"THE ROLE OF IGrds™ IN THE DESIGN OF TEXAS ROADWAYS"

submitted to

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Within the state of Texas, [2] there are more than 275,000 miles of state highways, county roads, and city streets. [3] A total of 75,000 of these miles are maintained by the State Department of Highways and Public Transportation. [4] These roadways were not created overnight. [5] Planning, designing, and constructing roadways is a process that takes many years. [6] The tools used to design roadways have evolved over the years from manual techniques to computer based procedures. [7]

This slide show is an introduction to the automated roadway design process used by the Department to design new highways or modify existing roadways. [8] The Department uses the Interactive Graphics Roadway Design System, better known as IGrds, as it's computer based design and drafting tool. IGrds is distributed by a national organization called AASHTO, the American Association of State Highway and Transportation Officials. To better understand the capabilities of IGrds, you must first be aware of the overall roadway design process. [9]

There are four stages in the development of a roadway project. These are : Preliminary engineering and route studies, [10] Location, Preliminary design, and determination of right-of-way and schematic requirements, [11] preparation of right-of-way data, [12] and PS&E, which stands for, Plans, Specifications, and Estimates. [13] The first stage involves preliminary engineering and the social, economic and environmental studies necessary to determine the proposed route. [14] It also includes the preparation of other data that may be required to support the proposed route at public hearings. [15] The second stage consists of the engineering studies and survey work needed to prepare preliminary schematics and to determine right-of-way requirements. [16] The third stage includes the

preparation of the right-of-way map and deeds for the approved location, staking of the right-of-way limits, and the completion of any other studies or additional survey work that may be required to proceed with the final design and preparation of the PS&E. [17] The fourth and final stage is the completion and preparation of PS&E. [18]

Years ago, roadway design was based on the principles and procedures used in the design of railroads. [19] The highway designers used the same techniques that were developed for, and used by the railroad designers of the 1800's. The design process of that day was difficult and time consuming. [20] A considerable amount of time and effort was spent preparing roadway construction plans. These plans had to be prepared by hand, based on data collected by surveyors in the field. All of the design computations were performed by hand with pencil, paper, and a slide rule, or adding machine. [21] The technology of the period did not provide the capability for precision or the flexibility for testing various designs. Minor modifications to the design often resulted in weeks or months of delays in updating and modifying roadway plans. [22] Keeping this in mind, the highway designers of the past should be commended for providing Texas with an excellent system of highways recognized around the country as one of the best state systems. [23]

Relatively recent technological advances have been major factors in the evolution of the design process. [24] Most surveying is now conducted through the use of aerial photographs. [25] These photographs are used to develop topographic maps based on known control points established by a highway field crew. [26] Current technology allows ground control points to be established using orbiting satellites. [27] Today's methods are quite accurate.

The maps developed with these methods are accurate to within six inches vertically and one foot horizontally. [28] The designer locates the roadway centerline on these topographic maps. The rest of the roadway and roadside features are then designed according to the Department's design standards. [29]

In the mid 1960's, the Department took a leadership role in the development of the roadway design system. **RDS** is a computer program that uses more than 500 fortran subroutines for computation, report generation, and plotting of roadway design features. RDS performs the design and earthwork calculations based on the input data provided by the designer. The RDS output is then used to develop the roadway construction plans. [30]

Computer graphics packages have expedited the roadway design process by reducing the amount of time required for drafting roadway construction plans. [31] Automated design is easier and less time consuming than previous methods, particularly when modifications to plans are required. [32]

RDS and IGrds are related, in that roadway design data can be exchanged between the two programs. IGrds uses the same fortran subroutines for calculation as RDS. [33]

The Department uses Intergraph's computing system to create the interactive graphics environment for IGrds. To develop a clearer understanding of IGrds, and it's purpose, we will show you where IGrds fits in the Department's roadway design process. [34] The detailed roadway design process begins in the individual districts or residencies. [35] Ground control point locations are identified and marked in the field. Aerial photography

is then performed by D-19, the Division of Automation. [36] The aerial photographs are then digitized and compiled into a map file that is returned to the designer. After the designer receives the map file, he or she begins using IGrds. The first step of the design is the location of the centerline alignment for the proposed roadway. [37] The centerline is provided to D-19, where terrain cross-sections are prepared and then returned to the districts. [38] RDS and IGrds are then used to proceed with the design process. [39]

The major processes included in the IGrds package are [40] coordinate geometry and survey computation, [41] horizontal and vertical alignment design and vertical geometry, [42] reduction of terrain data from field or aerial surveys, [43] typical design cross-section, configuration and computation, [44] design cross-section modification, [45] earthwork quantities processing, [46] and plan preparation and drafting. [47]

The primary uses of IGrds in the Department are creating and updating alignments, [48] preparing plan and profile sheets in conjunction with APPS, the Department's Automated Plan Preparation System, and establishing right-of-way locations. [49]

The horizontal alignment commands within IGrds fall into three categories: [50] Display horizontal alignment, [51] Define and modify horizontal alignment, [52] and Compute or identify elements. [53] The first category includes commands that display points of intersection, referred to as PI's, and centerline information that have been previously created and stored using either RDS or IGrds. [54] The second category includes commands that define or alter PI data for a given horizontal alignment. The horizontal alignment is modified by changing stationing, curve radii, or location of the PI and

recalculating the alignment. The last category includes commands to identify displayed roadways; to create, recalculate, or delete horizontal alignments; and to generate horizontal alignment reports. [55]

The vertical alignment module has three main functions. These are [56] establish vertical points of intersection, known as VPI's, [57] perform vertical alignment computations, and [58] display vertical alignment. [59]

The IGrds program can be operated in two different environments, either interconnected to a VAX mainframe computer, or [60] operated independently in a stand-alone mode on the engineering workstation. [61]

IGrds and Intergraph training has become increasingly important within the Department since its initial involvement with computer graphics many years ago. [62] With the advancement in computing ability within the Department comes an increasing need to provide technically sound and effective training. [63]

In March of 1989, the Department opened a training center in Austin, [64] which currently houses many of the Department's computer training courses. [65] Specifically for IGrds, there are two classrooms equipped to handle IGrds training, [66] each consisting of 12 engineering workstations for students and 1 for the instructor. [67] Each workstation seats two students and provides them access to pertinent training documents, reference documents, and other information that may be used in the training course. [68] The classroom is designed to provide the students a good working environment and the

opportunity to interact with the instructor. [69] The Department provides training ranging from introductory courses to the advanced automated roadway design using IGrds and RDS. [70] Beginning in 1985, a course called the Basic IGrds Workshop was taught to employees seeking a brief introduction into the world of IGrds. This course was geared toward the designer with limited IGrds experience. [71] Subsequently, a course called Prerequisite to Level III was introduced in 1989. This course provided training in IGrds, Engineering Workstations, and the VAX. [72] These courses were taught to prepare the student for the Level III design training courses. [73]

The Level III course was designed with eight sub-levels including courses in areas ranging from Preliminary Roadway Design to the preparation of P,S,&E. [74]

Do not be discouraged or do not feel that the IGrds mountain is too hard to climb, because you have just completed your first training module, the IGrds Slide Show. [75] Most of you will continue on to a training course called the IGrds Toolbox. [76] The toolbox is designed to further expose you to the world of IGrds. The name of the course is appropriate, as IGrds provides numerous tools that can help the designer expedite the once tedious task of designing roadways. Those who possess the skills to apply these tools provide themselves and the Department a wealth of versatility in roadway design. [77] We encourage you to learn more about the IGrds system by participating in the next training course. For more information concerning additional training, talk to your supervisor, training coordinator, or automation administrator.