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A Personal Computer Program for Drawing Accident Sites

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A Personal Computer Program for Drawing Accident Sites

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ABSTRACT

A personal computer program for drawing accident sites is described. The program design is reviewed and hardware requirements are defined. Standard features are explained and features unique to the needs of the accident reconstructionist, such as photogrammetry and a built-in accident site template, are presented. Its use with other computer accident reconstruction programs is illustrated. It is seen that the scaled accident site diagram provides an important element to the reconstruction, both as an analytical tool as well as a presentation tool.

ACCIDENT RECONSTRUCTION requires a combination of skills, including the ability to analyze information and present the results of that analysis to others. The analysis and presentation require the preparation of a scale diagram of the accident site. This paper describes a personal computer program, called EDCAD (Engineering Dynamics Computer-Aided Drafting), which has been designed and developed specifically to meet the analysis and presentation needs of the accident reconstructionist.

Program Description

EDCAD is a computer-aided drafting (CAD) program which follows the user's instructions to make a two-dimensional, scale diagram of the accident site. The instructions are provided in the form of measurements and labels which describe the accident site. The program uses these instructions to produce drawing entities (basic drawing elements, such as arcs, circles, fills, lines, merged results, pre-defined shapes and text) with the desired attributes (line type, color, etc.). A movable crosshairs is used to position the entities.

*Numbers in brackets designate references at the end of the paper.

The benefits of computerized drafting over conventional manual drafting include speed and accuracy, ease of making major modifications, additions and deletions, and the ability to rescale the drawing without having to start over. An entire drawing can be stored on a diskette and redrawn at a later date with virtually no manual labor. CAD is to drafting what word processing is to writing.

EDCAD is actually a mapping tool. It differs from other classical mechanical/architectural computer-aided drafting programs because its coordinate system, built-in accident site traffic template, photogrammetry feature, and ability to merge animated simulation results are designed for use by accident reconstructionists.

PROGRAM DESIGN

The EDCAD program is designed to integrate with other EDVAP [1]* programs. Therefore, its structure is similar to EDVAP. It uses the same Program Menu format (described below) and default data file concept (the last file is always saved for a future rerun). However, there are also many additional features. The most obvious new capabilities are the use of graphic interfaces, such as mice and plotters. EDCAD also creates a random-access data file, rather than a sequential-access ASCII file, to allow quicker and more flexible file editing operations.

Program Menu

The EDCAD program is structured by menus which control program execution and flow. The Program Menu (see figure 1) displays the list of options initially available by prompting the user to select a menu number:

1 - First-run, interactive session - This option starts EDCAD with a fresh screen. All drawing attributes (line type, fonts, colors, etc.) will be reset to their original values.

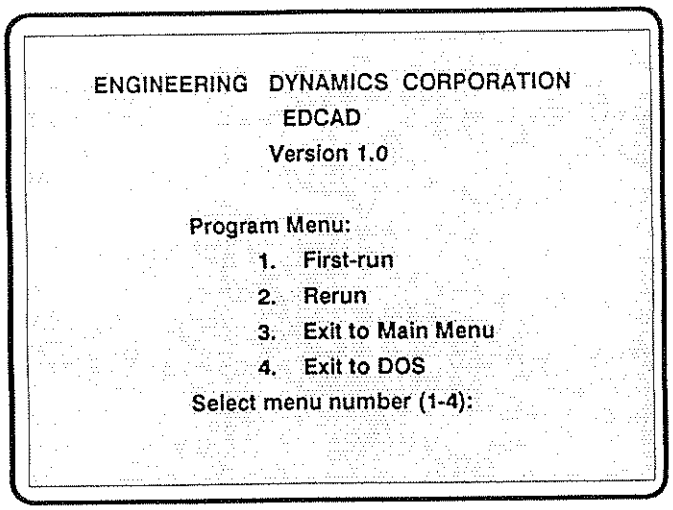

Figure 1 - EDCAD Program Menu which displays the beginning four options.

2 - Rerun with input from a previous session - This option redisplays a previously-saved drawing file. This option is usually selected in order to edit, add to, or print/plot a previously prepared drawing.

3 - Exit to Main Menu - This option closes all files and returns control to the EDVAP Main Menu. The user may then execute another EDVAP program, run the installation program or return to DOS.

4 - Exit to DOS - This option closes all files and returns control directly to DOS.

Main Screen Layout

By selecting 1 (first-run) or 2 (rerun) from the Program Menu, the EDCAD Main Screen is displayed (see figure 2). The Main Screen is divided into the drawing area (empty for a first run or displaying the prior accident site for a rerun), the command menu and several other important areas described in figure 2. The X-Y coordinates of the crosshairs are always displayed in the lower right corner.

Three-level Program Structure

EDCAD is designed around a three-level program structure. These levels are:

Command Level - Selecting from the Command Menu
Option Level - Selecting a command option
Data Entry Level - Entering data

The command level is the primary program level; the option level is next and the data entry level is last. Pressing *ESCape* always causes the program to step back to the previous level (i.e., from the data entry level to the option level, or from the option level to the menu level. This structured approach has been found to prevent the user from getting lost.

