

# Best Practices for Managing Geospatial Data

Second Edition





# Best Practices for Managing Geospatial Data

**All Rights Reserved**

This publication, or parts thereof, may not be reproduced in any form, by any method, for any purpose.

AUTODESK, INC., MAKES NO WARRANTY, EITHER EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO ANY IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE REGARDING THESE MATERIALS, AND MAKES SUCH MATERIALS AVAILABLE SOLELY ON AN "AS-IS" BASIS.

IN NO EVENT SHALL AUTODESK, INC., BE LIABLE TO ANYONE FOR SPECIAL, COLLATERAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES IN CONNECTION WITH OR ARISING OUT OF ACQUISITION OR USE OF THESE MATERIALS. THE SOLE AND EXCLUSIVE LIABILITY TO AUTODESK, INC., REGARDLESS OF THE FORM OF ACTION, SHALL NOT EXCEED THE PURCHASE PRICE, IF ANY, OF THE MATERIALS DESCRIBED HEREIN.

Autodesk, Inc., reserves the right to revise and improve its products as it sees fit. This publication describes the state of the product at the time of publication, and may not reflect the product at all times in the future. Autodesk Trademarks

**Autodesk Trademarks**

The following are registered trademarks or trademarks of Autodesk, Inc., in the USA and other countries: 3DEC (design/logo), 3December, 3December.com, 3ds Max, ActiveShapes, Actrix, ADI, Alias, Alias (swirl design/logo), AliasStudio, Alias|Wavefront (design/logo), ATC, AUGI, AutoCAD, AutoCAD Learning Assistance, AutoCAD LT, AutoCAD Simulator, AutoCAD SQL Extension, AutoCAD SQL Interface, Autodesk, Autodesk Envision, Autodesk Insight, Autodesk Intent, Autodesk Inventor, Autodesk Map, Autodesk MapGuide, Autodesk Streamline, AutoLISP, AutoSnap, AutoSketch, AutoTrack, Backdraft, Built with ObjectARX (logo), Burn, Buzzsaw, CAiCE, Can You Imagine, Character Studio, Cinestream, Civil 3D, Cleaner, Cleaner Central, ClearScale, Colour Warper, Combustion, Communication Specification, Constructware, Content Explorer, Create>what's>Next> (design/logo), Dancing Baby (image), DesignCenter, Design Doctor, Designer's Toolkit, DesignKids, DesignProf, DesignServer, DesignStudio, Design|Studio (design/logo), Design Your World, Design Your World (design/logo), DWF, DWG, DWG (logo), DWG TrueConvert, DWG TrueView, DXF, EditDV, Education by Design, Extending the Design Team, FBX, Filmbox, FMDesktop, GDX Driver, Gmax, Heads-up Design, Heidi, HOOPS, HumanIK, i-drop, iMOUT, Incinerator, IntroDV, Kaydara, Kaydara (design/logo), LocationLogic, Lustre, Maya, Mechanical Desktop, MotionBuilder, ObjectARX, ObjectDBX, Open Reality, PolarSnap, PortfolioWall, Powered with Autodesk Technology, Productstream, ProjectPoint, Reactor, RealDWG, Real-time Roto, Render Queue, Revit, Showcase, SketchBook, StudioTools, Topobase, Toxik, Visual, Visual Bridge, Visual Construction, Visual Drainage, Visual Hydro, Visual Landscape, Visual Roads, Visual Survey, Visual Syllabus, Visual Toolbox, Visual Tugboat, Visual LISP, Voice Reality, Volo, and Wiretap.

The following are registered trademarks or trademarks of Autodesk Canada Co. in the USA and/or Canada and other countries: Backburner, Discreet, Fire, Flame, Flint, Frost, Inferno, Multi-Master Editing, River, Smoke, Sparks, Stone, Wire.

**Third Party Trademarks**

All other brand names, product names or trademarks belong to their respective holders.

### **Third Party Software Program Credits**

Stingray® is Copyright © 1995-2005, Quovadx, Inc. All Rights Reserved. Protected by copyright and licenses restricting use, copying, distribution and decompilation. The Rogue Wave name and logo and the Stingray name and logo are either registered trademarks or trademarks of Quovadx, Inc. in the United States and/or other countries.

Xerces and Xalan are Copyright © 1999-2005, The Apache Software Foundation. Licensed under the Apache License, Version 2.0; you may not use this file except in compliance with the license. You may obtain a copy of the license at the following web address: <http://www.apache.org/licenses/LICENSE-2.0>.

Copyright © 1998-2006 The OpenSSL Project. All rights reserved.

This product includes software written by Tim Hudson (tjh@cryptsoft.com). This product includes cryptographic software written by Eric Young (eay@cryptsoft.com).

Copyright © 1995-1998 Eric Young (eay@cryptsoft.com). All rights reserved.

ACE™ is copyrighted by Douglas C. Schmidt and his research group at Washington University, University of California, Irvine, and Vanderbilt University, Copyright ©1993-2006, all rights reserved.

The Director General of the Geographic Survey Institute has issued the approval for the coordinates exchange numbered TKY2JD for Japan Geodetic Datum 2000, also known as technical information No H1-No.2 of the Geographic Survey Institute,to be installed and used within this software product (Approval No.: 646 issued by GSI, April 8, 2002).

MrSID image compression format is Copyright © 2005, LizardTech, a division of Celartem,Inc. All rights reserved.MrSID technology is protected by U.S. Patent No 5,710,835 and patents pending.

Portions of this computer program are Copyright © 2000 Earth Resource Mapping, Inc.

The OSTN97 coordinate transformation is © Crown copyright 1997. All rights reserved.

The OSTN02 coordinate transformation is © Crown copyright 2002. All rights reserved.

The OSGM02 coordinate transformation is © Crown copyright 2002, © Ordnance Survey Ireland, 2002.

FME Objects Engine Copyright © 2005 SAFE Software. All rights reserved.

Libcurl is Copyright ©1996 - 2007, Daniel Stenberg, <daniel@haxx.se>. All rights reserved.

The Redland RDF Application Framework is Copyright © 2000-2005 Institute for Learning and Research Technology, University of Bristol. Licensed under the Apache License, Version 2.0; you may not use this file except in compliance with the license. You may obtain a copy of the license at the following web address: <http://www.apache.org/licenses/LICENSE-2.0>.

GDAL is Copyright © 2000, Frank Warmerdam.

Portions of sample data provided by NAVTEQ. Copyright © NAVTEQ 2001-2006, All rights reserved.

Portions of this computer program are Copyright ©; 2000 Earth Resource Mapping, Inc.

The OSTN97 coordinate transformation is © Crown Copyright 1997. All rights reserved.

The OSTN02 coordinate transformation is © Crown copyright 2002. All rights reserved.

The OSGM02 coordinate transformation is © Crown copyright 2002, © Ordnance Survey Ireland, 2002.

FME Objects Engine © 2005 SAFE Software. All rights reserved.

Libcurl is Copyright (c) 1996 - 2006, Daniel Stenberg, <daniel@haxx.se>. All rights reserved.

The Redland RDF Application Framework is Copyright (C) 2000-2005 Institute for Learning and Research Technology, University of Bristol. Licensed under the Apache License, Version 2.0; you may not use this file except in compliance with the license. You may obtain a copy of the license at the following web address: <http://www.apache.org/licenses/LICENSE-2.0>.

GDAL is Copyright (c) 2000, Frank Warmerdam.

Portions of sample data provided by NAVTEQ. ©NAVTEQ 2001-2006, All rights reserved.

**GOVERNMENT USE**

Use, duplication, or disclosure by the U.S. Government is subject to restrictions as Use, duplication, or disclosure by the U.S. Government is subject to restrictions as set forth in FAR 12.212 (Commercial Computer Software-Restricted Rights) and DFAR 227.7202 (Rights in Technical Data and Computer Software), as applicable. Published By: Autodesk, Inc.

111 McInnis Parkway

San Rafael, CA 94903, USA

# Contents

<b>Chapter 1: Autodesk Geospatial</b>	<b>1</b>
<hr/>	
<b>About Autodesk Geospatial</b>	<b>2</b>
<hr/>	
<b>Bringing CAD and GIS Together</b>	<b>3</b>
<hr/>	
<b>Freedom and Flexibility</b>	<b>6</b>
<hr/>	
<b>Open Integration</b>	<b>7</b>
<hr/>	
<b>Extend the Power</b>	<b>10</b>
<hr/>	
<b>Autodesk Geospatial Breaks Down Barriers</b>	<b>12</b>
<hr/>	
<b>Conclusion</b>	<b>14</b>
<hr/>	
<b>Chapter 2: The Geospatial Value Chain</b>	<b>15</b>
<hr/>	
<b>Stage One: AutoCAD or AutoCAD LT</b>	<b>16</b>
<hr/>	
<b>Stage Two: AutoCAD Map 3D</b>	<b>18</b>
<hr/>	
<b>Stage Three: AutoCAD Map 3D + FDO</b>	<b>20</b>
What Is FDO?	22
What Are Features?	24
What Is a Schema?	26
<hr/>	
<b>Stage Four: Spatial Databases</b>	<b>28</b>
<hr/>	
<b>Stage Five: Topobase and Other Applications</b>	<b>30</b>

## Chapter 3: Optimizing the Workflow of Geospatial Data 33

---

<b>Accessing Geospatial Data</b>	<b>34</b>
Workflow: Create and edit database features	36
Workflow: Bring In Design Data from AutoCAD Civil 3D	41
Workflow: Use existing features as a starting point	44
<b>Using DWG Files As Data Sources</b>	<b>48</b>
Workflow: Combine DWG data sources and feature data sources	49
Workflow: Convert DWG objects to features	51
Workflow: Export DWG objects to a GIS data store	54
<b>Organizing and Managing Geospatial Data</b>	<b>58</b>
Workflow: Convert one schema into another	58
Workflow: Notify neighbors within a certain radius of a parcel	61
<b>Handling Styles and Symbols</b>	<b>65</b>
Workflow: Share styles with other users	65
<b>Analyzing Geospatial Data</b>	<b>69</b>
Workflow: Create a thematic map for web distribution	69
<b>Incorporating Raster Images and Surfaces</b>	<b>73</b>
Workflow: Build a 3D map using surfaces and raster images	75
<b>Publishing Geospatial Data</b>	<b>78</b>
Workflow: Publish for print or plot	78
<b>Distributing Geospatial Data</b>	<b>82</b>
Workflow: Create a Web-based application	83
<b>Chapter 4: Common Business Problems and Their Solutions</b>	<b>87</b>
<b>Government</b>	<b>88</b>
Managing raster-based drawings	88
<b>The Utility and Telecom Industries</b>	<b>91</b>

Example solution #1: Mapping system	91
Example solution #2: Managing as-designed and as-built data	93
Example solution #3: Work order management	95
Example solution #4: Asset management with automated distribution	97
<hr/>	
<b>Other Industries</b>	<b>100</b>
Property Management	100
<hr/>	
<b>Chapter 5: Sample Maps</b>	<b>103</b>
<hr/>	
<b>Maps Using Surfaces</b>	<b>104</b>
State of Washington relief map	104
Yosemite trail map	104
Marin County land use map	104
Indian subcontinent wall map	104
<hr/>	
<b>Thematic Maps</b>	<b>109</b>
Literacy in India	109
USA geology map	109
New Mexico land ownership and population	109
<hr/>	
<b>Maps Using Raster Images</b>	<b>114</b>
Deforestation in Chiapas, Mexico	114
Landsat mosaic	114
New Orleans	114
<hr/>	
Glossary	119
<hr/>	
Index	129



Chapter 1:

# Autodesk Geospatial

From planning through design, construction, and maintenance, Autodesk Geospatial delivers powerful data interoperability and a fully integrated platform for managing spatial data assets.

# About Autodesk Geospatial

For many organizations, such as governments, utility and telecommunication providers, and engineering and construction firms, spatial data is crucial. It's essential that these organizations have the tools to take full advantage of all their data and spatial information, which is typically stored in a variety of locations such as desktops, file servers, CAD servers, GIS servers, and web servers. And because the data is routinely managed by different people across various departments—including engineers, GIS specialists, and IT personnel—these organizations need a way to avoid data redundancy, a costly situation that happens when each functional entity is using, storing, and managing the same data differently.

Information used by GIS teams in planning and analysis is frequently re-created by engineers in the design phase. Similarly, GIS professionals often find a way to import CAD information into their systems but can end up with data stripped of much of its valuable engineering detail—such as text and dimensioning that exist in CAD drawings but aren't preserved or read by GIS applications.

If everyone could use data from a common source and continually update it with current information, the entire organization would save time and money while minimizing repetitive tasks.

# Bringing CAD and GIS Together

Autodesk brings two leading technologies together to help organizations get the full value from spatially enabled data. Using Autodesk Geospatial to bridge computer-aided design (CAD) and geographic information systems (GIS), organizations can use existing resources, reduce redundancy and errors, and increase operational efficiency.

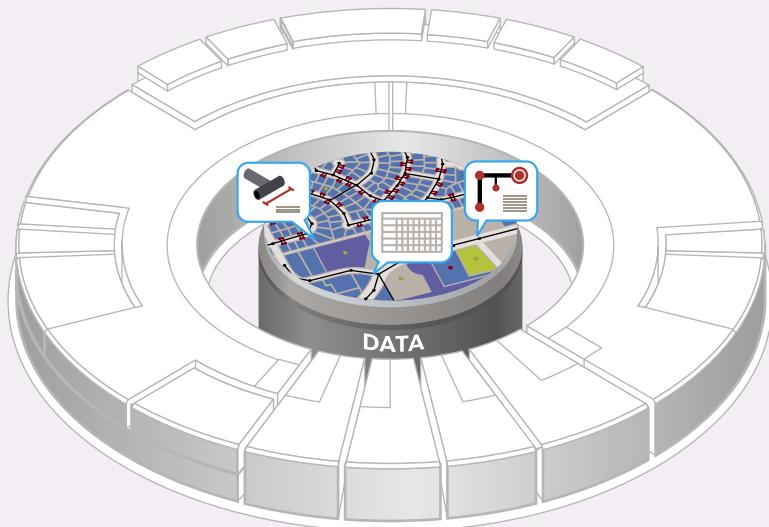
Autodesk Geospatial makes it easier to access essential information across an organization regardless of the format or location in which it is stored. These solutions help streamline processes by eliminating disparate systems and creating an environment where data stored in a central database can be constantly refreshed through real time updates from the field. This proven, easy-to-learn technology is intuitive to professionals trained in either CAD or GIS.

