CD-ROM INCLUDED

INSIDE
ArcView® GIS

Second Edition

Population Density by County, 1990

Scale 1: 38,137,311

Scott Hutchinson
and Larry Daniel

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ONWORD® *P R E S S*

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By Scott Hutchinson and Larry Daniel

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Warning and Disclaimer

This book is designed to provide information about learning to use the ArcView GIS program. Every effort has been made to make the book as complete, accurate, and up-to-date as possible; however, no warranty or fitness is implied.

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About the Authors

Since 1983, **Scott Hutchinson** has worked with geographic information systems (GIS) in the U.S. Soil Conservation Service, the Arizona Department of Transportation, and the Arizona State Land Department. He has a B.S. degree in agriculture (soil science) from the University of Arizona. He recently completed a system, using ArcView, that linked digitized land parcel and other resource data to the Arizona State Land Department Business Systems database, to provide querying and mapping of the state's trust land. Scott is an ESRI-certified ArcView instructor, and is presently providing ArcView training in the Washington, D.C., metro area.

Larry Daniel is president and principal consultant of the Daniel Consulting Group, a GIS management consulting and software development organization out

of Austin, Texas. In years prior to forming DCG, he was vice president of the Castillo Company in Phoenix, Arizona, and director of GIS at MPSI in Tulsa, Oklahoma. Larry holds an M.A. in geography from the University of Texas at Austin and a B.S. in computer engineering from Bucknell University. He has been involved with GIS for over ten years, has been an ongoing columnist for *Business Geographics* since 1993, has contributed to other professional journals such as *GIS World, GeoInfo Systems, Earth Observation Magazine, Computer-Aided Engineering,* and *Design Management,* and is also a co-author of *INSIDE MapInfo Professional.*

his knowledge so capably with others. It was a pleasure to work with Scott and High Mountain Press, and to then witness success of the first edition—I hope that the second edition serves as well toward enriching the use of the ArcView product.

Thanks, too, to the many people who have been personally involved in fueling my success with GIS—Ken Foote and David Huff at the University of Texas, Rick Baumgartner at IBM, Mark Darling at American Isuzu, and the many clients I serve—with each day we seem to push, challenge, and advance each other's interests.

Lastly, a hearty and very special thanks to my wife and family: Mel, Melanie, Lianna, Dwight, and Meredith. You have endured with me many of the trials and long hours necessary to make these types of projects happen—thank you for being my support.

Larry Daniel

Acknowledgment of Desktop Mapping Innovators

Many organizations and individuals in the private and public sectors have served as innovators in the use and development of GIS and desktop mapping. Several of these innovators provided data or ArcView applications for this book. Our special innovator list follows: Equifax/NDS; International House of Pancakes; Arizona State Land Department; American Isuzu Motors; Maine Department of Environmental Protection; Dr. James F. Campbell, School of Business Administration, University of Missouri-St. Louis; and Professor Ben Niemann, Land Resources Department, and Professor Steve Ventura, Environmental Studies Department, University of Wisconsin-Madison.

While compiling our second edition, we posted several calls for "real world" material and found many parties in the ArcView community willing to share their applications. Special thanks to Jayan Devasundarum (Maryland State Health Department), Gwen Ford (University of South Carolina), Robert Greene (Los Alamos National Laboratory), Leigh McNaught (ViGYAN), and Janko Tchoukanski

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OnWord Press Credits

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Introduction

Congratulations on selecting ArcView GIS and for choosing this book. ArcView GIS is the premier PC-based geographic information system (GIS) software by Environmental Systems Research Institute, Inc. (ESRI). This book will help validate your organization's good judgment in choosing ArcView GIS.

INSIDE ArcView GIS is not just a rehash of the ArcView GIS manual and online help system created by writers who are not familiar with the software. This book contains the knowledge that comes from time spent on the front lines of public and private sector organizations, helping individuals, departments, corporations, and government agencies learn to work effectively using GIS and desktop mapping software. Our experience has ranged from helping business people and government agency professionals to get started with GIS to teaching developers how to customize GIS software to fit their unique environments. We have included tips and tricks that we have learned over time—many of which are either not in the manuals or are difficult to find.