The flow chart in figure 3 shows the Menu Level program loop. Other than moving the crosshairs, which is possible at all three program levels, only one action can take place at the command level: A command or function can be chosen. Control is then transferred to the option

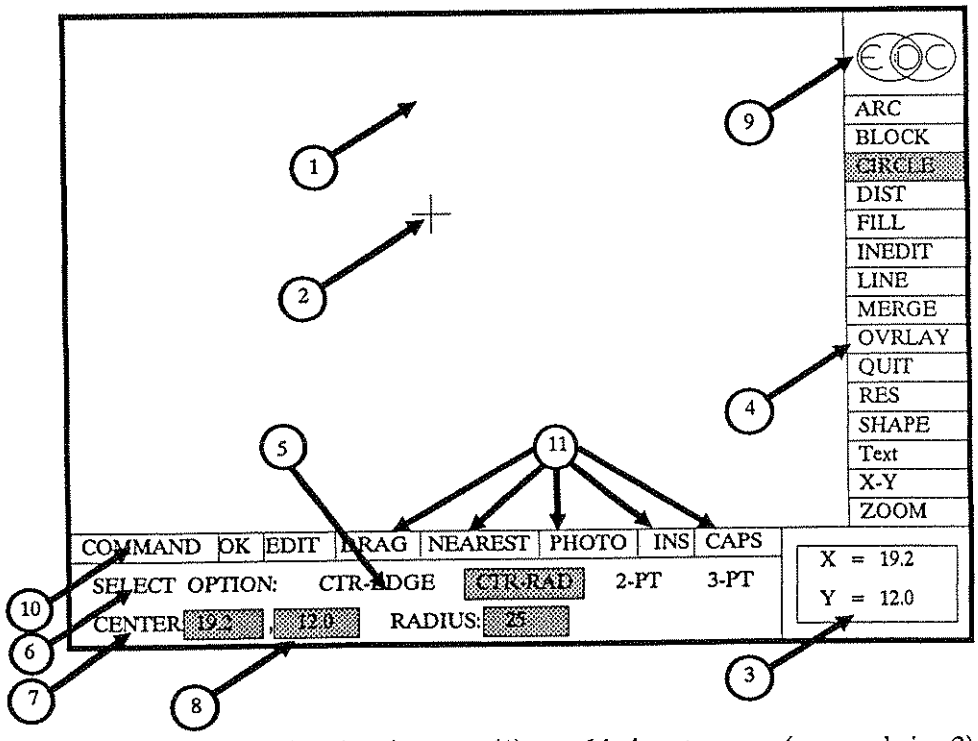

Figure 2 - Main Screen Layout, showing drawing area (1), graphic input cursor (or crosshairs, 2), X-Y coordinate display box (3), command selection menu (4), option selection menu and data entry area (5), option list (6), question prompts (7), data entry box (8), "ESCape box" (9), and miscellaneous "status boxes" (10,11).