# Most Valuable Asset

Data lives at the center of any infrastructure project and is one of an organization's most valuable assets. People change jobs, companies reinvest in software, but the data owned by these organizations remains permanent.

Autodesk Geospatial neither puts data into a proprietary format nor locks it into a particular application for accessing or managing it. Autodesk gives geospatial professionals the tools they need to increase the value of data assets by helping to ensure that these assets are properly maintained, usable, and accessible to the entire organization in a secure and scalable manner. Implementing Autodesk Geospatial also enables organizations to combat the high levels of redundancy, inaccuracy, data mismatches, currency issues, and versioning problems that often result from information that is not easily shared or accessed.

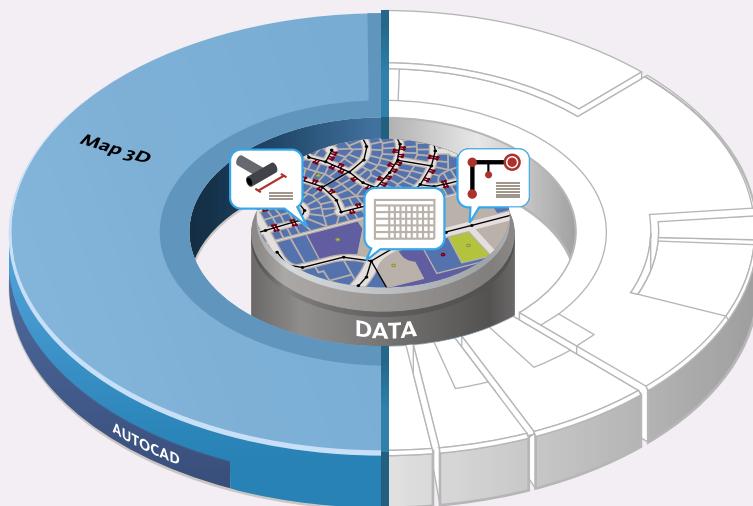
**Data is at the center of any infrastructure solution and the central component of Autodesk Geospatial.**



# Unlock the Data

Many engineers today work in hybrid IT environments, with software and applications from a variety of vendors. Autodesk Geospatial is ideally suited for this situation. For instance, using AutoCAD Map® 3D software, engineering staff can create and edit ESRI® ArcSDE® data using CAD tools built on the world's leading CAD application—AutoCAD® software—enabling them to work on geospatial data in its native environment. Autodesk FDO Data Access Technology is the method for working with ESRI and many other data. Incorporated into Autodesk Geospatial products, FDO Data Access Technology helps increase productivity—saving time by enabling users to seamlessly work on a variety of spatial and non-spatial databases and files without translation and consequent loss of data. AutoCAD Map 3D is the leading engineering GIS platform for creating and managing spatial data. The software bridges CAD and GIS by providing direct access to data, regardless of how it is stored, and by enabling the use of AutoCAD tools for maintaining geospatial information.

**AutoCAD Map 3D bridges the gap between CAD and GIS by providing easy access to data that used to be locked up in the GIS department**

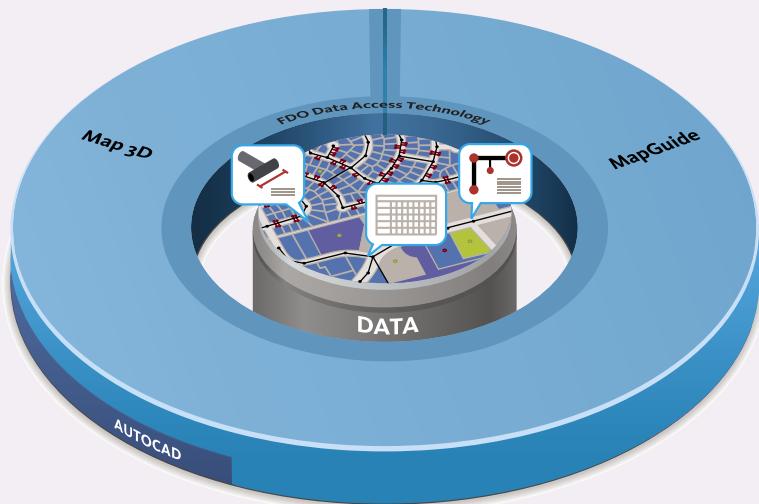


# Freedom and Flexibility

City and state agencies everywhere need to maintain maps and building plans, as well as all the related information that goes with them. And agencies need to publish all of this information to the web for interdepartmental and public use. These agencies are looking for a fast, flexible way to deliver spatial information to customers, internal teams, and other enterprise applications.

An advanced server-based platform, Autodesk MapGuide® software enables organizations to deliver valuable spatial information or analysis tools over the web. Agencies and organizations using MapGuide get maximum value from existing data, as well as a reduction in the cost associated with the publication of spatial information.

**Autodesk MapGuide delivers dynamic mapping and spatial content via the web.**

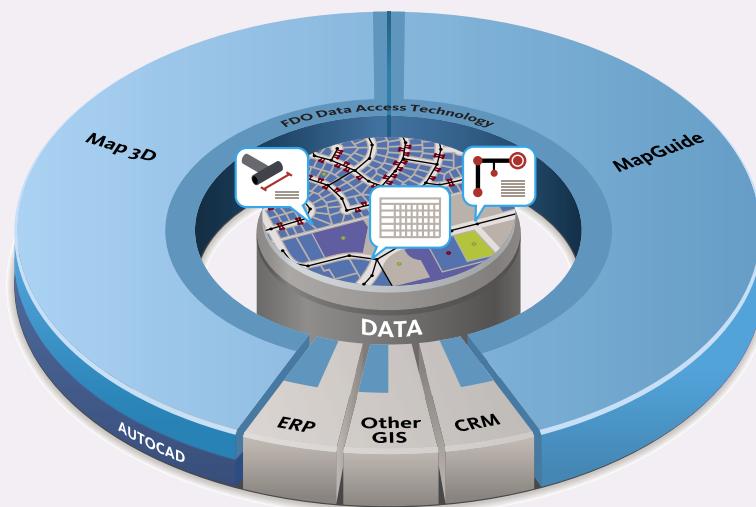


# Open Integration

The growing need for openness and interoperability between traditional GIS applications and mainstream IT systems, as well as integration with public or private web mapping services, calls for seamless data access in native formats and platforms. Without seamless data access, organizations face the inefficiency and inaccuracy of having to translate data into the format supported by the GIS or enterprise application to provide a shared, single view of the data.

In recent years, this challenge has become even more difficult. GIS users today have access to geospatial data in a variety of relational databases and file formats, and via an increasing number of web-based map services. Autodesk FDO Data Access Technology, incorporated into all Autodesk Geospatial applications, provides the solution.

**FDO Data Access Technology enables Autodesk Geospatial products and enterprise applications work natively with spatial data.**



To make it easier for developers to extend the capabilities of FDO Data Access Technology, Autodesk, in partnership with the Open Source Geospatial Foundation™ (OSGeo™), has released FDO Data Access Technology and the MapGuide Open Source project.

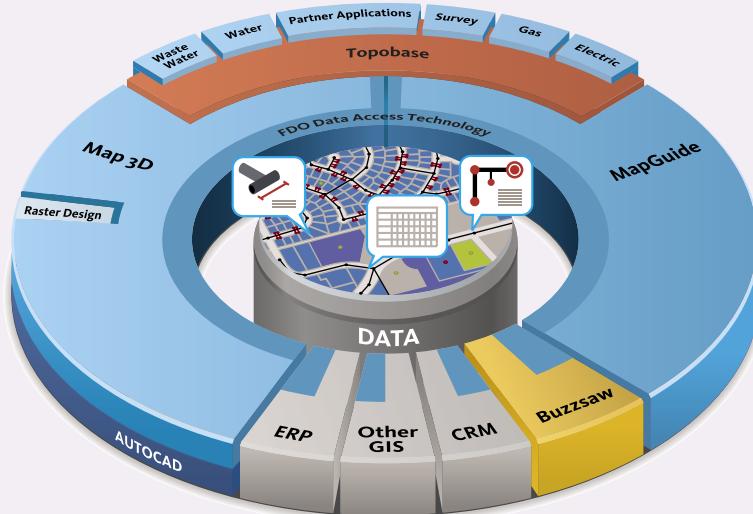
Developers all over the world can now tap into powerful web-mapping and geospatial data access technology without the additional expense of legacy middleware. The results are faster innovation of web mapping solutions, more frequent software releases, and lower cost of entry and ownership.

# Power and Sophistication

As organizations grow, so does the need for a solution to create, manage, and share spatial information both internally and externally. Extending the power of AutoCAD Map 3D and Autodesk MapGuide, Autodesk® Topobase™ software is a sophisticated infrastructure design and management solution that provides industry-specific data models and workflows, and enables teams to share spatial information across departments. In addition, it provides advanced functionality and tools, such as topology, business rules, jobs (versioning), network analysis, and network tracing. Topobase helps users see the big picture with an integrated view of all of their enterprise data.

With Autodesk Topobase it's easy to answer questions such as How many and what type of pipe, electrical pole, or manhole do I have? Which customers will be affected if I turn off this valve or shut down this transformer? How many miles of paved streets do I have?

**Autodesk Topobase extends the power of AutoCAD Map 3D and Autodesk MapGuide, helping to ensure the quality of infrastructure data.**



# Extend the Power

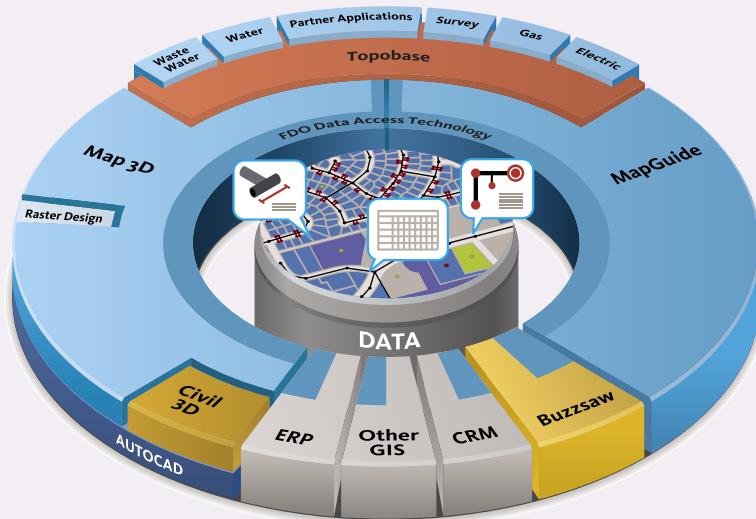
In addition to the core foundation, Autodesk has other applications and extensions on top of the geospatial platform. These include AutoCAD® Civil 3D® and AutoCAD® Raster Design software, as well as the Autodesk® Buzzsaw® collaborative project management service.

Autodesk Geospatial enables organizations to seamlessly integrate civil engineering designs into CAD and GIS workflows. Built on top of AutoCAD Map 3D, AutoCAD Civil 3D is a purpose-built civil engineering tool that uses a dynamic engineering model to maintain intelligent object relationships to complete transportation, site development, sewer, stormdrain, and subdivision projects faster. Make a change in one place and the entire project updates instantly, increasing productivity, saving time, and decreasing costs. In addition, AutoCAD Civil 3D provides the ability to export data to SDF format files, which lets users quickly populate a spatial database with civil engineering data.

Many government agencies and utility companies still use hard-copy maps, so the ability to scan and convert them into vector-based geographic data is crucial. With Autodesk Raster Design organizations can manipulate and edit raster images such as orthophotography and satellite photos, as well as convert scanned legacy hardcopy maps to vector data.

Helping to ensure that accurate information is always available to everyone involved in any infrastructure project, the web-based Autodesk Buzzsaw collaboration environment streamlines the way teams manage and share information. Buzzsaw makes it easier than ever to send out bids to contractors, as well as forward design drawings to structural engineers, architects, and contractors—and to get them back swiftly. It's the ultimate toolset for project management.