We hope that *INSIDE ArcView GIS* enables you to get "up and running" with ArcView GIS. If you have any comments, questions, or recommendations about the book, we encourage you to contact us at OnWord Press, 2530 Camino Entrada, Santa Fe, NM 87505-4835, USA, or to e-mail us at *readers@hmp.com.*

On the Current Status of Desktop Mapping and ArcView GIS

Recent developments by Microsoft and other companies incorporating mapping functionality into desktop applications support the observation that desktop mapping has joined the ranks of "mainstream" applications such as spreadsheets, databases, and presentation graphics. Advances in imaging, global positioning systems (GPS), and pen-based computing are further extending the functionality of desktop mapping. Given that an estimated 80 percent of all data has a spatial component, you might ask where desktop mapping does not apply!

All major functionality of geographic information systems (GIS) software is present in ArcView GIS. ArcView GIS has several other notable strong points: Avenue, the object-oriented programming language; direct access to ARC/INFO coverages; connectivity to CAD data; sophisticated ArcView extensions; and database connectivity through use of ESRI's Spatial Database Engine (SDE).

Avenue

The advantages of using Avenue for customizing ArcView GIS are covered in Chapter 14, but they are worth summarizing here. ArcView GIS is comprised of objects and requests, and Avenue is an object-oriented programming language that allows you to directly access these objects. Because Avenue provides the ability to access the objects with which ArcView GIS is constructed, it allows a high level of control over all aspects of your environment, including data, applications, interface, and output. Even if you have no immediate intention of customizing ArcView GIS, you can think of Avenue as an insurance policy: when and if you require customization, Avenue's capabilities and power will be available.

Direct Access to ARC/INFO

The ability to directly access ARC/INFO coverages is clearly an advantage to sites using ARC/INFO or with ready access to data in ARC/INFO format. Given that ARC/INFO is the leading UNIX-based GIS software, this is no small advantage. ArcView GIS provides the ability to leverage an existing ARC/INFO installation by

adding ArcView GIS Windows or UNIX-based seats to a network. Existing ARC/INFO workspaces can be copied without translation from the UNIX host to standalone Windows ArcView GIS installations.

The advantage of being able to access spatial data in ARC/INFO format extends to users not directly associated with an ARC/INFO site. The widespread use of ARC/INFO among government agencies, coupled with the wide range of exchange formats supported by ARC/INFO, makes it highly probable that most third-party data providers will be running ARC/INFO and, as such, will be able to directly supply data in either ARC/INFO coverage or ArcView shapefile format. If spatial data in whatever format is available for your project, it can likely be converted to ArcView format via ARC/INFO.

Connectivity to CAD Data

With ArcView GIS 3.*x,* you can also create themes directly from CAD drawing and exchange files. Specifically, themes can be created from an AutoCAD *.dwg* or *.dxf* file, or from a MicroStation *.dgn* file. This offers you the ability to store and access data in its native format without the need for translation, enabling CAD users to continue to create and maintain data while extending the capability for ArcView GIS to display and query this data.

Availability of ArcView GIS Extensions

With ArcView GIS 3.*x,* the functionality of ArcView is greatly extended through the availability of the optional Analyst extensions. These extensions—Network Analyst, Spatial Analyst, and many others—provide functionality previously only available within the ARC/INFO software. The Network Analyst extension provides a strong suite of tools with which to perform optimum routing, closest facility, and service area analysis. The Spatial Analyst extension adds powerful raster modeling functionality to the core ArcView GIS data model. This allows for sophisticated analysis with respect to density, proximity, and surface modeling.

Spatial Database Engine

With ArcView GIS 3.*x,* the ArcView data model is extended to support connectivity to large databases storing spatial data. This connectivity is accomplished by

using the Spatial Database Engine (SDE). SDE uses the power of an RDBMS, such as Oracle or Informix, to provide fast display and query of spatial databases comprised of hundreds of thousands of features. With SDE, ArcView GIS can be used as a front end for displaying and querying all data—spatial and tabular—and can allow the data to be stored in a single database.

Book Structure

ArcView GIS is a program with immense capability and a wealth of features. This functionality is further extended with the release of ArcView GIS 3.*x.* ArcView GIS can be straightforward and easy to learn, if approached correctly. This book is organized by logical and functional sections to help you learn ArcView GIS quickly and efficiently.

Chapter 1 presents a description of ArcView GIS and the historical development of desktop mapping.

Chapter 2, "The Whirlwind Tour," contains a sample project in order to give you a sense of how an ArcView GIS project feels from beginning to end. Data for the sample project and for the exercises in subsequent chapters are recorded on the companion CD-ROM. In addition, we have saved the end results of the sample project and the exercises in "incremental projects" on the CD-ROM.