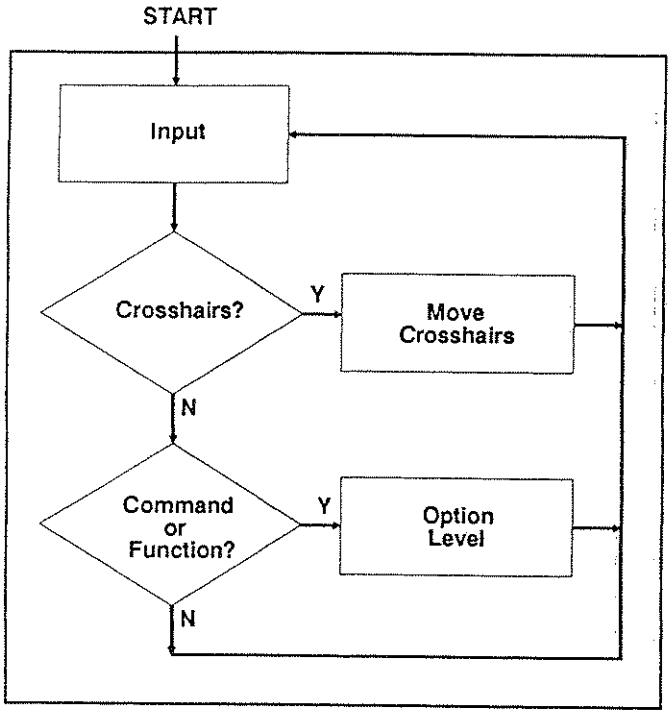

Figure 3 - Main Level Loop Flow Chart

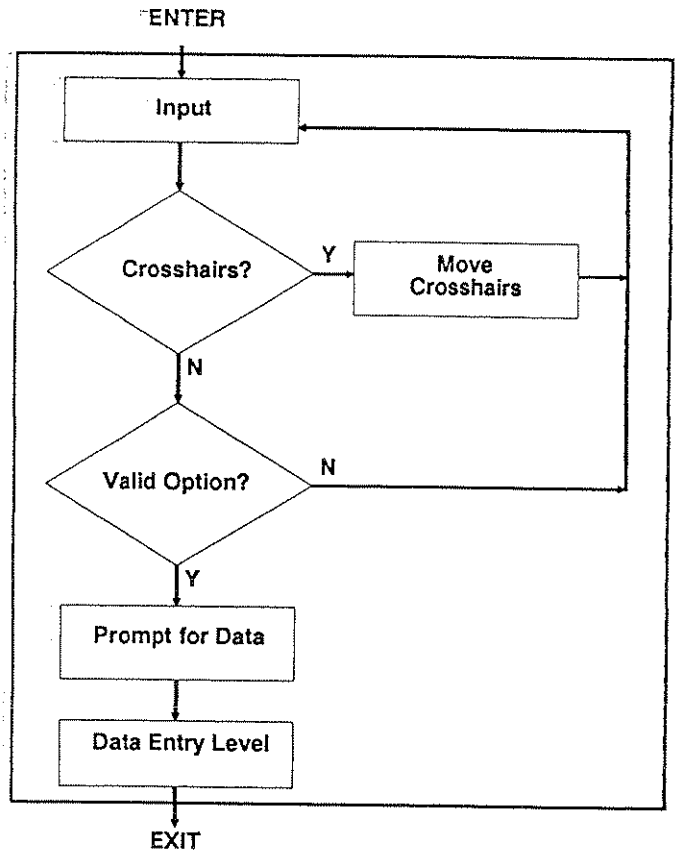

Figure 4 - Option Level Flow Chart

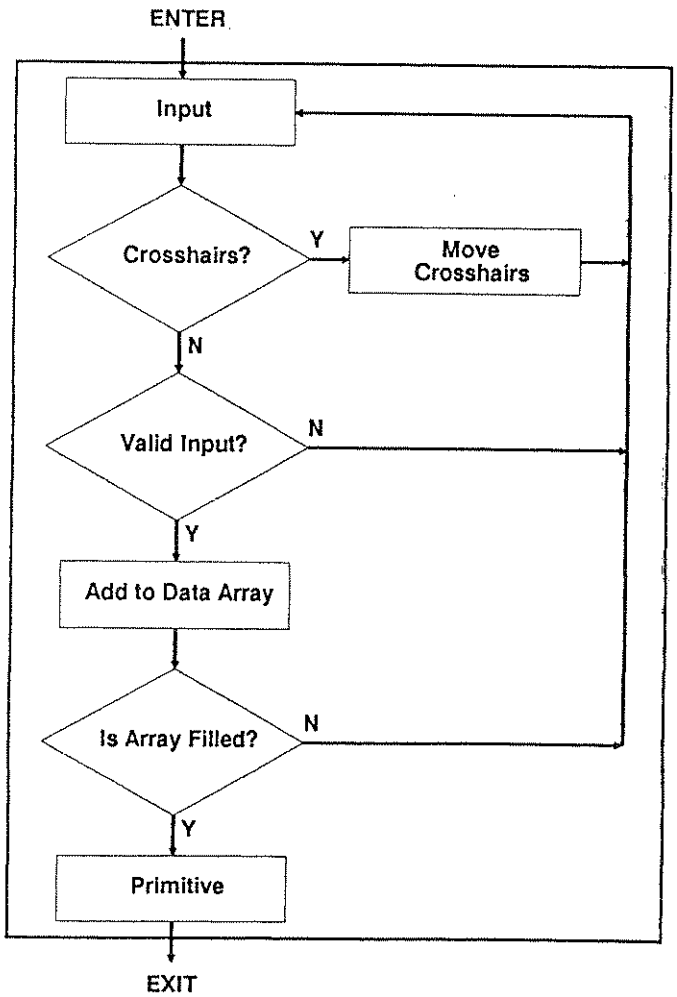

Figure 5 - Data Entry Level Flow Chart

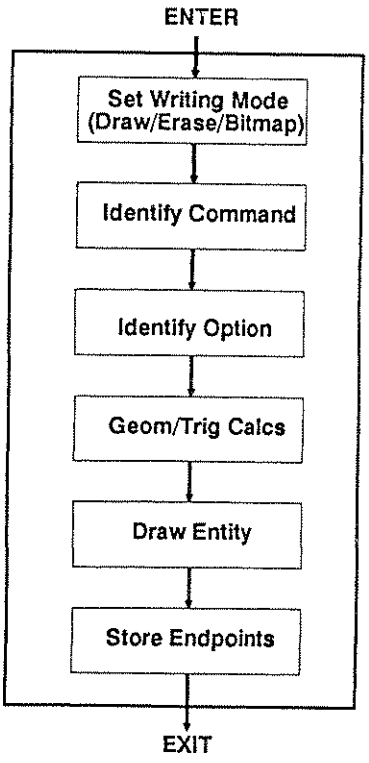

Figure 6 - Primitive Drawing Flow Chart

level. The entire program structure is built around this simple concept.

The flow chart in figure 4 describes the Option Level. At this level, the options associated with the chosen command or function are presented and selected, the appropriate data prompts are displayed, and control is transferred to the data entry level.