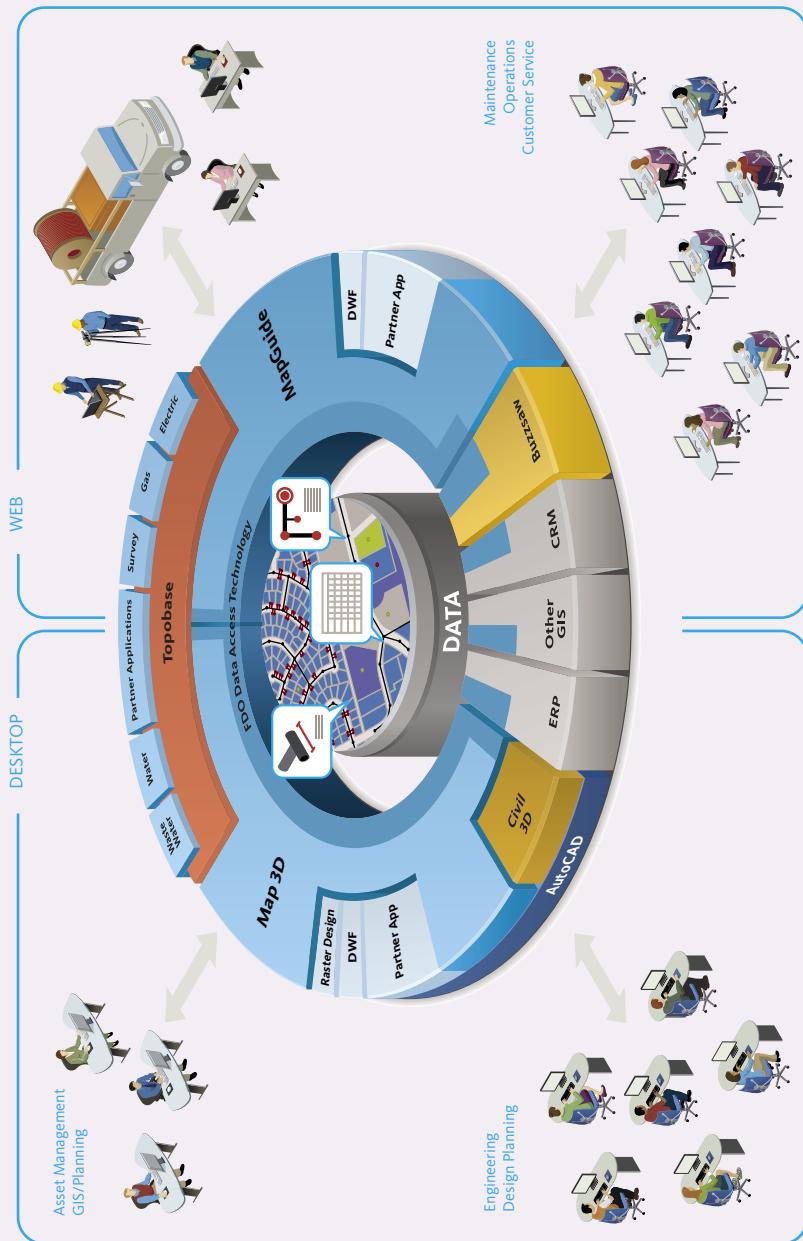
**Autodesk Civil 3D, Raster Design, and Buzzsaw extend Autodesk Geospatial—  
bringing in sophisticated model-based design, the ability to edit raster  
images, and collaborative project management.**



# Autodesk Geospatial Breaks Down Barriers

Autodesk Geospatial enables organizations to fully harness the power of their data by bridging the gap between engineering and GIS departments and the rest of the organization.

From planning through design, construction, and maintenance, Autodesk Geospatial delivers powerful data interoperability and a fully integrated platform for managing spatial data assets.



# Conclusion

Today, tens of millions of people use some sort of CAD-based software, with most using the industry leading AutoCAD software. These skilled professionals are responsible for the design and management of the world's infrastructure. Autodesk Geospatial enables CAD-trained professionals to use their powerful design tools to work directly with sophisticated GIS databases and manage asset information directly within GIS using familiar tools.

Organizations that adopt Autodesk Geospatial solutions save time and money almost immediately, greatly minimizing time-consuming data conversion, error-prone data redundancy, and the loss of valuable engineering precision that comes from managing data separately. This all leads to a reduction in siloed information, while enabling organizations to manage and access the most current data. Increased operational efficiency is the result.

Designed to bridge the gap between CAD and GIS systems, the components of Autodesk Geospatial work together to break down the barriers around data, so that organizations can design, manage, publish, and integrate spatial data more efficiently. By adopting Autodesk Geospatial, organizations can build powerful solutions that easily grow as the organization evolves, ensuring that spatial data is used to full advantage.

Chapter 2:

# The Geospatial Value Chain

This chapter explains the five stages of the Autodesk geospatial value chain. These stages define how organizations typically work with their geospatial information. The five-stage model may help you understand where you are today and how you can extend the value of your geospatial data going forward.

# Stage One: AutoCAD or AutoCAD LT

Since it was first introduced, AutoCAD has been used by engineers and drafting technicians to create maps. These CAD maps stored in DWG files have provided a viable mapping solution for municipalities, public works departments, utility companies, and many other organizations. Many of these organizations have migrated from paper-based, mylar, or vellum files, and now store their infrastructure data in DWG drawings on the desktop computer or in a file directory on a server. Data for individual assets is often stored as blocks, along with the attribute data associated with them.

However, there are limitations to a system that uses a CAD program such as AutoCAD or AutoCAD LT as the principal mapping tool:

- Only one user can access any particular DWG map.
- The maps have no geo-referencing information (coordinate system) assigned to them.
- AutoCAD does not import or export commonly used mapping formats, such as SHP.

If your organization is using AutoCAD or AutoCAD LT but needs to add spatial intelligence to the data, bring in data from other sources, or allow multiple designers to edit the same data, you have outgrown Stage 1 and may be ready to move to Stage 2 or Stage 3

A “traditional” way of working with DWG files as source data looks like this:

## Stage One: A traditional way of using DWG files in AutoCAD



Parcels



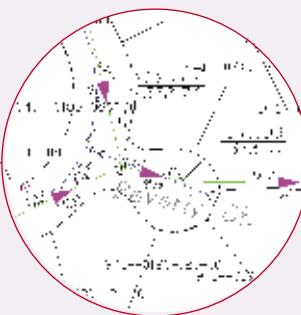
Single user only



Sewers



Water pipes



Blocks with attributes

Separate DWG files

## Stage Two: AutoCAD Map 3D

At this stage, CAD files are still used as the primary data source, but AutoCAD Map 3D is used as the application for creating and editing geospatial data. AutoCAD Map 3D makes it easier for engineers, drafting technicians, and GIS specialists to collaborate on projects and to share mapping information. Project teams can use their AutoCAD knowledge and training while taking advantage of GIS tools and functions.

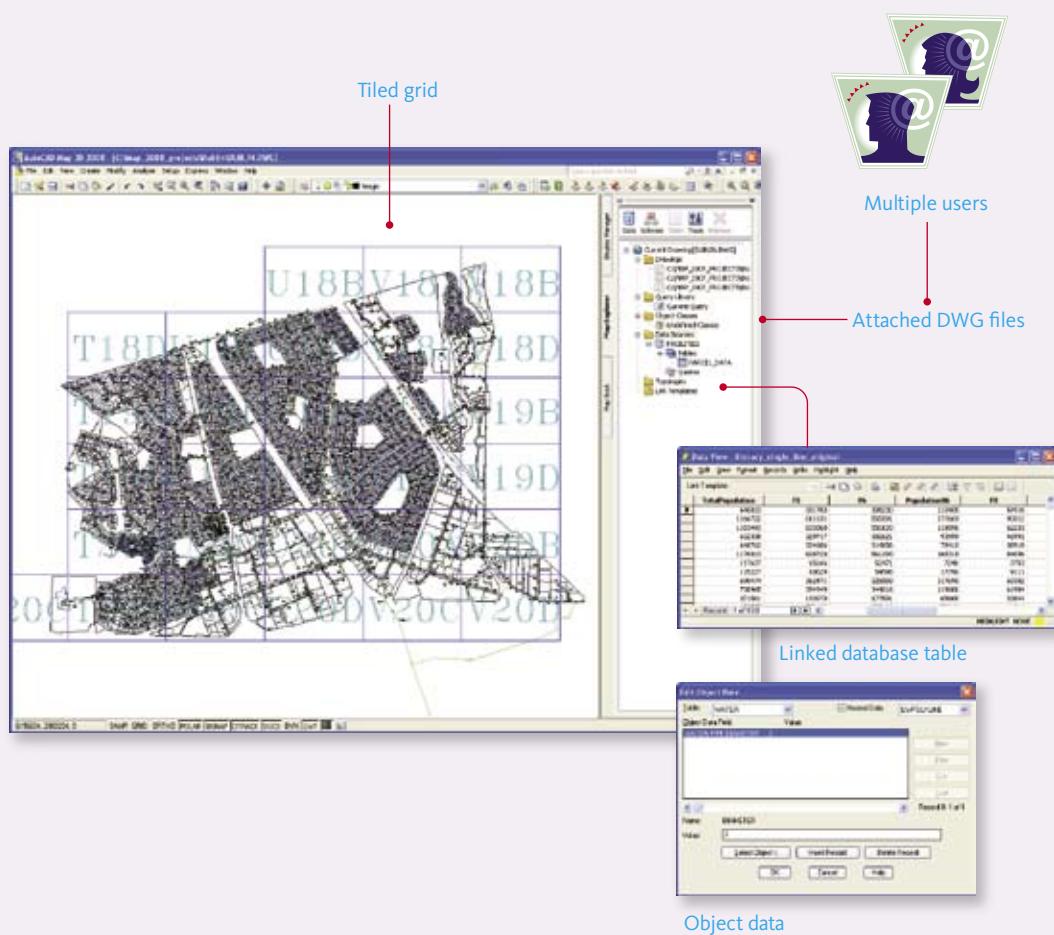
AutoCAD Map 3D provides specific functionality that is not available in AutoCAD:

- Multi-user access—Access DWG drawings at the same time.
- Work across tiles—Attach and query multiple DWG files, which makes it easier to work with tiled data sets.
- Coordinate systems—Bring in DWG, GIS, and raster data with different coordinate systems and have the data overlay properly.
- Drawing cleanup—Detect and fix geometric errors in DWG files.
- Import/Export—Bring in data from other departments and vendors and combine it with data in your DWG files (for example, ESRI SHP).

Many customers who have invested in AutoCAD Map 3D use only the basic features listed above and continue to maintain a large library of DWG maps. Data is stored as object data or as links to an attached database, such as Microsoft® Access. The following illustration shows a typical project with attached drawings, a linked database, and multiple users.

When your organization wants to extend its CAD information to more people and to make use of additional mapping (GIS) capabilities, you may be ready to move to Stage 3.

## Stage Two: Sharing data using AutoCAD Map 3D



## Stage Three: AutoCAD Map 3D + FDO

AutoCAD Map 3D provides data-access and data-management tools to make the process of integrating different types of data easier. In particular, FDO data providers and a consistent data-connect interface simplifies access and management of multiple feature sources. With AutoCAD Map 3D, you can extend your existing workflows and take advantage of efficiencies created through geospatial tools and store some of your information in a spatial data store, such as SDF. Also, you can augment your maps (DWG or other) by bringing in data from a variety of formats, including free data sources, such as web services (WMS and WFS). For more information about FDO technology, see [What is FDO?](#)

SDF (Spatial Database File) format can be very useful at this stage. SDF is an open format for storing both geometry and associated attribute data. The SDF format is a GIS-oriented alternative to DWG. SDF has some significant advantages over DWG:

- It stores and manages an order of magnitude more data than DWG.
- It is very fast, allowing Autodesk applications, such as AutoCAD Map 3D and MapGuide (Autodesk MapGuide Enterprise and MapGuide Open Source), to read and display tens of thousands of features per second.
- It provides the power of a database without the overhead and cost of a full relational database management system (RDBMS), such as Microsoft® SQL Server™ or Oracle®.
- An SDF file can store a single feature class, or it can store multiple feature classes. see [What are features?](#)
- It is easy to manage, providing access to the database schema. see [What is a schema?](#)

With AutoCAD Map 3D, you can extend the traditional reach of DWG files and combine data sources with maximum flexibility. This way of working with multiple data sources looks like this:

### Stage Three: Accessing multiple data sources through FDO

Seamless data coverage

The screenshot shows a map of a geographic area with multiple layers visible. A red callout points to the map area with the text "Seamless data coverage". Another red callout points to the "Display Manager" window, which lists various data sources and their types: SDF, SHP, and Raster.

The Data Table shows the attributes of features.

The layers in the map come from several different data sources.

Display Manager

Current Map: Default

Data Style Table Groups Tools

Parks\_points Hospital Roads Parks

Hydro

- floodzone
- River
- Creeks

Zoning Parcels

City\_Boundary DEM File

Map Base

## What Is FDO?

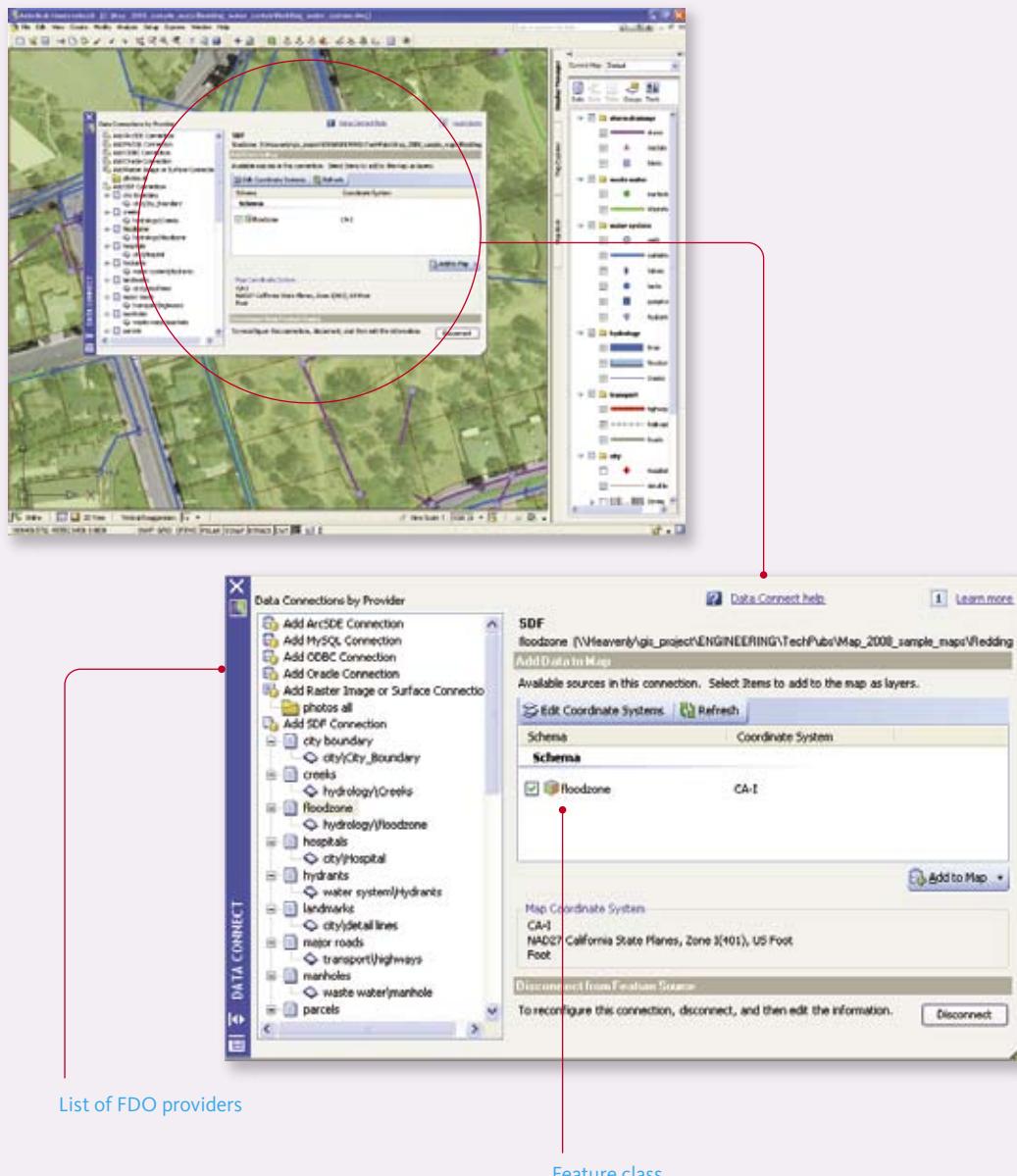
FDO Data Access Technology is Autodesk's common geospatial data access platform. FDO is incorporated into Autodesk Geospatial products, and is also available as a standalone, open source technology for developers. FDO supports the creation of data-store neutral applications and makes it easier to exchange information. The underlying technology is based on open standards, so it eliminates many of the difficulties commonly encountered when working with proprietary systems. Using FDO Providers, you can connect directly to ESRI ArcSDE and SHP, Oracle, Microsoft SQL Server and MySQL feature sources, as well as access public data sources via WMS and WFS. You can also access data providers developed by the open-source community using FDO. The result is that you can build a map using layers of data from many different sources, while accessing all of those data sources in exactly the same way.

