0.0 to 5.0 sec.).
- Area Type - Choose “CBD” (Central Business District) or “Other”. CBD indicates that the intersection is subject to the relative inefficiency of business area intersections.

Zone B-1 in Figure 4.1 has headings for the four approaches. For each approach, there is a sketch indicating the direction of inbound lanes and a label with inbound direction and leg number.

Zone A-2 in Figure 4.1 has labels for 8 data items that define traffic conditions at the intersection. Zone B-2 in Figure 4.1 has option buttons for each of these items for the four approaches. If an option button does not include exactly the value that you wish to use, choose the available option that best fits your problem. It may be desirable to make two calculations, one with the options nearest your preferred value but smaller and one with the options nearest your preferred value but larger. For an approach with no inbound lanes, option buttons for the approach are dimmed and not usable. The 8 data items are:

- Percent Heavy Vehicles - Percentage of vehicles in the traffic stream with more than four wheels touching the ground.
- Grade, % - Percent grade seen by inbound vehicles, with uphill being positive.
- Parking Maneuvers/Hour - Number of vehicles that enter or leave a parking place adjacent to the lane group. Note that 0 and No P (No Parking) are different.
- Buses Stopping/Hour - Number of local transit busses that stop for passengers with 250 feet (upstream or downstream) of the stop line.
- Conflicting Peds/Hour - Number of pedestrians per hour that conflict with turning vehicles.
- Lane Saturation Flow - Ideal saturation flow rate per lane.
- Use Lane Util. Fact - Choose “YES” or “NO”. “YES” uses the calculated lane utilization factor when calculating saturation flow. “NO” indicates that lane volumes within groups are assumed balanced, forcing a lane utilization factor of 1.0.
- Arrival Type - Code to indicate quality of progression:
 1. Dense platoon arriving at start of red interval,
 2. Moderately dense platoon arriving at middle of red interval or dispersed platoon arriving throughout red interval,

3. Random arrivals,
4. Moderately dense platoon arriving at middle of green interval or dispersed platoon arriving throughout green interval,
5. Dense to moderately dense platoon arriving at start of green interval, and
6. Exceptional, near ideal progression.

Zone 3 in Figure 4.1 has 5 buttons to open additional dialog boxes. The 4 leftmost buttons activate dialog boxes for 4 HCM modules: Volume Adjustment, Saturation Flow, Capacity, and Level of Service. In each dialog box, calculated data items may be reviewed with provision to override some items. The rightmost button activates a dialog box for viewing and printing module data and supplementary worksheets arranged on forms using the default browser.

The 4 HCM module dialog boxes have some common features, shown in Figure 4.2. Each HCM module dialog box has an option button labeled “Approach:” for choosing one of the four approaches. An approach with no inbound lanes is dimmed (“SB” in Figure 4.2-b) and cannot be chosen. Each HCM module dialog box has an option button for choosing a lane group. Choices in the “Lane Group” option button (Figure 4.2-c) will include the specific lane groups for the chosen approach. A group will be a combination of movements including “LT” (left turn), “TH” (through) and “RT” (right turn). For approaches with protected and permissive left turns, both “LT(Pri)” (Figure 4.2-d) and “LT(Sec)” will be seen. An “*” following a lane group identifies a critical group. “Not current” (Figure 4.2-a) in the Lane Group option button means that HCM data has not yet been calculated and is invalid.