The flow chart in figure 5 shows the Data Entry Level. At this level, the user is prompted for the necessary input data. The data is then entered and stored in a data array. When the array has all the appropriate data, control is transferred to the primitive drawing subroutine.

The primitive subroutine, figure 6, first sets the writing mode (various operations use different techniques to display and erase data). Next, Primitive identifies the command and options, reads the data array, performs the required mathematical calculations to convert the input data into the format required by the entity (arc, circle, etc.) and, finally, performs the drawing operation. No user interaction occurs during this subroutine.

At the conclusion of the data entry loop, control is returned to the main loop, the drawing file is updated, and EDCAD awaits the user's next command or function.

PROGRAM TECHNICAL DATA

EDCAD is written in structured Microsoft QuickBASIC. It is divided into three modules containing 76 callable subroutines and 29 in-line subroutines totalling approximately 6500 lines of code. EDCAD is compiled using the QuickBASIC runtime module, BRUN40.EXE, and the Microsoft Version 3.61 Overlay Linker.

Object libraries

EDCAD uses a library of assembly language graphics subroutines, called GSS*CGI, developed by Graphic Software Systems. The object libraries are added to the EDCAD object modules during the linking process.

Device Drivers

EDCAD uses GSS*CGI device drivers, also developed by Graphic Software Systems, to provide device independence. This means that EDCAD will perform on many different computer configurations, including many different types of graphics display adapters, printers and plotters.

Hardware Requirements

EDCAD runs on IBM compatible personal computers with 640 kb of random access memory (RAM) and a hard disk.

A graphics display adapter is required. Those adapters currently supported include the CGA (color graphics adapter), the EGA (enhanced graphics adapter) and the Hercules graphics adapter.

A printer or plotter is required for a hard copy of the results. Virtually all IBM-compatible dot-matrix printers are supported. Hewlett-Packard and Houston Instrument plotters (and their compatibles) are currently supported. Calcomp plotters will be supported soon.

A math coprocessor is not required, but will increase the speed of the calculations (CAD programs are quite math-intensive).

A mouse (pointing device for input) is not required, but greatly increases the user's efficiency while entering data. Microsoft and Mouse Systems mice are supported.

Input Devices

EDCAD uses the computer's keyboard as the primary input device. All commands and functions can be selected using the keyboard. The keyboard's cursor controls can be used to position the crosshairs for graphic input. The keyboard can also be used to enter graphic data (X,Y coordinates, lengths, angles and text strings).

A mouse can also be used to select commands, options and functions as well as quickly position the crosshairs for graphic input.

Output Devices

The output devices used by EDCAD are the computer's video display, dot-matrix graphics printers and single or multi-pen plotters. The display is the primary output device. Printers and plotters are used for reports and presentations, as well as for scaled diagrams to be used for analysis. Some video display adapters allow the output to be routed directly to a VCR.

PROGRAM FEATURES

The EDCAD program has a feature set common to most computer-aided drafting programs as well as features unique to the needs of the accident reconstructionist. This feature set is described below.

Command Menu - All commands for drawing and editing are displayed in alphabetical order along the right side of the screen, and are selected using a keyboard or a mouse.

Command Options - Optional methods of data entry are available for most commands.

Interactive Input - EDCAD responds to the input data as it is entered, thus insuring correct syntax.

On-line Help - The *HELP* function provides direct, on-screen access to a file containing the equivalent of more than 50 typewritten pages of detailed information for each of the commands, options, and data entry formats.

Correcting Drawing Errors - EDCAD has functions which erase errors. If an item is erased by mistake, it can be restored.

Merging - The output from other EDVAP programs, currently EDSVS, EDVTS, EDCRASH and EDSMAC, can be merged automatically onto a finished site drawing.

Site Template - EDCAD has a built-in library of pre-drawn objects, such as vehicles and highways, which make it possible to *compose* an accident site very quickly.

Printing and Plotting - Hard copies of EDCAD drawings can be produced on dot-matrix printers and single- or multi-pen plotters.

Editing Drawings - EDCAD creates a drawing file which can be edited. This is accomplished using a built-in drawing file editor called *INEDIT*.

Multiple Drawing Overlays - Up to eight separate overlays, or drawing layers, are allowed and may be displayed individually or simultaneously. This allows the accident scene to be drawn on one overlay, the skids and gouges on another, and the vehicles on a third. Various accident scenarios may be presented on the remaining overlays.

Commands and Functions

EDCAD has seventeen commands and twelve functions which are used to create and modify drawings. These commands and functions are summarized below.

Commands

The following commands are available, displayed along the right side of the computer display:

ARC - draws circular and non-circular arcs (spline curves) using three different options.

BLOCK - copies and moves blocks of entities.

CIRCLE - draws circles using four different options.

DIST - determines the distance between two points, including the X and Y components and angle relative to the X axis. *DIST* can also be used to triangulate between two points.

ERASE - erases individual drawing layers or the entire drawing.

FILL - floods an area with a pre-defined pattern.

GOTO - moves the crosshairs to a specified point on the drawing.

INEDIT - invokes the drawing file editor, which is used to review and modify any portion of the drawing.

LINE - draws straight lines using five different options.