All FDO providers access data stored in data tables using standard database concepts. An FDO feature source is any source of feature data that can be accessed using an FDO provider. It can be a file, such as SDF or SHP, a relational database, such as Microsoft SQL Server, or it can be middleware, such as ArcSDE. These feature sources can contain a single feature type, such as parcels, or they may contain a complex data model with multiple features and attribute tables.

When you organize and classify your data, and use FDO Data Access Technology, you can work with much larger data sets than you can with traditional DWG files. Classifying data and storing it in an FDO feature source also gives you more flexibility when styling your data, allowing you to move beyond basic CAD maps to advanced cartography and presentations. In a DWG file, style is a property of the AutoCAD object. However, data stored in an FDO feature source does not have any styling. Styling is separate from the data. This means you can use the powerful style engine, shared by AutoCAD Map 3D and MapGuide, to create different maps with different representations of the same data. For example, you can reorganize layers, change colors, use transparency, and theme features based on their attribute data.

## FDO providers and feature classes in AutoCAD Map 3D

AutoCAD Map 3D with Data Connect open



## What Are Features?

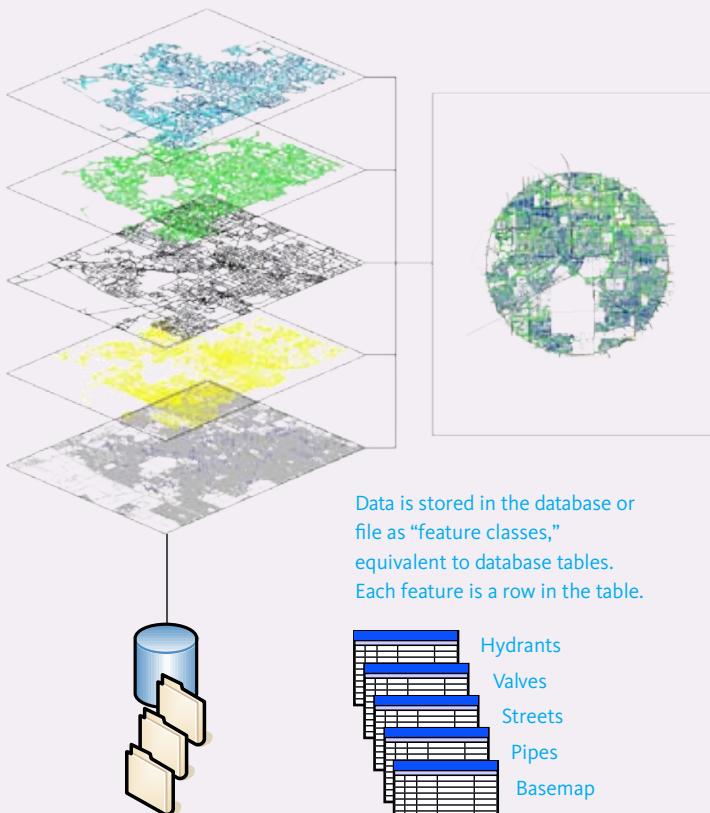
In the map shown in [Stage Three: AutoCAD Map 3D + FDO](#), the data is not stored as plain geometry—points, lines, and polygons, plus attributes—but is stored as features, which are real-world objects combining spatial and attribute data, such as roads, parcels, and rivers. The diagram on the facing page gives a quick overview of the concept of features, in case you are not familiar with them.

The features in your map could be stored in an Oracle database, a SQL Server database, an SDF file, or a web feature service (WFS). Or it could be stored in all of the above. Unlike in earlier versions of AutoCAD Map 3D, you do not have to import SHP files and SDF files. You can work with data in its native format without translation or import/export. Multiple users can access the same data, which reduces data redundancy and allows sharing of information with other organizations and applications.

Each layer in Display Manager refers to a single feature class. These are not the traditional AutoCAD-style layers, used to organize objects in the DWG file, but “geospatial” layers, which are used to organize and style features. For example, in the illustration for [Stage Three: AutoCAD Map 3D + FDO](#), which shows a map of the city of Redding, California, there are six layers: one each for parcels, parks, roads, rivers, creeks, and the city boundary. Each layer is styled using a common styling interface. Layers that have associated attributes can also be themed, using the same interface.

Features generally have attribute data associated with them. This data can be viewed and edited with the Data Table, which is a tool similar to the Data View tool that you may be familiar with. The difference between the two is that Data View shows the content of database tables that have been linked to objects in the DWG file, while the Data Table shows the attribute data that is a part of the feature and that is stored with the geometry. No attaching or linking is necessary.

## A map consists of features, arranged in layers



## What Is a Schema?

Spatial data that is stored as features in a database does not organize itself. Feature classes and attributes must be defined before any features can be added. This definition of the database content is called a schema.

A schema is a structure that describes the organization of feature classes in the data store. In simple terms, each feature class has its own table in the database, and each attribute or property has a column in a table.

For more information about schemas, such as how to view and modify them, see the section [Organizing and Managing Geospatial Data](#) in Chapter 3.

## Schemas, feature classes, and database tables

### Schema

Electric	•	Schema name
Poles	•	Feature class
ID	•	Properties
Name		
Material		
Install_date		
Transformers	•	Feature class
ID	•	Properties
Name		
Type		
Install_date		

### Database tables

Poles			•	Feature class
ID	Name	Material	•	Properties
0001	WP001	wood		
0002	WP002	wood	•	Features
0003	WP003	wood		
0004	WP004	wood		
0005	WP005	wood		
0006	WP006	wood		

# Stage Four: Spatial Databases

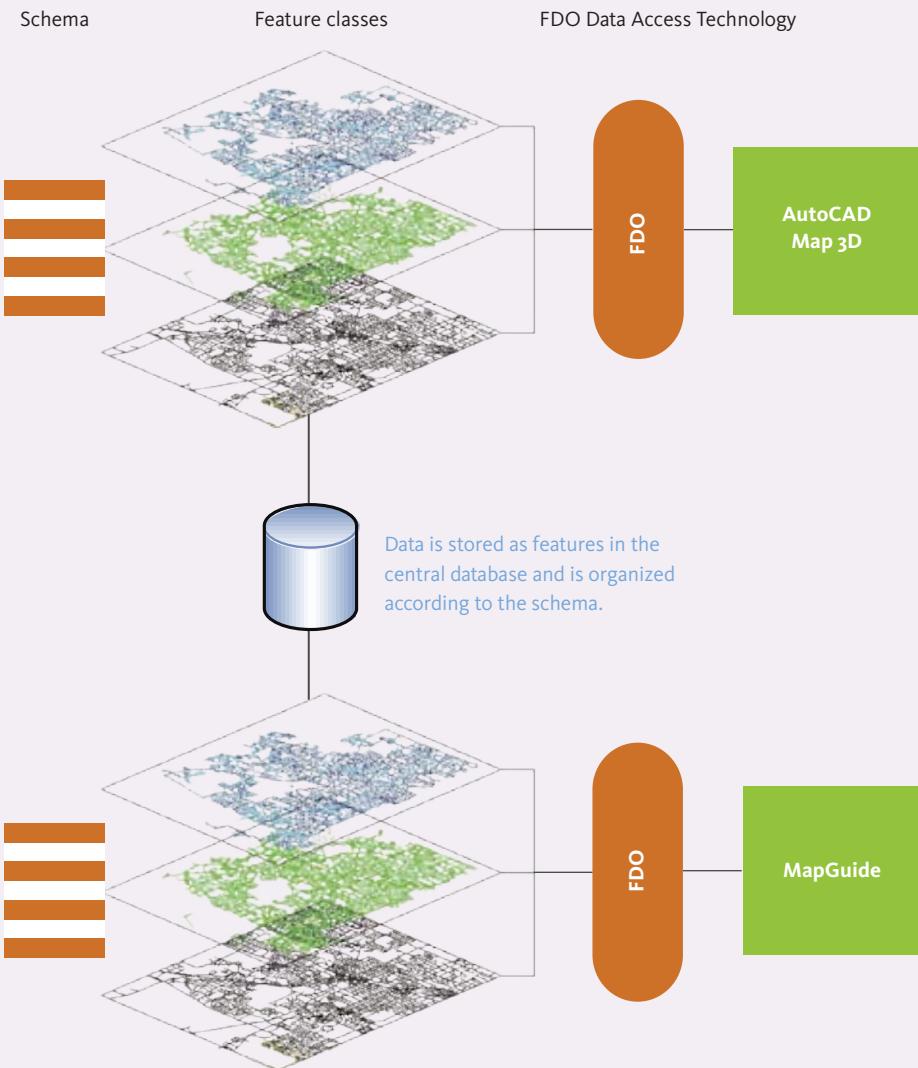
Moving from Stage 3 to 4, you extend the use of your information. At this stage, you start to make full use of relational databases. Stage 3 and Stage 4 are almost the same, except Stage 3 is still a file-based environment (for example, based on SDF) while Stage 4 is based on a relational database management system (RDBMS). If you are already at Stage 3, it is very easy to migrate from SDF or SHP files to a full-scale RDBMS, such as Oracle or Microsoft SQL Server. With AutoCAD Map 3D, you can move from one type of database solution to another as your requirements evolve. Any database schema can be translated into any other. You don't need proprietary middleware, so you are never locked into any one database or software vendor.

In Stage 4 you gain the benefits of:

- RDBMS security and scalability
- Multiple users reading and writing any information
- Sophisticated data models

You may find that you want to move up to a database after you have been using SDF or SHP and have been in Stage 3 for a while. For example, you may have a lot more people interested in, or dependent upon, the data. You may be wondering how you are going to organize and manage the rules and security models for these additional people. How will you scale a system that supports at present only ten people to hundreds or even thousands more users? Stage 4 is based on the same data as Stage 3, but employs more powerful software to meet the requirements of an expanded organization.

## Stage Four: The power of a relational database



# Stage Five: Topobase and Other Applications

In Stage 5, GIS data and functionality is used across different departments and applications. At this stage, mapping data becomes an integral part of the enterprise. GIS data and functionality are woven into other systems, integrating with assessor databases, permitting systems, enterprise resource planning (ERP) systems, and more. Autodesk, Autodesk partners and resellers, and system integrators can all help customers build powerful solutions to meet specific business goals and manage specific workflows.