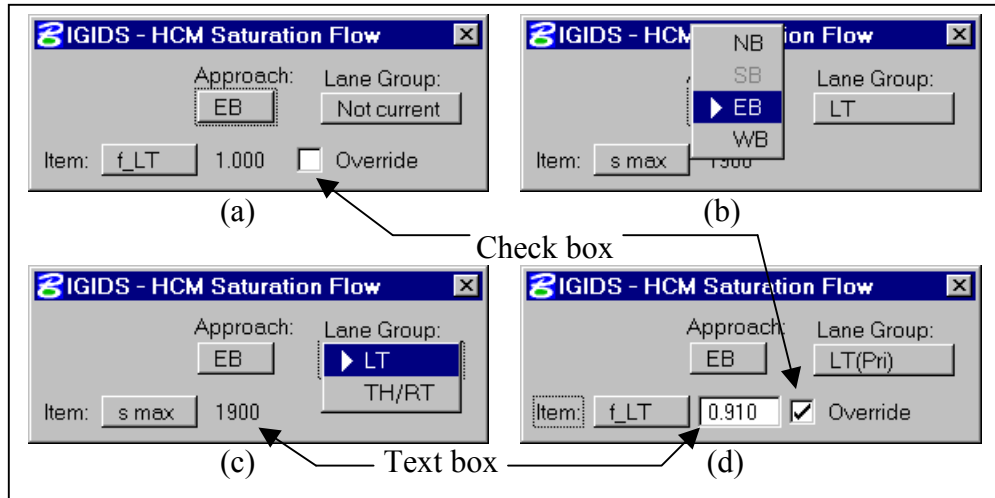


Figure 4.2 Typical HCM module dialog box

In each HCM module dialog box, a data item is chosen with the “Item” option button. Items for the 4 modules are described in sections below.

Calculated or user entered data for the chosen Approach, Lane Group and Item is shown in the text box (Figure 4.2-c). If it is permitted to override the calculated value, the “Override” check box is shown (Figure 4.2-d). If checked, the text box is enabled for data entry and a value to override the calculated value may be entered. After overriding a

value, HCM calculations must be redone for the override to take effect. The value shown in the text box with override unchecked was used in the most recent HCM calculation.

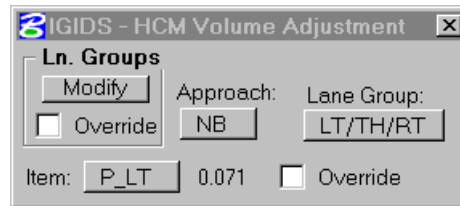


Figure 4.3 Volume Adjustment dialog box

Volume Adjustment items are shown in Table 4.1. Some items are associates with traffic movements and some with lane groups. The Lane Group option button label will change to reflect this.

Table 4.1 Items in Volume Adjustment dialog box

Item	Description	Movement	Lane group
V	Movement Volume V (vph)	X	
PHF	Peak Hour Factor PHF	X	
v_p	Flow Rate V_p	X	
V	Adjusted Flow Rate in Lane Group v		X
P_LT	Proportion of Left Turns in Lane Group P_{LT}		X
P_RT	Proportion of Right Turns in Lane Group P_{RT}		X

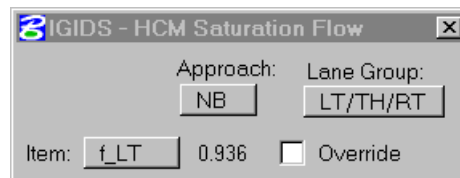


Figure 4.4 Saturation Flow dialog box

Saturation Flow items are shown in Table 4.2. Some items are associates with traffic movements and some with the approach. The Lane Group option button will be hidden for items that apply to the approach.

Table 4.2 Items in Saturation Flow dialog box

Item	Description	Group	Approach
s _{max}	Ideal Saturation Flow	X	
N	Number of Lanes N	X	
f _w	Lane Width Factor f_w	X	
f _{HV}	Heavy Vehicle Factor f_{HV}		X
f _g	Grade Factor f_G		X
f _p	Parking Factor f_p	X	
f _{bb}	Bus Blockage Factor f_{BB}	X	
f _a	Area Type Factor f_A		X
f _{LU}	Lane Utilization Factor f_{LU}	X	
f _{RT}	Right Turn Factor f_{RT}	X	
f _{LT}	Left Turn Factor f_{LT}	X	
S	Adjusted Saturation Flow Rate s	X	

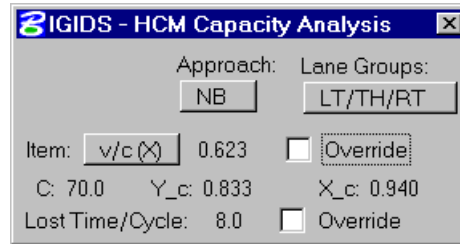


Figure 4.5 Capacity Analysis dialog box

Capacity Analysis items are shown in Table 4.3. The first 6 items are lane group related, while the last 4 apply to the intersection.