MERGE - automatically adds the results of a previous EDCRASH, EDSMAC, EDSVS or EDVTS analysis to the EDCAD accident site drawing. Vehicles are displayed at selected time intervals or locations.

OVRLAY - selects up to eight drawing overlays which may be individually or simultaneously displayed.

QUIT - saves the drawing file and returns to the Program Menu.

RES - selects the desired drawing resolution (the incremental distance the crosshairs moves), ranging from 1/100 feet to 10 feet.

SHAPE - creates and displays complete objects. EDCAD has a library of pre-defined shapes called the Site Template which contains pre-drawn vehicles, intersections and objects commonly found at accident sites.

TEXT - adds graphic text to the drawing using four different options. Graphic text can be displayed at any size and angle.

X-Y - displays an X-Y coordinate axis system on the drawing (four types are available).

ZOOM - sets the scale and selects the portion of the drawing to be displayed on the display, printer or plotter. The *ZOOM* range is virtually infinite.

Functions

Functions provide additional drawing and editing capability to the program. The following functions are available by pressing a function key (a keyboard template is used to identify each function):

HELP - displays information about the choices which are currently available to the user at any program level.

PHOTO - a photogrammetry feature which allows you to determine actual dimensions and locations of objects using photographs taken at the accident scene.

DRAG - visually positions an object or an entity by moving it around the screen until the desired final location is selected.

NEAREST - selects the X,Y coordinates of a previously-entered point, such as the end of a line or arc.

REDRAW - redisplays the selected drawing overlays.

OPTIONS - sets the entity line type, line width, fill type, color, and text fonts.

UNDO - erases single entities and objects.

OOPS - restores an inadvertently-erased entity or object.

CALC - a calculator with built-in accident reconstruction functions (not currently implemented, but scheduled for a future release).

MENU - turns the menu display on and off (for printing) Using this function, the accident site drawing fills the entire screen..

PLOT - routes the drawing to a plotter. The plotter may have single or multiple pens and may be any commercial size (A through E or roll paper).

PRINT - routes the drawing to a dot-matrix printer.

INPUT DATA REQUIREMENTS

EDCAD requires alpha-numeric input data which describes the accident site. These accident site measurements and the coordinate system convention are described below.

Accident Site Measurements

Accident site measurements are recorded in the form of coordinate data, lengths and angles. Coordinate data are X-Y pairs which describe locations at the accident site. Every coordinate pair requires two values - the X component and the Y component - which describe the distances (in feet) in the direction of the X and Y axes, respectively, from a reference point (origin). Length data requires the entry of a single number. This number simply defines the distance (in feet) between two points, such as the length of a pavement stripe. Angles, like lengths, also require the entry of a single number which defines the angle (in degrees) between two lines. Character strings (text) may also be entered for labelling various points of interest on the accident site.

SAE Coordinate System

EDCAD uses the coordinate system adopted by the Society of Automotive Engineers (SAE J670e - Vehicle Dynamics Terminology [2]). All accident site information is entered according to the earth-fixed coordinate system.

The earth-fixed coordinate system can be thought of as a large coordinate system attached to the surface of the earth. Once selected, it must never be moved. The origin of the X-Y axes which define the coordinate system may be placed anywhere. (For convenience, the origin is usually fixed by an immovable landmark as close as possible to the accident site.) The Z axis points downward towards the center of the earth (in the direction of gravity). All angles in the X-Y (horizontal) plane are positive clockwise about the Z axis. An angle of 0 or 180 degrees defines a line parallel to the X axis. An example of the SAE coordinate system used at an accident site is shown in figure 7.

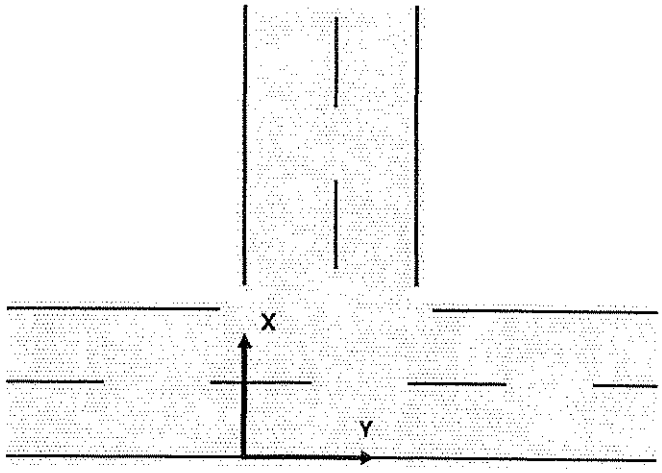

Figure 7 - SAE Coordinate System

SAMPLE APPLICATION

The use of EDCAD and its inter-relationship with other EDVAP programs can be illustrated with a sample application. In this example, EDCAD was first used to create a scale diagram of the accident site (see figure 8).