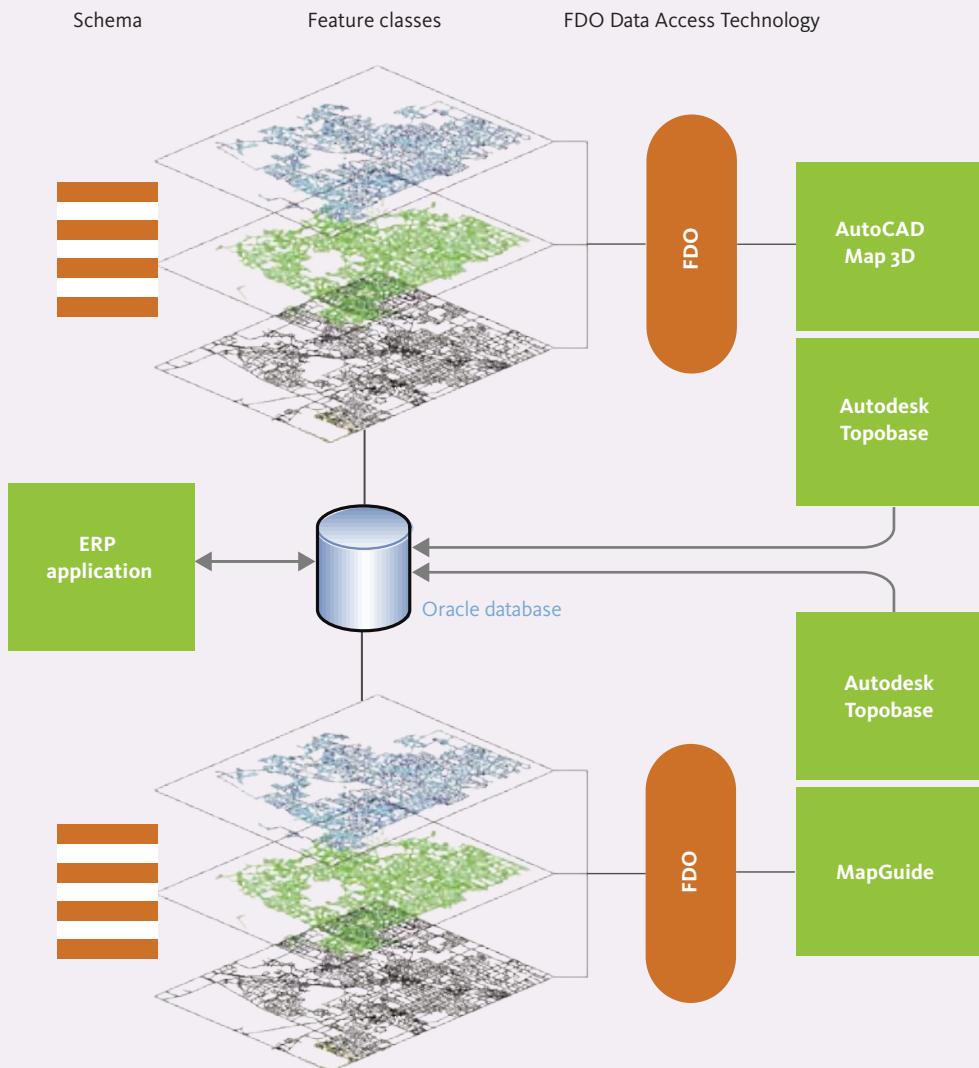
Data in an FDO feature source such as Oracle or Microsoft SQL Server, can be used by many departments and enterprise applications. For example, If your company already has a back-office system managing work-order and asset records using an Oracle database, you can use AutoCAD Map 3D to manage the spatial data and attribute data that goes with those records.

Your existing systems may connect data in an FDO feature source to data or processes in a customer relationship management (CRM) or ERP system and may not even generate a map. CAD and GIS do not always generate output in map form. They can also provide data to an application server for geospatial analysis (machine to machine or application to application).

Stage 5 is the stage of powerful solutions. Many Autodesk customers are already operating in Stage 5, managing geospatial data in sophisticated databases and integrating with other enterprise applications. Alongside AutoCAD Map 3D and MapGuide, customers can deploy Autodesk Topobase, which makes this kind of powerful solution easier to build and easier to manage by adding additional tools, such as business rules, topology, long transactions, workflows, network analysis, and reporting.

Autodesk Topobase provides vertical applications to manage different types of infrastructure, such as water, wastewater, and power. These individual applications come preconfigured with industry-specific data models. The data models capture relations between features. For example, the water module manages features such as pipes, hydrants, and valves, the relationships between those features, and all the underlying attributes relevant to those features. By providing centralized access to spatial data and enhanced processes, Autodesk Topobase improves the way vital tasks get done throughout organizations.

## Stage Five: Geospatial data in the enterprise





Chapter 3:

# Optimizing the Workflow of Geospatial Data

This chapter shows you how to use AutoCAD Map 3D to manage spatial data. The workflows in this chapter demonstrate efficient ways to perform specific tasks such as editing objects in a central data store or incorporating as-built data into a central database.

# Accessing Geospatial Data

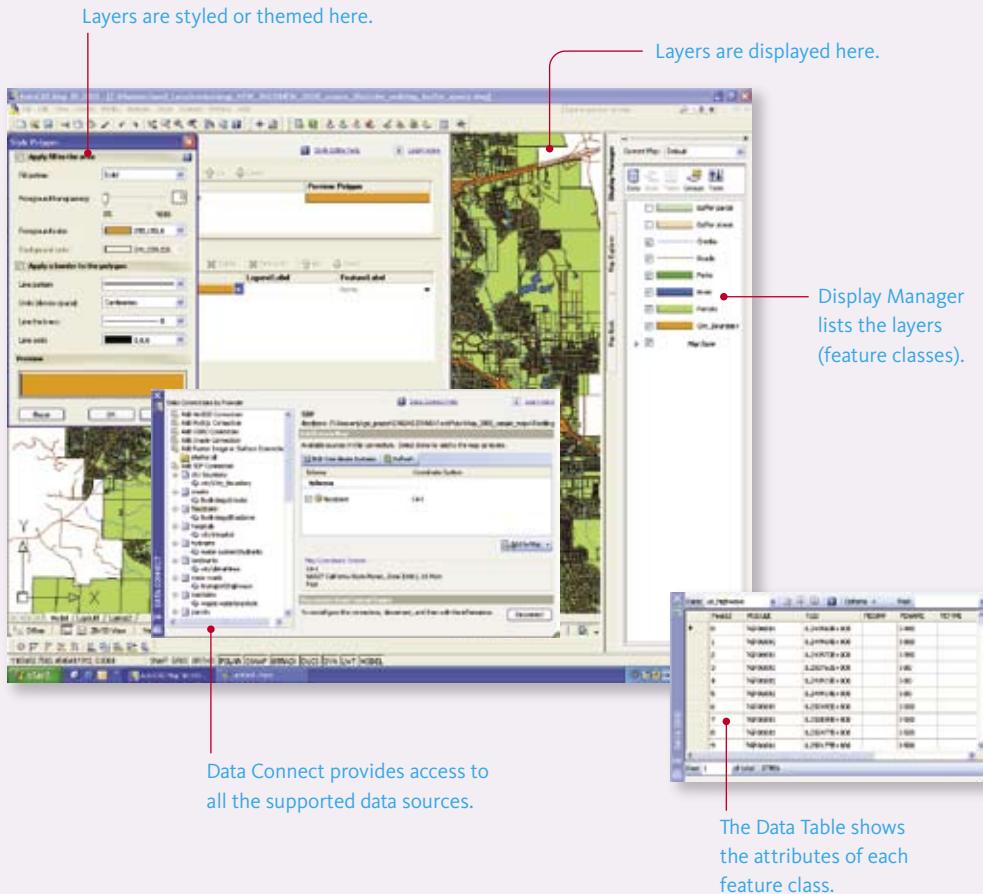
Direct access to geospatial data natively stored in a database is an essential requirement for operate-and-manage systems. The ability to use the design tools provided by AutoCAD Map 3D to create and edit features managed in the central data store provides many benefits. Design data coming from AutoCAD, AutoCAD Civil 3D, or other programs, can be combined with additional geospatial data coming from other geospatial sources (such as SHP, SDF, or Oracle). AutoCAD Map 3D now provides, in a single application, all of the data integration, data management, and create and edit functions necessary for organizations of any size.

AutoCAD Map 3D supports direct access to databases such as Oracle, ArcSDE, Microsoft SQL Server, ODBC, and MySQL. In addition, there are also providers for file based data stores: SDF, SHP, and raster. Finally, there are two providers that support open standards by offering a direct connection to web services: WFS (Web Feature Service) for vector data, and WMS (Web Map Service) for bitmapped data. The complete list of providers/data sources looks like this:

- Oracle
- ArcSDE
- Microsoft SQL Server
- ODBC (for points)
- MySQL (on Windows and Linux)
- SDF (Spatial Database Format)
- SHP
- Raster (read only)
- WMS (Open Geospatial Consortium Web Map Service)
- WFS (Open Geospatial Consortium Web Feature Service)

In AutoCAD Map 3D, you create maps by adding layers in the Display Manager. Each of the layers contains a single feature class, as shown in the following illustration. All of the layers may come from the same data source or each layer may come from a different data source. For example, the following illustration shows a map that has several layers, each of which refers to a different feature source. However, each layer is listed in the same way in Display Manager and is styled in the same way.

## Common interface for viewing attributes and styling layers



Of course, you can also use DWG files, either together with one or all of the feature sources above, or by creating layers in Display Manager, as in previous releases. For more information, see [Using DWG Files As Data Sources](#).

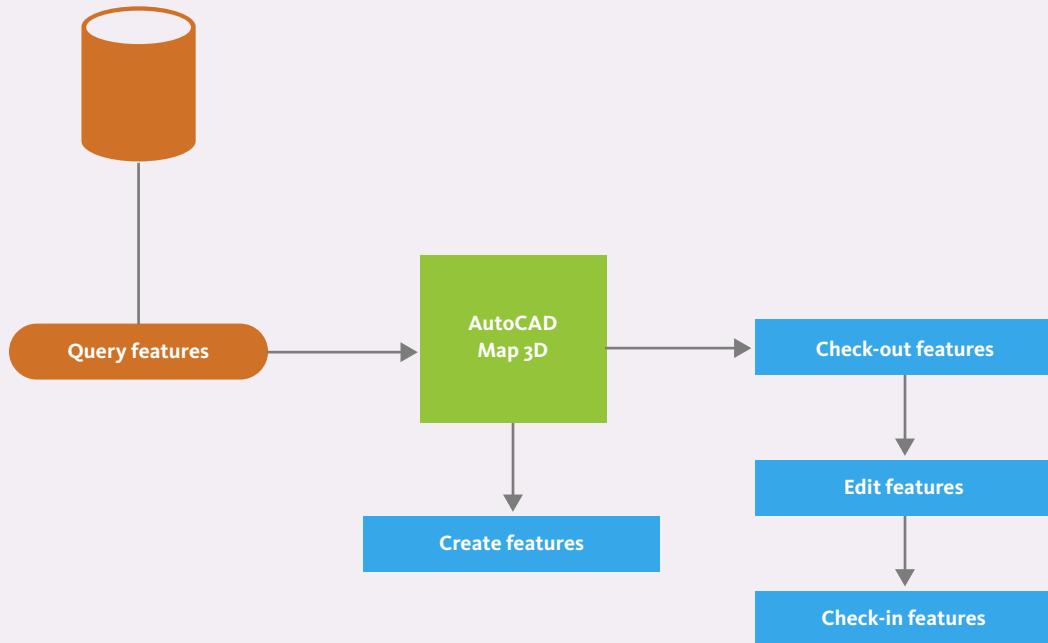
## Workflow: Create and edit database features

This workflow shows how you would use AutoCAD Map 3D to edit and create features that are stored in a central database. Here is a typical scenario for this workflow:

- Many engineers or mapping technicians are accessing the same data, which is stored in a central database.
- A particular engineer needs to make changes to some existing features, and also add some new ones.

Here is the high-level flow diagram:

### Create and edit database features

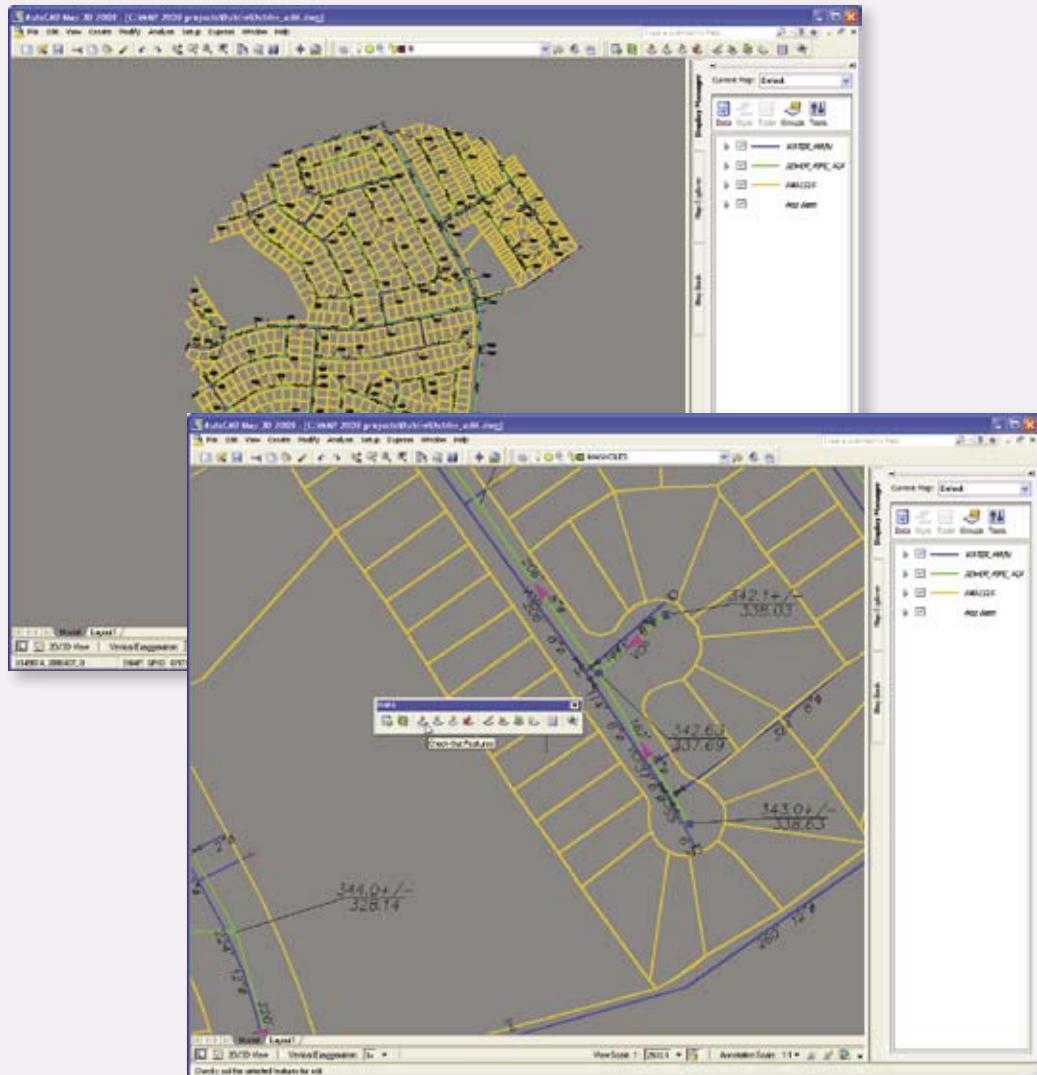


In AutoCAD Map 3D, the mapping or drafting technician queries features in the area of the map to be edited. In this example, water mains and sewer pipes are brought into the map, as well as the background parcels for reference. The data is automatically styled as it is brought into AutoCAD Map 3D, so that it appears with the appropriate colors and line weights.