Table 4.3 Items in Capacity Analysis dialog box

Item	Description	Ln. Group	Intersection
V	Adjusted Flow Rate v	X	
S	Adjusted Sat. Flow Rate s	X	
v/s	Flow Ratio v/s	X	
g/C	Green Ratio g/C	X	
C	Lane Group Capacity c	X	
v/c (X)	Lane Group v/c Ratio X	X	
C	Cycle Length C		X
Y _c	Y_c		X
X _c	X_c		X
Lost Time/Cycle	Lost Time per Cycle L		X

IGIDS - HCM Level of Service

Approach: NB Lane Groups: LT/TH/RT

Item: v/c (X) 0.623

Delay: Approach: 16.0 LOS: B

Intersection: 35.4 LOS: D

Figure 4.6 Level of Service dialog box

Level of Service items are shown in Table D. All are lane group related. At the bottom of the dialog box, Delay and Level of Service for the chosen approach and also the intersection are shown:

Table 4.4 Items in Level of Service dialog box

Item	Description
v/c (X)	Lane group v/c Ratio X
g/C	Green Ratio g/C
d ₁	Uniform Delay d₁
PF	Progression Adjustment Factor PF
C	Lane group capacity c
T	Duration of analysis period, hours
K	d ₂ calibration Term k
I	Upstream factor
d ₂	Incremental Delay d₂
d ₃	Residual demand delay
Delay	Lane Group Delay
LOS	Lane Group Level of Service LOS

IGIDS - HCM View Data

Input Capacity

Signal

Vol Adj

Sat Flow

Fig 9-17

Fig 9-18

Level of Serv.

LOS

Supp. Unif. Delay

Reload All

Dec 21, 2000 10:48:14 AM

Figure 4.7 View Data dialog box

Each time the HCM data is recalculated, files in with data for each module and any necessary worksheets are created. These files are in HTML format and can be

viewed using a web browser such as Microsoft Internet Explorer or Netscape Navigator. The View Data dialog box has an option button for each file that may be created. A button with dimmed text indicates that the form was not created during the most recent HCM calculation. To view a file, click the appropriate button to have the file opened in the computer's default browser. The browser's print function may be used to for printing. Date and time at bottom of dialog box are when the most recent calculation was done.

Zone 4 in Figure 4.1 has 6 buttons to control HCM processing. The leftmost 3 buttons each initiate an HCM recalculation. The "V/C" button also plots the v/c ratio for each lane group. The "Delay" button also plots vehicle seconds of delay for each lane group and total delay for the approach, with an additional plot with approaches and intersection total. In each case, the plot is positioned near the corresponding leg, with plot for approach and intersection delay near the intersection center. The "Del Gra" button deletes any graphics that were plotted by above procedure. The "Done" button saves all HCM data to the IGIDS database and closes the HCM dialog boxes. The "Cancel" button closes the HCM dialog boxes without saving and data. Clicking the close box at the very top right of the dialog box is same as "Cancel".

CHAPTER 5 – IGIDS TRAINING MATERIALS

The IGIDS training materials includes the IGIDS User's Manual as a Microsoft Word document, an overview of IGIDS as a Microsoft PowerPoint presentation, the training course as a Microsoft Word document, and the training course as a Hyper Text Markup Language (HTML) file for the web. Each of these training materials was updated to reflect the additions, modifications, and enhancements to IGIDS performed during this project. All of the files are available through the University of Texas at Austin Department of Civil Engineering's anonymous ftp site and web page:

<http://www.ce.utexas.edu/prof/rioux/pub/igids/igids.htm>
<ftp://ftp.ce.utexas.edu/igids/>
<ftp://ftp.ce.utexas.edu/igids/documentation/>
ftp://ftp.ce.utexas.edu/igids/training_manual/html/
ftp://ftp.ce.utexas.edu/igids/training_manual/word/
<ftp://ftp.ce.utexas.edu/igids/igids.ppt>

The IGIDS software is also available through The University of Texas at Austin, Department of Civil Engineering's anonymous ftp site:

<ftp://ftp.ce.utexas.edu/igids/readme.txt>
<ftp://ftp.ce.utexas.edu/igids/dos/ustn50/>
<ftp://ftp.ce.utexas.edu/igids/dos/ustn55/>
<ftp://ftp.ce.utexas.edu/igids/winnt/ustn50/>
<ftp://ftp.ce.utexas.edu/igids/winnt/ustn55/>
<ftp://ftp.ce.utexas.edu/igids/winnt/ustn57/>
<ftp://ftp.ce.utexas.edu/igids/winnt/ustn70/>
<ftp://ftp.ce.utexas.edu/igids/winnt/ustn71/>

A test training session was held for 11 TxDOT employees at the Houston District Office on August 22-24, 2001. Comments and recommendations from the test training session were incorporated in the training materials.