Chapters 3 through 10 focus on learning ArcView GIS's basic tools and functionality. Topics include projects and views; data display; data query; extending data; editing shapefiles; CAD and image themes; creating charts, graphs, and reports; and layouts (printing custom maps, charts, and reports). Exercises provide the opportunity to apply and experiment with what you have learned in respective chapters.

Chapters 11 through 14 focus on advanced topics. Chapter 11, "Beyond the Basics," covers overlay operations, advanced classification, hot links to data, and editing tables. An exercise is included that demonstrates these areas.

Chapter 12, "Advanced Functionality," introduces database themes, as well as the Network Analyst and Spatial Analyst. Chapter 13 covers optimization of project design, focusing on application-driven projects. Chapter 14, "ArcView Customiza-

tion," discusses how to customize the interface and provides an introduction to Avenue, the programming language provided with ArcView GIS.

The final chapter, "ArcView in the Real World," presents case studies of ArcView GIS projects in government, business, and academia.

Four appendices contain information on installation and configuration, the transition from ArcView 2.*x* to ArcView GIS 3.0, a functionality quick reference, and a discussion of the nine MicroVision segments by Equifax National Decision Systems that are used in this book.

The glossary contains definitions of selected terms specific to GIS and ArcView GIS. Finally, the book ends with a general index.

Typographical Conventions

✓ **TIP:** *Tips on functionality usage, shortcuts, and other information aimed at saving you time appear like this.*

➥ **NOTE:** *Information about features and tasks that is not immediately obvious or intuitive appears in notes.*

✗ **WARNING:** *A handful of warnings appear in this book. They are intended to help you avoid committing yourself to results that you may not have intended.*

The names of ArcView GIS user interface items, such as menus, windows, menu items, tool buttons, icons, and dialog window items, are capitalized.

Access the Edit menu and select Paste. A copy of the theme will appear at the head of the view's Table of Contents.

User input as well as names for files, directories, variables, fields, themes, tables, coverages, and so on, are italicized.

From the Project window, switch to the *$IAPATH\data* directory and add the *ihopad2.dbf* and *ihopcmp2.dbf* tables.

Emphasis is indicated by italics.

> In ArcView, the *destination table* is the table to which the fields of the *source table* will be appended.

General function keys appear enclosed in angle brackets. The Shift and Control keys are pressed at the same time as a mouse button or another key. Examples appear below.

> <Shift>
>
> <Tab>
>
> <Esc>
>
> <Ctrl>
>
> <Enter>

Key sequences, or instructions to press a key immediately followed by another key, are linked with a plus sign. Examples follow:

> <Ctrl>+s
>
> <Shift>+<Tab>

Companion CD-ROM

> ◆ **NOTE:** *The companion CD-ROM does **not** contain the ArcView GIS software. You must purchase and install ArcView GIS separately.*

The companion CD-ROM contains the following files:

❏ Data and project files (in ArcView GIS 3.*x* format) referenced throughout this book.

❏ A sample extension for use with ArcView GIS: the Navigation Tools Plug-In by Planet One GIS Software.

❏ Sample software and data files by Claritas, Inc.

The CD is organized into three main directories or levels, as described below.

❐ *avfiles*—ArcView GIS data and project files. The following subdirectories contain the files by platform type:

- *unix*—UNIX
- *mac*—Apple Macintosh
- *windows*—Windows (3.1, NT, and 95) in uncompressed form
- *zipfile*—Windows (3.1, NT, and 95) in compressed form

❐ *planet1*—Navigation Tools Plug-In, which contains subdirectories for the platforms below. (See "Installing and Using the Plug-in" below.)

- *mac*
- *unix*
- *win16*
- *win32*

❐ *claritas*—Sample software and data for use on Windows 3.1, Windows NT, and Windows 95 platforms. (See "Claritas Sample Software and Data Files" section below.)

The table below presents major directories and subdirectories of CD-ROM contents. Cumulative file size totals by subdirectory are included.