The technician selects the pipes to be included in the editing session and checks them out, using the new Check Out Features command (see the following illustration). This action locks those features so that no one else can edit them—the type and level of locking depends on the database or data store that the features come from.

## Create and edit database features 1

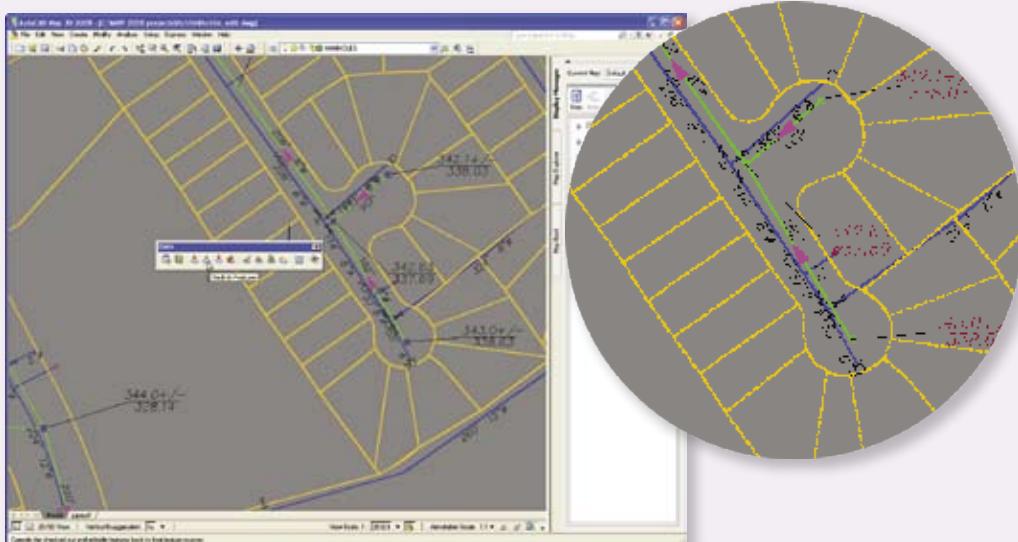
A query is made that includes the features to be edited.



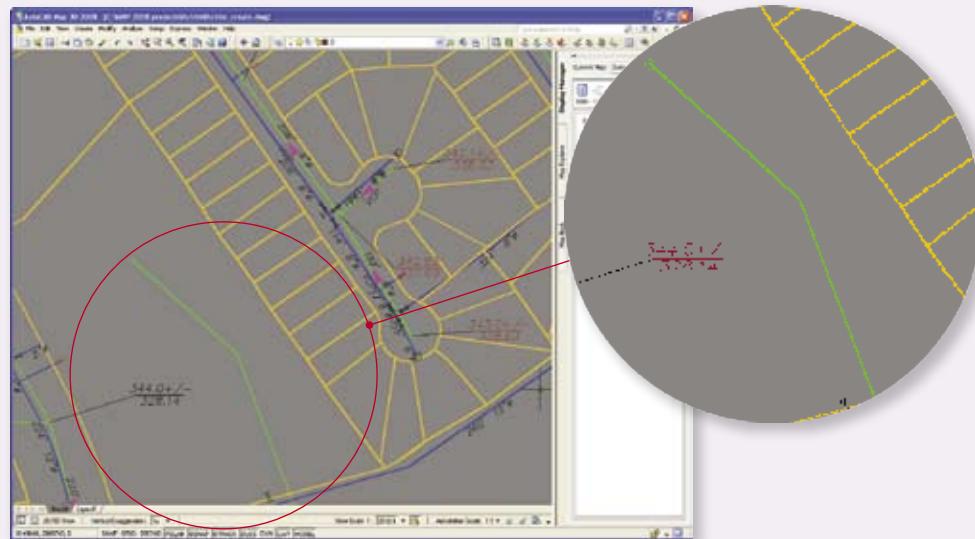
The pipes to be edited are selected and checked out.

After the technician has finished editing the spatial and attribute data of the features, he or she uses the Check In Features command to unlock the features and write them back to the data store (see illustration 2, which follows). There are also new pipes to add, so the Pipes feature class is selected in Display Manager. When the new lines are drawn, they are automatically styled and added to the feature class as pipe features. They are then saved to the data store and the edit and create operation is complete. Because the data updates are made directly to the central data store, any web applications that access the data stay current and reflect the latest changes.

## Create and edit database features 2



The pipes are edited, then checked back in.



The new pipes are added.

For an animated demonstration of steps in this workflow, see the following topics in *GIS Skills for Engineers* (available on the AutoCAD Map 3D Help menu):

- Edit feature geometry directly in a SHP file using CAD tools
- Draft new features for an existing feature class

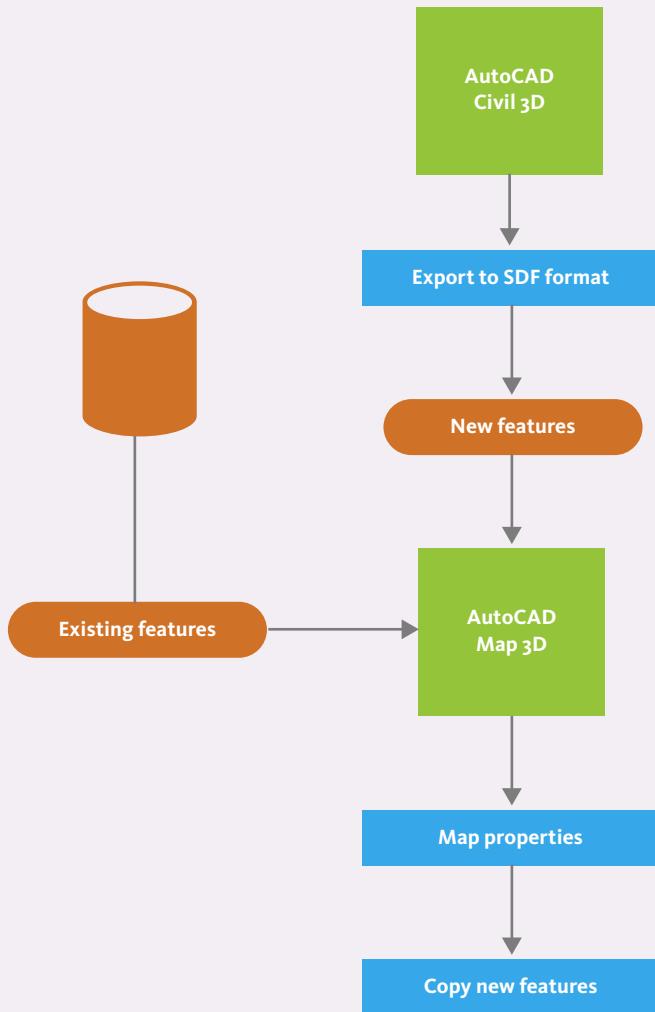
### Workflow: Bring In Design Data from AutoCAD Civil 3D

This workflow shows how parcel and road data can be transferred from AutoCAD Civil 3D to AutoCAD Map 3D for data management tasks. The data is used to create features, which are then added to the central database. Here is the scenario for this workflow:

- A new subdivision has been built, and an engineer wants to pass the design data to the mapping department so that it can be added to the existing parcel map.
- The mapping department needs to add tax assessment data from a database to the new parcels.

Here is the high-level flow diagram:

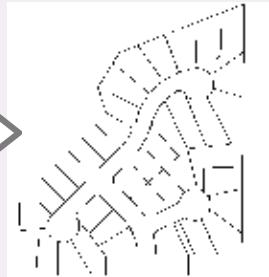
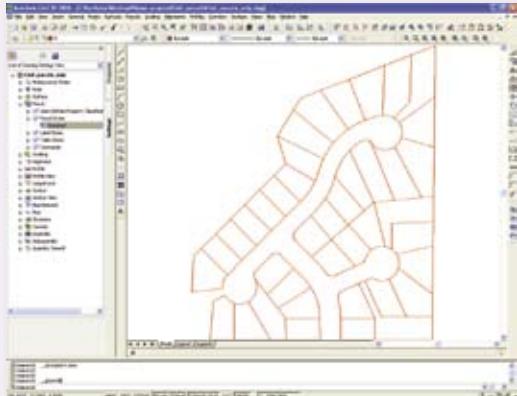
### Bring in design data from AutoCAD Civil 3D



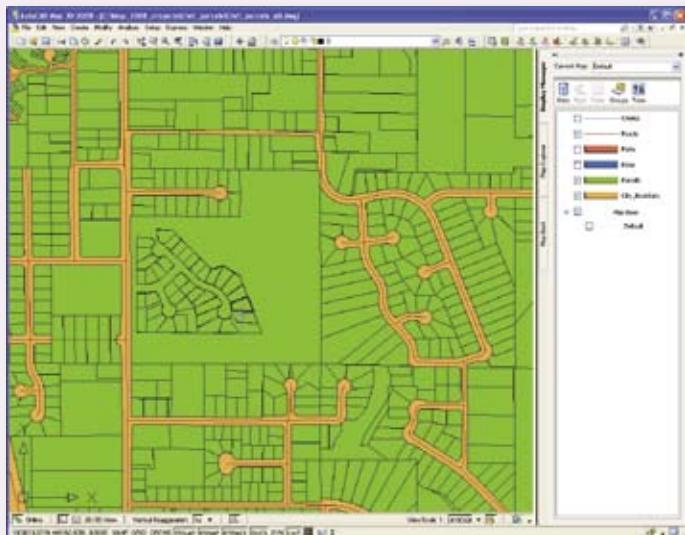
In AutoCAD Civil 3D, the engineer exports the parcel and road data to SDF format, where it is stored as a set of features with attributes that AutoCAD Map 3D can read. Using AutoCAD Map 3D, the mapping technician queries the parcel and road data for the area of the new subdivision from the central database. In this case, the tax assessment data is stored in a different database, so that data is queried as well.

## Bring in design data from AutoCAD Civil 3D

Roads and parcels are exported to SDF features.



New SDF features are combined with existing features.



The mapping technician brings the SDF features for the new parcels and roads into the map and checks that they are in the correct location. He then maps the parcel ID property of the new parcels to the parcel ID property of the existing parcels, using the Bulk Copy command in AutoCAD Map 3D. He saves the mappings to a file for future use.

The parcels are then copied to the database. In this process, they inherit all of the fields in the original parcel records, including those for tax assessment. The mapping department can then add the tax assessment data to the records for the new parcels.

For an animated demonstration of steps in this workflow, see the following topics in *GIS Skills for Engineers* (available on the AutoCAD Map 3D Help menu):

- Bring in parcel data from AutoCAD Civil 3D (second animation)
- Bulk copy from a SHP file to an SDF file

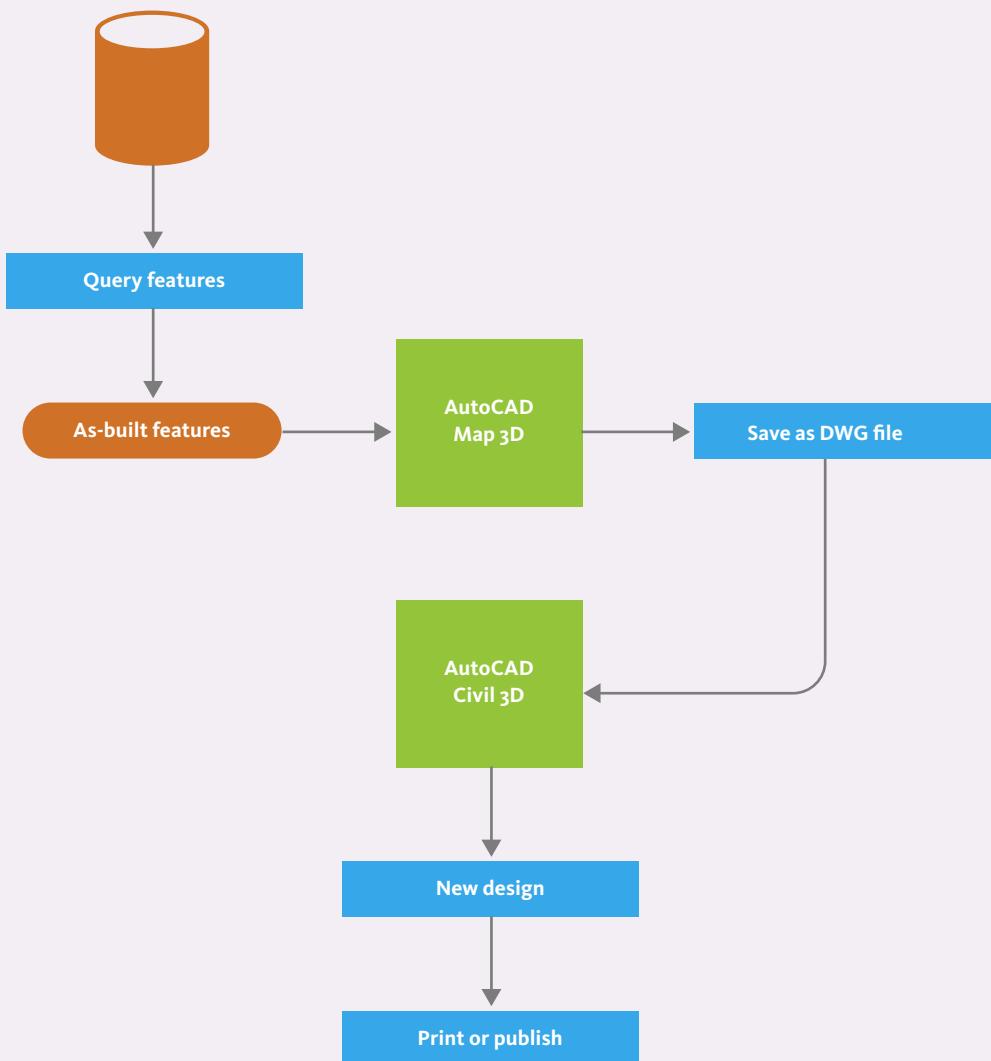
### Workflow: Use existing features as a starting point

This workflow illustrates a situation that is the reverse of the previous workflow. In this case, existing features are used as the starting point for a new design. Here is the scenario for this workflow:

- Engineers are laying out road alignments for a subdivision and need to view where the existing infrastructure is located.
- At the same time, the mapping department is making adjustments to the boundaries of some of the existing parcels in the area.