CHAPTER 6 – SUMMARY AND RECOMMENDATIONS

The Interactive Graphics Intersection Design System (IGIDS) is a computer software program developed for TxDOT that assists engineers in the analysis and design of individual, at-grade intersections. IGIDS is a MicroStation application which contains (1) geometric, traffic data, and signalization definition tools including an interface for files created by GEOPAK; (2) built-in analysis tools for vehicle turning templates; horizontal sight distance checking for stop sign, yield sign, and no control; vertical sight distance checking within the horizontal sight triangle; pavement striping definition and tabulation; and the 1998 Highway Capacity Manual (HCM) Chapter 9 procedures; and (3) interfaces to external analysis programs for the TEXAS Model for Intersection Traffic (TEXAS), PASSER II-90, the TxDOT Automated Plan Preparation System (APP), and the Signal Operations and Analysis Package (SOAP). IGIDS can operate in English or metric units. IGIDS has an extensive web-based training course. IGIDS software, documentation, and training materials are available through the University of Texas at Austin Department of Civil Engineering's anonymous ftp site and web page.

IGIDS should continue to be implemented statewide within TxDOT. Computer software developed in this project should be distributed throughout TxDOT and used to analyze and design isolated intersections. TxDOT personnel in major urban district offices should be trained to use IGIDS and the new enhancements.

IGIDS should continue to be enhanced as TxDOT design professionals recommend additional features. There is great benefit to TxDOT to have most of the intersection analysis and design tools coordinated by IGIDS where duplication of effort can be minimized and a consistent interface presented in a CAD environment.

REFERENCES

1. Lee, Clyde E., Thomas W. Rioux, and Charlie R. Copeland, "The TEXAS Model for Intersection Traffic - Development", Research Report 184-1, CFHR 3-18-72-184-1, Center for Highway Research, The University of Texas at Austin, Austin, Texas, December 1977.
2. Lee, Clyde E., Thomas W. Rioux, Vivek S. Savur, and Charlie R. Copeland, "The TEXAS Model for Intersection Traffic - Programmer's Guide", Research Report 184-2, CFHR 3-18-72-184-2, Center for Highway Research, The University of Texas at Austin, Austin, Texas, December 1977.
3. Lee, Clyde E., Glenn E. Grayson, Charlie R. Copeland, Jeff W. Miller, Thomas W. Rioux, and Vivek S. Savur, "The TEXAS Model for Intersection Traffic - User's Guide", Research Report 184-3, CFHR 3-18-72-184-3, Center for Highway Research, The University of Texas at Austin, Austin, Texas, July 1977.
4. Rioux, Thomas W., and Clyde E. Lee, "TEXAS - A Microscopic Traffic Simulation Package for Isolated Intersections", 56th Annual Meeting of the Transportation Research Board, Washington, D. C., January 1977 and Transportation Research Record 644, 1977, pages 45-51.
5. "SOAP84 User's Manual", FHWA-IP-85-7, Federal Highway Administration, U. S. Department of Transportation, January 1985.
6. "SOAP84 Data Input Manual", FHWA-IP-85-8, Federal Highway Administration, U. S. Department of Transportation, January 1985.
7. Lee, Clyde E., Robert F. Inman, and Wylie M. Sanders, "User-Friendly TEXAS Model - Guide to Data Entry", Research Report 361-1F, CTR 3-18-84-361-1F, Center for Transportation Research, The University of Texas at Austin, Austin, Texas, November 1985.
8. "Vehicle Turning Characteristics For Use In Geometric Design", Geometric Design Section, Highway Design Division, State Department of Highways and Public Transportation, Austin, Texas, 1987.
9. Chang, Edmond Chin-Ping, Lei, James Chiang-Kou, and Messer, Carroll J., "PASSER II-87 Microcomputer User's Guide", Research Report 467-1, Texas Transportation Institute, Texas A&M University, 1988.
10. "Supplement to SOAP84 User's Manual", FHWA-IP-85-7, Transportation Research Center, University of Florida, Gainesville, Florida, September 1988.
11. Lee, Clyde E., Randy B. Machemehl, and Wiley M. Sanders, "TEXAS Model Version 3.0 (Diamond Interchanges)", Research Report 443-1 F, Center for Transportation Research, The University of Texas at Austin, Austin, Texas, January 1989.
12. A Policy on Geometric Design of Highways and Streets 1990, American Association of State Highway and Transportation (AASHTO), 1990.
13. Rioux, Thomas W., "Simulation of Diamond Interchange Traffic Operations", 70th Annual Meeting of the Transportation Research Board, Washington, D. C., January 1991.
14. Rioux, Tom, Robert Inman, Randy B. Machemehl, and Clyde E. Lee, "TEXAS Model for Intersection Traffic - Additional Features", Research Report 1258-1F,