This accident site drawing was used, together with information obtained from the police accident report, to locate the vehicle impact and rest positions. EDCRASH used this information to reconstruct the accident (see figure 9). The EDCRASH output was then supplied to EDSMAC, and after several iterations, EDSMAC illustrated the collision sequence (see figure 10). This collision sequence was transferred directly to the previously-prepared accident site diagram using EDCAD's *MERGE* command (see figure 11) to provide the final presentation of how the accident occurred. The final drawing could then be printed for file or report purposes, plotted on a D-size sheet of drafting velum using a single- or multi-pen plotter for presentation purposes or put on video tape to present an animated accident sequence.

CONCLUSIONS

A computer program, called EDCAD, for preparing scaled accident site drawings has been described. The program uses a simple, three-level structure and incorporates a mouse for input, and printers and plotters for output. The features of the program include photogrammetry and a built-in template of objects commonly found at accident sites. The ability to merge results from other EDVAP programs has been illustrated. The scaled accident site diagram provides an important element to the reconstruction, both as an analysis tool and a presentation tool.

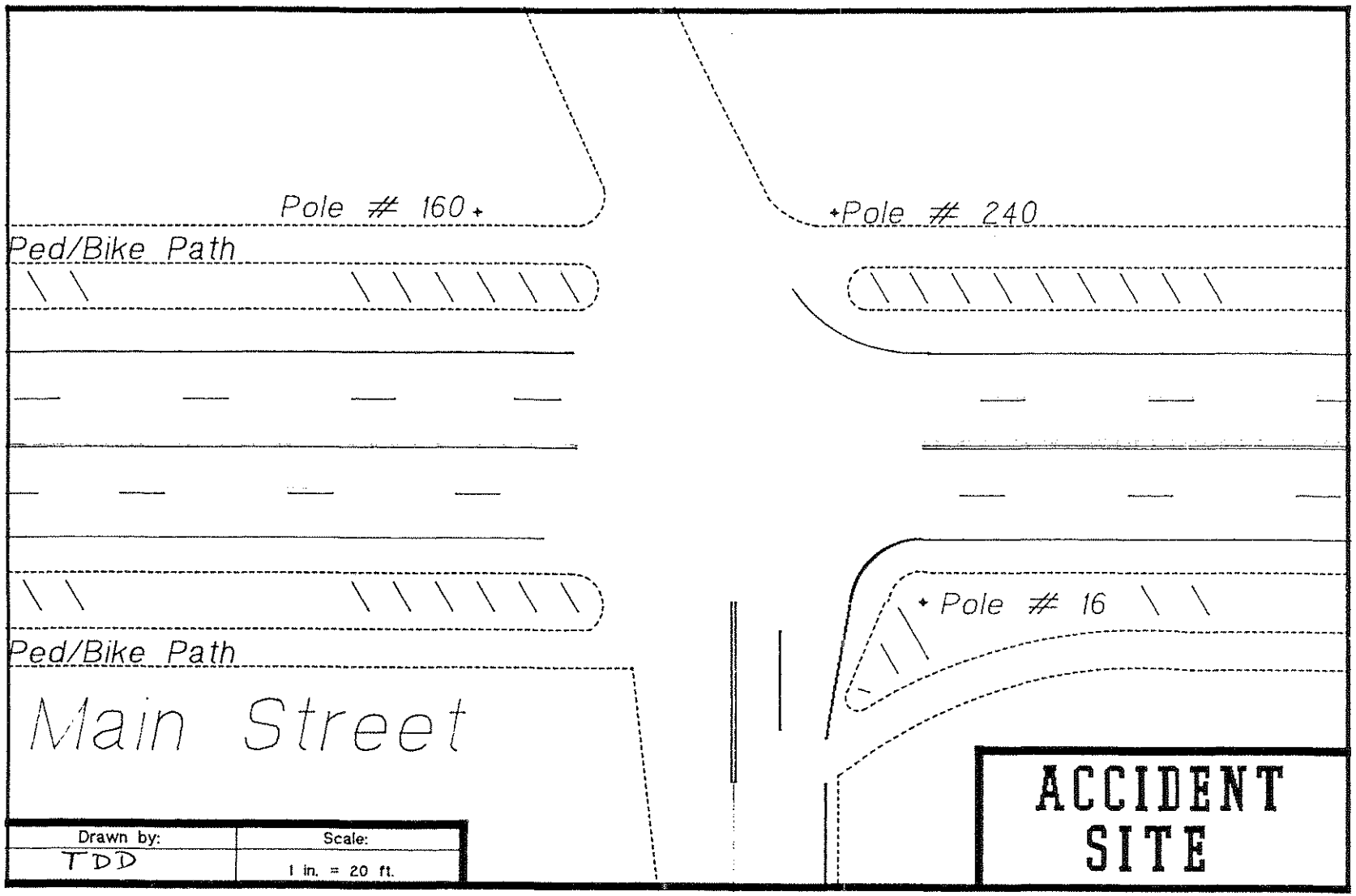

Figure 8 - EDCAD Scaled Accident Site Drawing

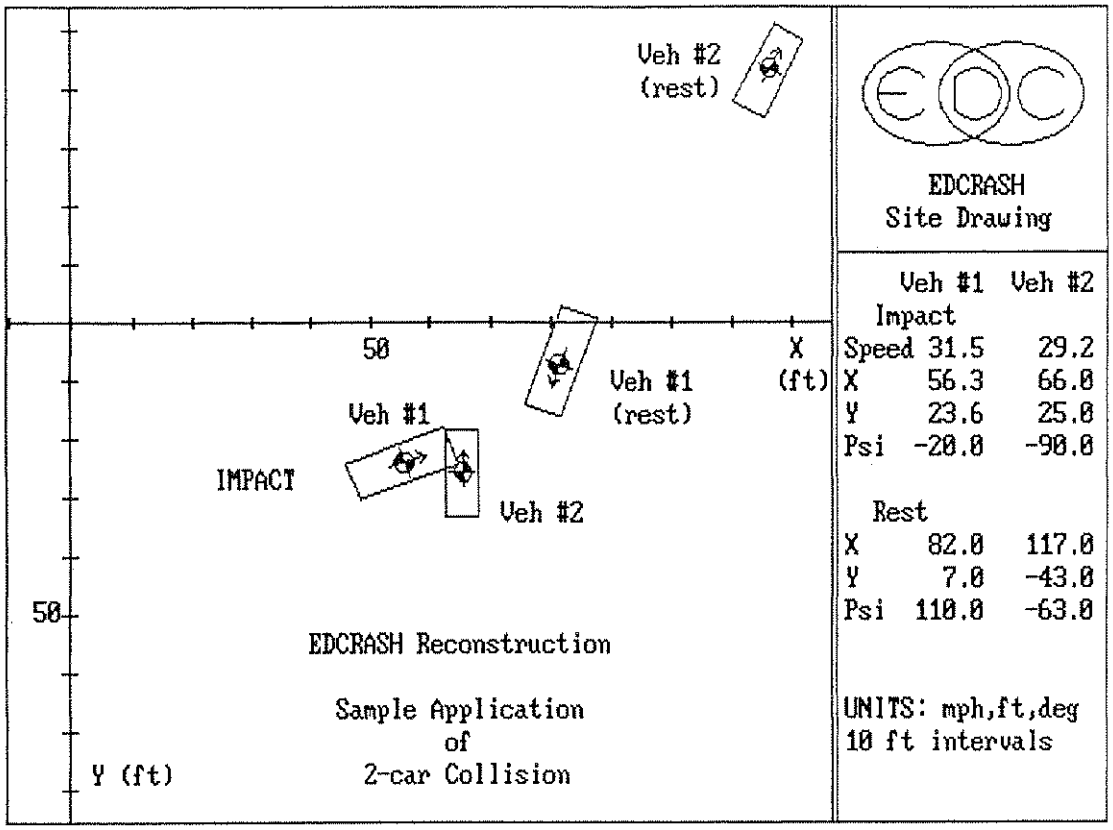

Figure 9 - EDCRASH Reconstruction of Accident

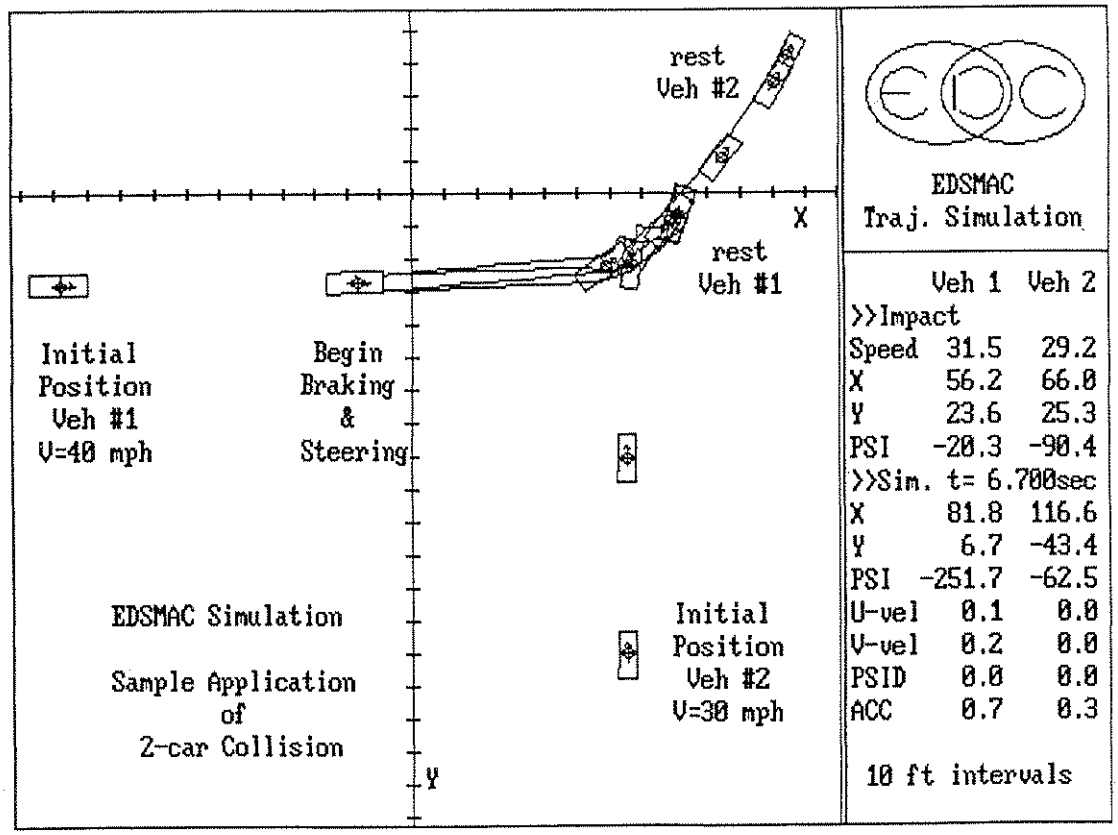

Figure 10 - EDSMAC Simulation of Accident

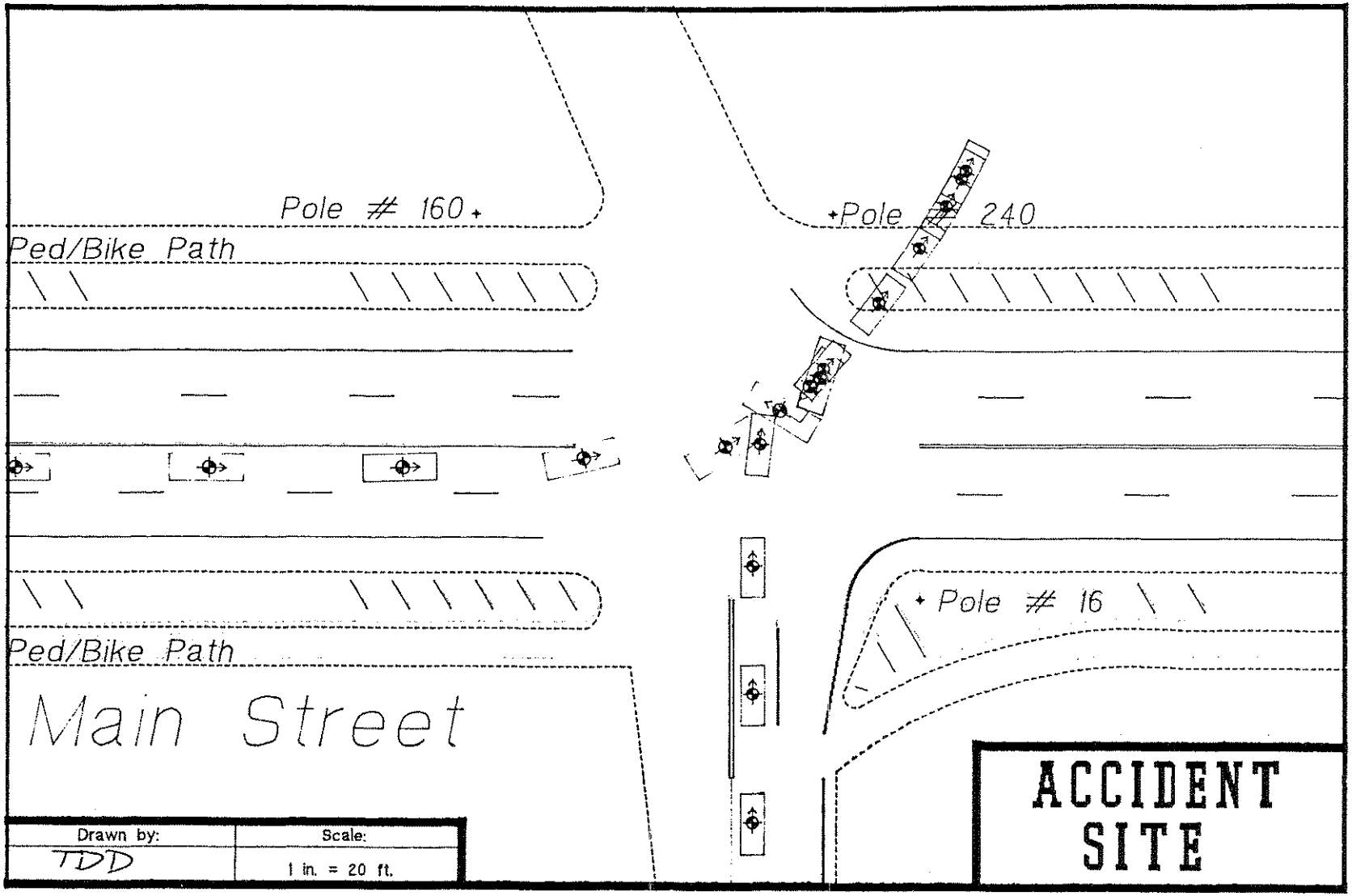

Figure 11 - EDCAD Scaled Accident Site Drawing with Merged EDSMAC Results

REFERENCES

1. Vehicle Analysis Package, Version 2, Engineering Dynamics Corporation, Lake Oswego, OR, 1986.

2. Vehicle Dynamics Terminology, Society of Automotive Engineers, Technical Report SAE-J670e, July, 1976.

TRADEMARKS

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