Here is the high-level flow diagram:

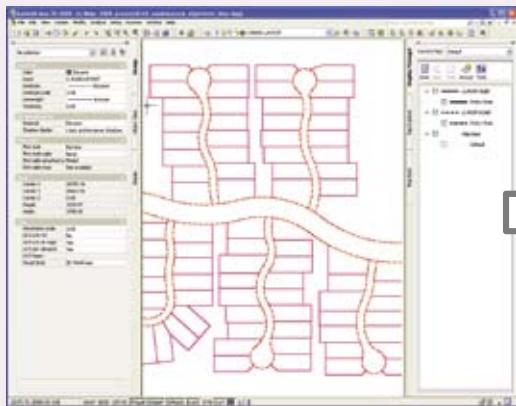
## Use existing features as a starting point



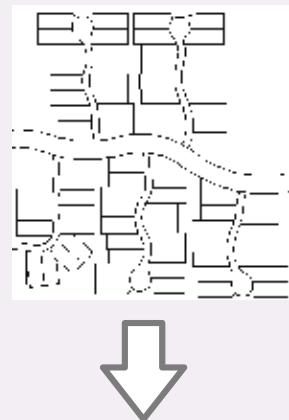
In this example, AutoCAD Map 3D and AutoCAD Civil 3D are being used in parallel to work on the data stored in the central database. The mapping department queries the parcel map and brings in a set of parcel features that need to be edited. The engineers work in AutoCAD Civil 3D to design infrastructure, such as pipes, cables, and road centerlines.

## Use existing features as a starting point

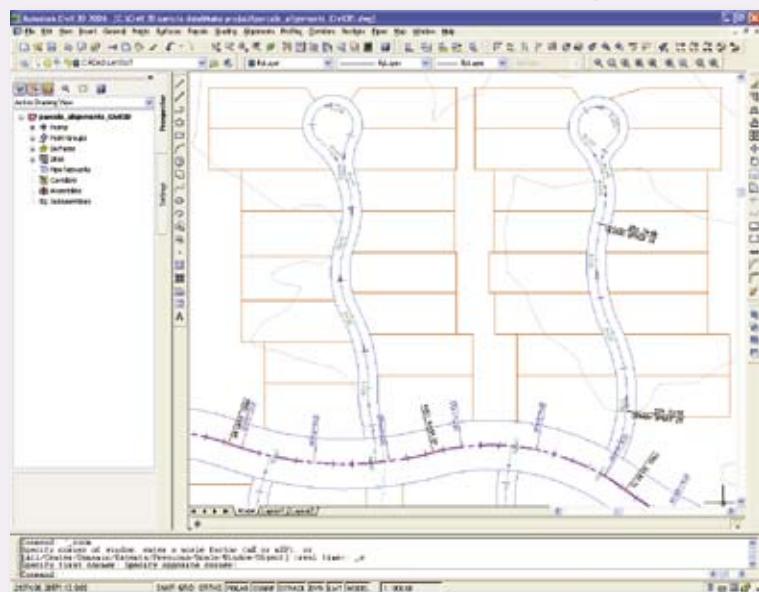
Parcels are edited in AutoCAD Map 3D.



Parcels are exported to DWG.



Road alignments are completed in AutoCAD Civil 3D.



The mapping department completes its work on the parcels in the subdivision and exports the parcel features in DWG format. The engineers read these features directly into their designs in AutoCAD Civil 3D. When they have completed work on the road alignments and other new infrastructure, construction documents are prepared.

For an animated demonstration of steps in this workflow, see the following topic in *GIS Skills for Engineers* (available on the AutoCAD Map 3D Help menu):

- Bring in parcel data from AutoCAD Civil 3D (first animation)

# Using DWG Files As Data Sources

DWG files remain an essential part of the workflow of many departments. There are basically three approaches to working with spatial data in AutoCAD Map 3D:

- Use DWG files exclusively, perhaps in conjunction with linked databases.
- Mix the two; that is, use DWG files as one data source among several or many others.
- Use feature sources (such as Oracle, SDF, and SHP) exclusively without opening any DWG files.

If you use both feature sources and DWG files together, you have an environment that is very flexible. You do not have to move all your data to features but can migrate to feature sources as required by your workflow. You can keep whatever data you need as DWGs, work with those files in AutoCAD Map 3D and selectively take advantage of the functions in AutoCAD Map 3D that work exclusively with features, for example, the enhanced performance for large datasets or the 3D grid-surface engine. One reason you may want to keep data in DWG format is if you have a lot of annotation in your DWG files. The first workflow in this section describes this kind of “mixed” DWG/feature-sources approach.

If you use feature sources exclusively, then you may want to convert geometry/objects that you receive in DWG files to features, in order to have all your data in a consistent format. Converting means saving DWG objects as features and assigning them to existing feature classes. Migrating DWG objects in this way takes some preparation and processing time. However, there are utilities that you can use to speed up the process. The advantages of having all of your data stored as features in a central data store have been discussed elsewhere in this book. The second workflow in this section explains this process of converting DWG objects to features.

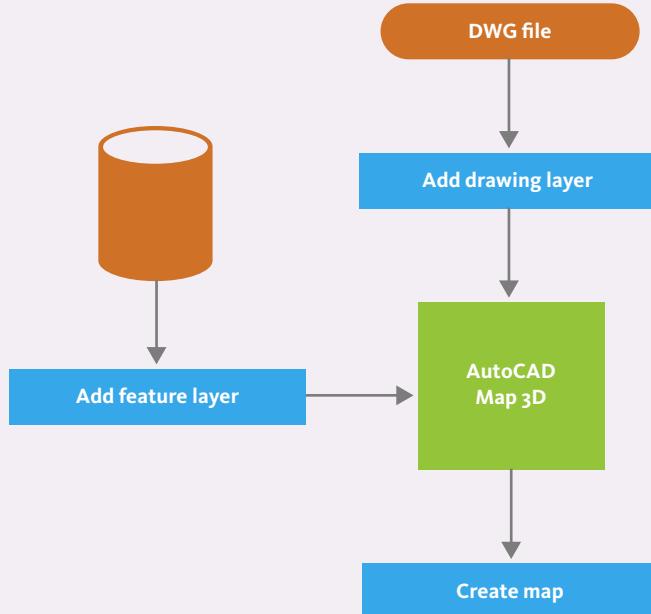
## Workflow: Combine DWG data sources and feature data sources

This workflow shows how layers created from attached DWG files can be combined with layers created from feature sources in the same map. Here is the scenario for this workflow:

- A mapping technician wants to create a presentation map of railway and road networks.
- State and district data is in SHP format, while the railway and road network data is in DWG format.

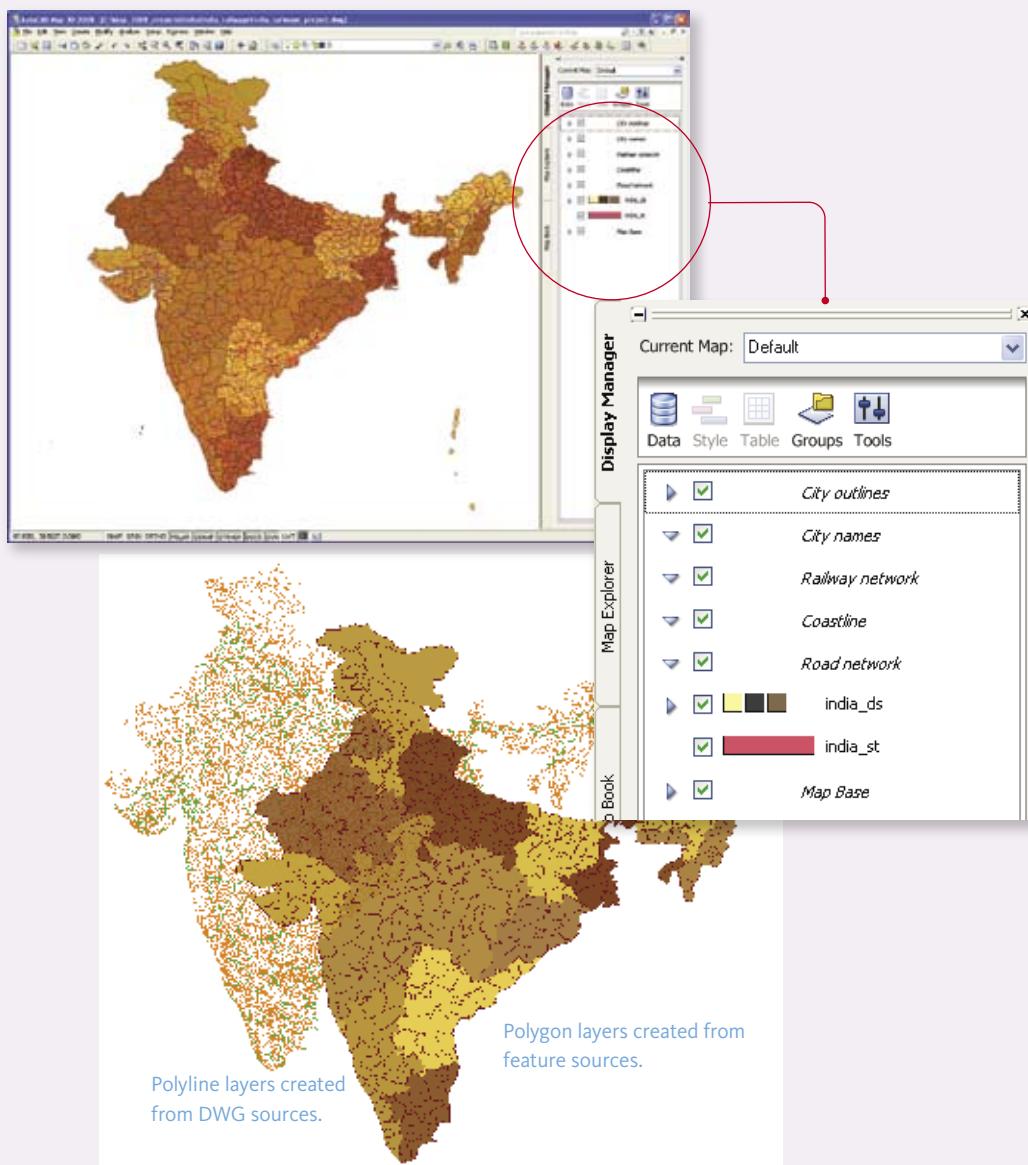
Here is the high-level flow diagram:

### Combine DWG data sources with feature data sources



In AutoCAD Map 3D Display Manager, the mapping technician adds new feature layers that refer to feature sources in SHP format. Continuing in Display Manager, he themes the state polygons in a neutral color scheme to provide the background for the map. Also, he specifies that the district polygons are red and 50% transparent so that the finer divisions of the district boundaries overlay the state polygons, but leave them visible.

## Combine DWG data sources with feature data sources



Having completed the background, the mapping technician uses the Map Explorer in AutoCAD Map 3D to attach the DWG files that contain the road and railway network. He adds DWG layers (drawing layers) for the finer network of railways and roads. These drawing layers refer to one or more of the original layers in the attached DWG files. Any data that is not on the DWG layers appears in the Map Base layer in Display Manager.

He then uses the Display Manager to add styles for the railway and road polylines, styling them in a contrasting color so that they stand out from the background. The map is then saved as a DWG file. The final DWG file therefore acts as a “project” file that contains references to both the attached DWG files and to the feature sources. The DWG also stores the queries to bring in the road and rail networks as well as the styling applied to them.

For an animated demonstration of steps in this workflow, see the following topics in *GIS Skills for Engineers* (available on the AutoCAD Map 3D Help menu):

- Include AutoCAD layers in the Display Manager
- Theme by individual values
- Set transparency for parcels and other features

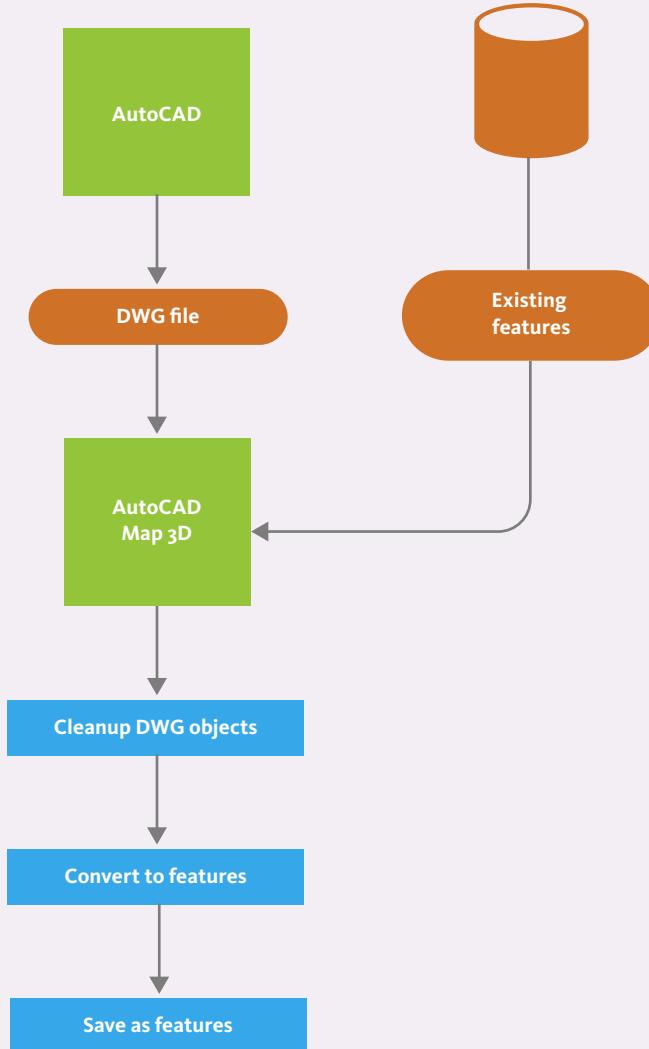
### Workflow: Convert DWG objects to features

This workflow shows how objects can be taken from a DWG file and converted to features, so that they can be added to the central data store. Here is the scenario for this workflow:

- A designer working for an electric utility company uses AutoCAD to draft a design to supply electricity to a set of parcels in a new subdivision.
- A mapping technician receives the design in DWG format. She now wants to add the new design to the existing electric facilities in the central database.