- CTR 3-18-91/2-1258-1F, Center for Transportation Research, The University of Texas at Austin, Austin, Texas, January 1993.
15. "MicroStation Customer Support Library Reference Manual", Version 4 for Clix, DOS, and MAC, Document DSYS11540, Bentley Systems, Inc. and Intergraph Corporation, 1990.
 16. Rioux, Thomas W., Robert F. Inman, Charles H. Berry, Clyde E. Lee, and Randy B. Machemehl, "Interactive Graphics Intersection Design System: First Stage Development", Research Report 1139-1F, Center for Transportation Research, The University of Texas at Austin, Austin, Texas, November 1991.
 17. "MicroStation User's Guide", Version 4 for Clix, Document DGA051410, Bentley Systems, Inc. and Intergraph Corporation, 1991.
 18. "MicroStation Reference Guide", Version 4 for Clix, Document DGA051710, Bentley Systems, Inc. and Intergraph Corporation, 1991.
 19. "MicroStation MDL Manual", Version 4 for DOS, Document DGA022410, Bentley Systems, Inc. and Intergraph Corporation, 1991.
 20. "MicroStation User's Guide", Version 5, Document DGA0514110, Bentley Systems, Inc. and Intergraph Corporation, September 1993.
 21. "MicroStation Reference Guide", Version 5, Document DGA054210, Bentley Systems, Inc. and Intergraph Corporation, September 1993.
 22. "MicroStation Development and Support Guide", Version 5, Document DGA054310, Bentley Systems, Inc. and Intergraph Corporation, September 1993.
 23. "MicroStation MDL Programmer's Guide", Version 5, Document DGA055010, Bentley Systems, Inc. and Intergraph Corporation, November 1993.
 24. "MicroStation MDL Function Reference Manual", Version 5, Document DGA055110, Bentley Systems, Inc. and Intergraph Corporation, December 1993.
 25. Rioux, Thomas W., Robert F. Inman, Randy B. Machemehl, and Clyde E. Lee, "Interactive Graphics Intersection Design User's Manual", Research Report 1308-1F, Center for Transportation Research, The University of Texas at Austin, Austin, Texas, December 1994.
 26. A Policy on Geometric Design of Highways and Streets 1994, American Association of State Highway and Transportation (AASHTO), 1994 (Metric).
 27. Highway Capacity Manual Special Report 209, Transportation Research Board, National Research Council, Washington, D.C., Third Edition, 1994.
 28. "MicroStation 95 Academic Suite PC Setup Guide", Bentley Systems, Inc., 1995.
 29. "MicroStation 95 Academic Suite User's Guide", Bentley Systems, Inc., 1995.
 30. "GEOPAK", GEOPAK Corporation, North Miami Beach, Florida, 1996.
 31. "MicroStation 95 Academic Suite Upgrade Guide", Bentley Systems, Inc., 1996.
 32. 1980 Texas Manual on Uniform Traffic Control Devices for Streets and Highways, Texas State Department of Transportation, Austin, Texas, 1980, with Revision 6, 1996.
 33. "McTrans Newsletter", Center for Microcomputers in Transportation, Transportation Research Center, University of Florida, Gainesville, Florida, 1997.
 34. Rioux, Thomas W., Robert F. Inman, Randy B. Machemehl, and Clyde E. Lee, "Interactive Graphics Intersection Design System (IGIDS) Training Manual", Research Report Number 0-1291-1, Center for Transportation Research, The University of Texas at Austin, Austin, Texas, January 1998.

35. Highway Capacity Manual Special Report 209, Transportation Research Board, National Research Council, Washington, D.C., Third Edition, 1998.