AVFILES (contain the same files for all platforms)	
DATA	11.2 Mb
DAYCARE	1.79 Mb
PROJECTS	2.1 Mb
WORK	(empty)
PLANET1	
MAC	366.5 Kb
UNIX	366.5 Kb
WIN 16	827.7 Kb
WIN 32	894.1 Kb

CLARITAS	
root directory files	114.73 Kb
DEMO	10.45 Mb
RESOURCE	3.33 Mb
SAMPLES	
BOUNDARY	763.5 Kb
HEALTH	20.1 Mb
HIGHWAY	136.1 Kb
LANDMARK	11 Kb
REALEST	17.21 Mb
RETAIL	16.59 Mb
SOLUTION	1.21 Mb

Installing the ArcView GIS Files from the CD-ROM

With regard to mounting and accessing the CD-ROM, some commands are very specific to the type of operating system and/or workstation you are using. Consequently, you should refer to the ArcView GIS *Installation Guide.* This guide shipped with your ArcView GIS CD-ROM.

Sections on transferring files from the CD-ROM to your hard disk according to operating system appear below.

Windows 3.1, Windows NT, and Windows 95

ArcView GIS users on these platforms have the options of installing compressed files (a slightly less time-consuming procedure) or uncompressed files. Both are covered below.

Compressed Files

1. Create a directory named *insideav* on your hard drive for the data and project files. You can issue the following command at the DOS prompt:

   ```
   md {drive:}\insideav
   ```

   Another option is to use File Manager to create the directory. (Select Create Directory from the File menu.)

3. Assuming the CD-ROM has been mounted as the d: drive, copy the *av.exe* file from the d: drive's *avfiles\zipfile* directory to the *insideav* directory on your system. You can enter the following command from the DOS prompt:

```
copy d:\avfiles\zipfile\av.exe {drive:}\insideav
```

Or you can copy the file using File Manager. (Drag the *av.exe* file from the CD-ROM drive to the *insideav* directory on your hard disk.)

4. Run the following self-extracting command from the DOS prompt:

```
av.exe -d
```

Or select the *insideav* directory in File Manager, choose Run from the File menu, and enter the above command.

5. To access the sample data with the accompanying ArcView GIS project files, you need to set the following environment variable on your system. For Windows 3.1 and Windows 95, add the following line to your *autoexec.bat* file:

```
SET IAPATH={drive:}\insideav
```

where *{drive}* represents the letter of the drive on which you have installed the sample data and projects.

For Windows NT, the environment variable is set from the Control Panel via the following steps: (a) From the Start menu, select Settings | Control Panel. (b) In the Control Panel window, open the System icon and click on the Environment tab. (c) Type *IAPATH* in the variable box and *{drive}\inside* in the value box, and click the Set button. If you are running ArcView when the environment variable is set, you must restart ArcView for the variable to take effect.

Uncompressed Files

1. Create a directory named *insideav* on your hard drive for the data and project files. You can issue the following command at the DOS prompt:

```
md {drive:}\insideav
```

Or use File Manager to create the directory.

2. Insert the CD-ROM in your CD drive. If you wish to copy files using the DOS prompt, go to step 3. If you prefer to copy files using File Manager, go to step 4.

3. To use the DOS prompt to copy the subdirectories and files from the *avfiles* directory on the CD-ROM to your *insideav* directory, use the command below. The command assumes the CD-ROM is mounted on the d: drive.

```
xcopy d:\avfiles\windows\*.* {drive:}\insideav /s
```

4. To use File Manager to copy the files from *avfiles\windows* on the CD-ROM to your *insideav* directory, select the *data* subdirectory on the CD-ROM and drag it to the *insideav* directory on your hard drive. Follow the same procedure for the remaining three subdirectories under *avfiles\windows* on the CD-ROM.

5. To access the sample data with the accompanying ArcView GIS project files, you need to set the following environment variable on your system. (See your system documentation for more information about how to do this.)

```
SET IAPATH={drive:}\insideav
```

Apple Macintosh

1. Create a folder on your system and name it *insideav*.

2. Insert the CD-ROM in the CD drive.

3. Double-click on the CD-ROM's icon on your Desktop.

4. Open the *avfiles* folder on the CD-ROM. Inside you will find four sub-folders titled *data, projects, daycare,* and *work.* Select the four folders and drag them to your *insideav* folder.

UNIX

1. Mount the CD-ROM. Each brand of UNIX workstation has a different syntax. (Refer to the ArcView GIS *Installation Guide* for more information.)

2. Make a directory named *insideav*.

3. Change your working directory to *insideav*.

4. To copy the files and directories from the *avfiles/unix* directory on the CD-ROM, enter the following command line. This command