Here is the high-level flow diagram:

### Convert DWG objects to features

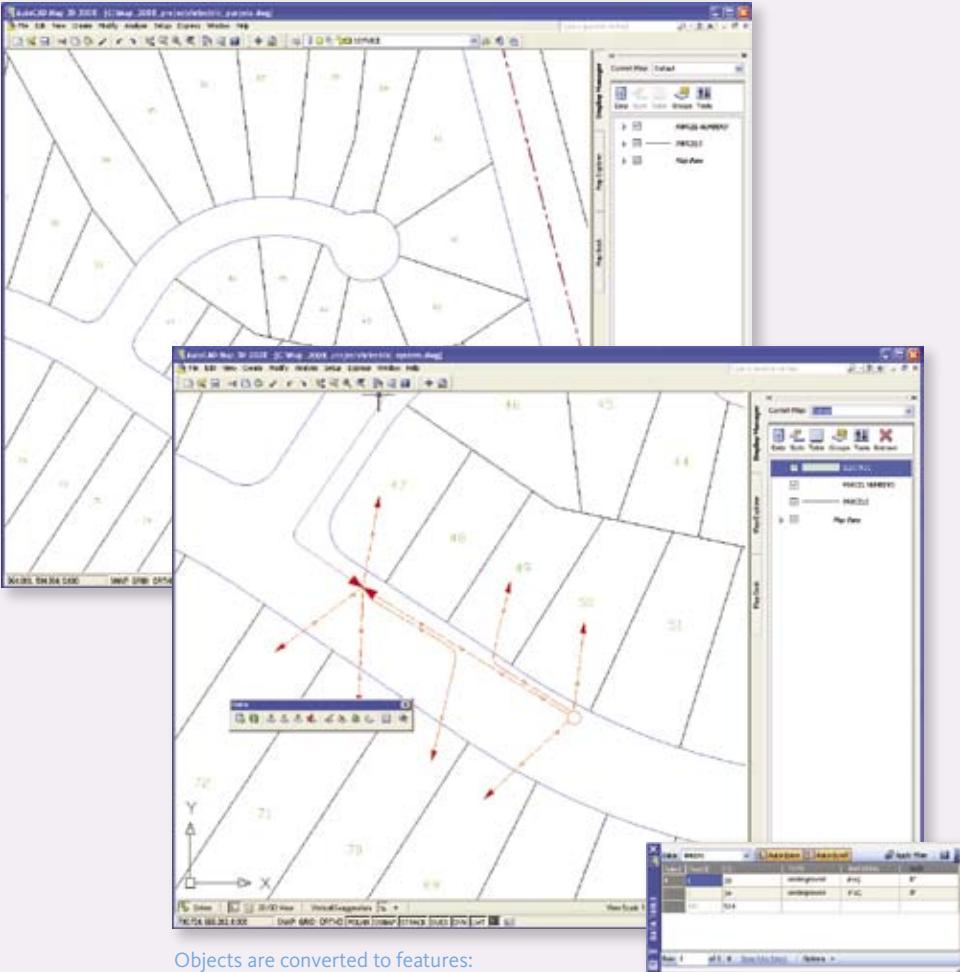


In this workflow, it is assumed that the mapping technician is familiar with the schema of the central data store, that is, the feature classes that it contains, for example, transformers, poles, and cables. (The Schema Editor utility in AutoCAD Map 3D can be used to define and view the schema of any FDO data store.)

Using AutoCAD Map 3D, the mapping technician queries the database to display the parcels to which the design applies. She also creates a drawing layer (see previous workflow) and displays the DWG objects that make up the new electric design (shown in red in the following illustration). She checks the objects to make sure they have no problems, such as overshoots or duplicates, and corrects them if necessary, using the DWG cleanup utility in AutoCAD Map 3D.

### Convert DWG objects to features

Existing parcel features



Objects are converted to features:  
cable, handholes, transformers, etc.

Data Table is used to add attribute values.

Using the Create Feature From Geometry command, she selects the individual objects, such as lines and circles and converts them to features. For example, the lines in the DWG are converted to cable features and the circles are converted to handhole features. When the lines and circles are converted to features, they automatically take on the properties of the features in the data store, for example, cable type, material, and so on. The mapping technician specifies the values for these properties during the conversion process.

This process of converting objects to features is easy when there are relatively few objects, as in this example. However, if there are many objects to be converted, you should export the DWG objects to SDF to automate the process (see the next workflow in this section).

For an animated demonstration of steps in this workflow, see the following topics in *GIS Skills for Engineers* (available on the AutoCAD Map 3D Help menu):

- Bring in a subset of features using a query
- Include AutoCAD layers in the Display Manager
- Clean up duplicates, gaps, and other accuracy problems
- Create new features from existing AutoCAD objects

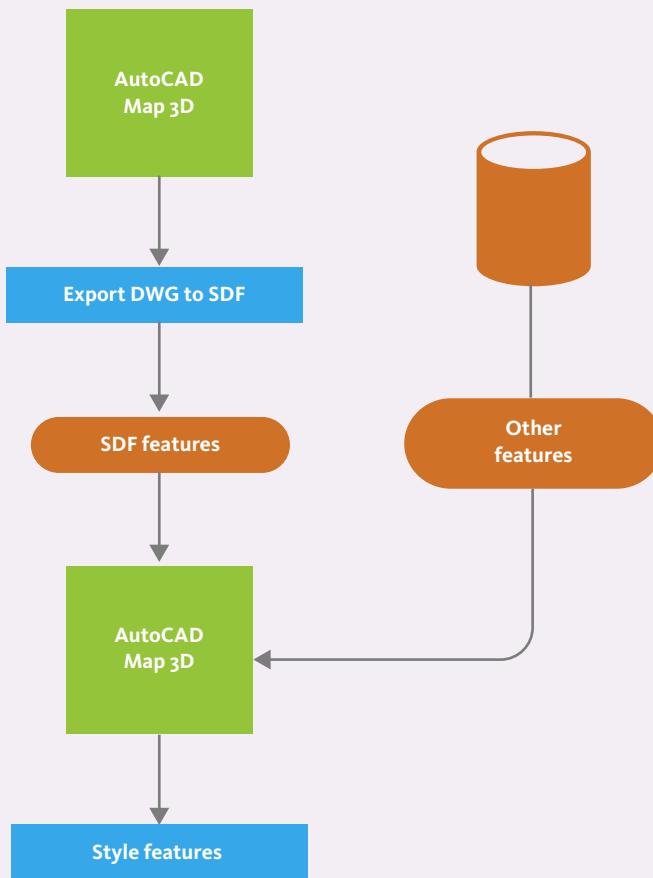
### Workflow: Export DWG objects to a GIS data store

This workflow shows how to export large numbers of DWG objects to SDF format, and convert them into features at the same time. Here is the scenario for this workflow:

- An engineer working for the transport department of a suburban city has been asked to provide city data for inclusion in maps being created at the regional level.
- Technicians in the regional planning office collect transport data from all the cities in the region and use the data to produce detailed proposals for new transport infrastructure.

Here is the high-level flow diagram:

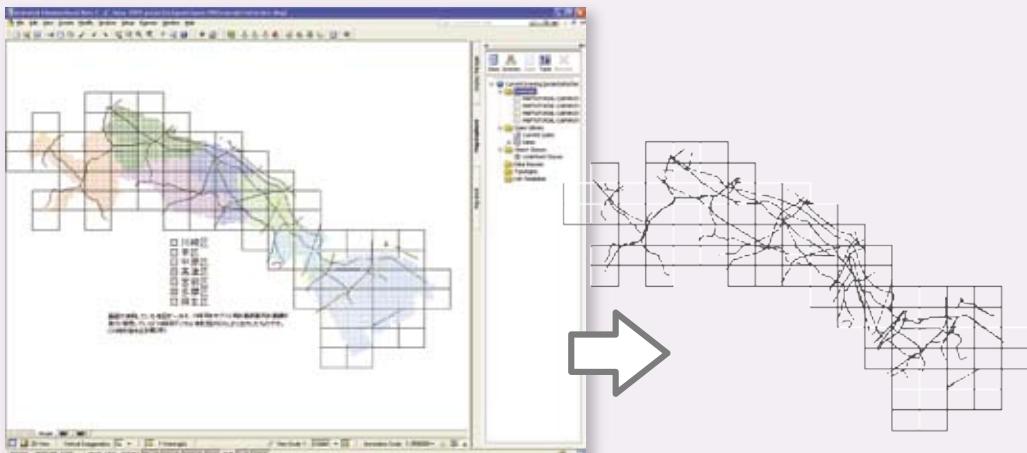
## Export DWG objects to SDF



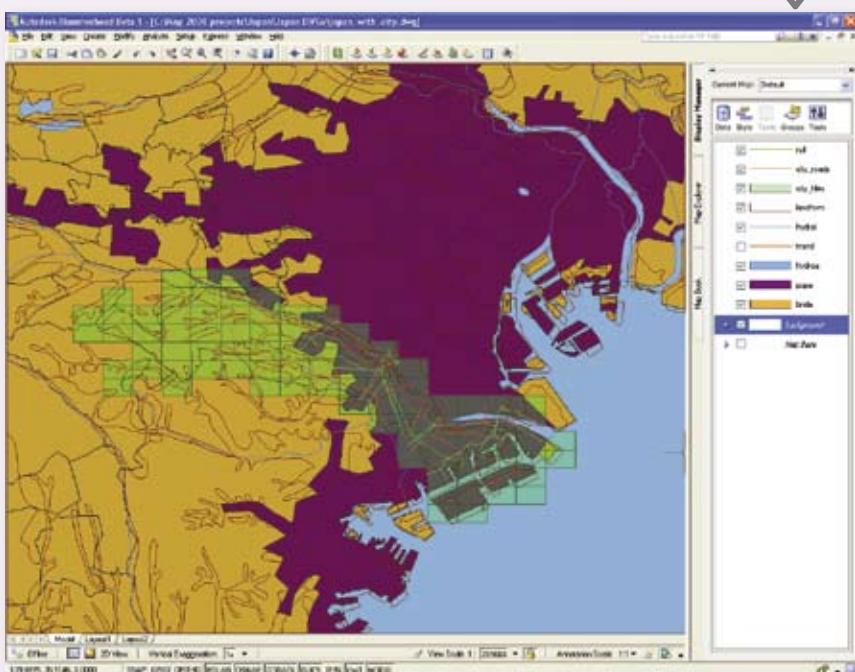
In AutoCAD Map 3D, the engineer opens the DWG files that contain the data requested by the regional office. He then exports the DWG data to SDF format, using the option to export specific AutoCAD layers. Each of the layers becomes a feature class in the SDF file. Any attributes that are stored as object data or in linked database tables are exported as well.

In the regional planning office, the mapping technician responsible for developing maps for the regional transport plan opens the existing planning map in AutoCAD Map 3D. Then, she uses the Data Connect dialog box to bring in feature classes from the SDF file provided by the city.

## Exporting layers from a DWG file for use in a regional map



AutoCAD layers are exported to SDF format.  
Each layer becomes a feature class in the SDF file.



The feature classes are brought into the regional map from the SDF file.  
They are styled in Display Manager.

*Data from the city of Kawasaki, Japan, used by permission (Digital map 2500, approval No.136 issued by The City of Kawasaki).*

The features brought in from the SDF file are not styled, that is, they have no color, linewidth, or other style properties assigned to them. The mapping technician uses the Style Editor in AutoCAD Map 3D to style the new features according to the cartographic conventions already established by the planning office.

For an animated demonstration of steps in this workflow, see the following topics in *GIS Skills for Engineers* (available on the AutoCAD Map 3D Help menu):

- Export data from the current DWG to a GIS data store (SDF)

# Organizing and Managing Geospatial Data

AutoCAD Map 3D lets you organize and manage data in a database or data store by giving easy access to its schema. The Schema Editor utility allows you to view and edit the structure of any schema in any of the data sources supported by FDO (for the complete list, see [Accessing Geospatial Data](#)).

Although complete database schemas are typically set up by experienced database administrators, the tools in AutoCAD Map 3D allow less experienced users to work with a schema to perform essential tasks, such as creating a new schema with new feature classes or to bulk-copy features from one schema to another. When you are connecting to feature data to bring into your map, you can browse the schema of any feature source, selecting only the feature classes you want to access. Using the Schema Editor, you can also perform the following tasks on any FDO data stores and their schemas:

- Create a new data store in the supported FDO providers. This process includes defining the schema, setting up feature classes, and setting up properties.
- Build a schema using an external program such as Microsoft Visio and import it into FDO, using standard protocols such as UML and XML.
- Bulk-copy data from one database to another by mapping the properties of the source database to the properties of the destination database.

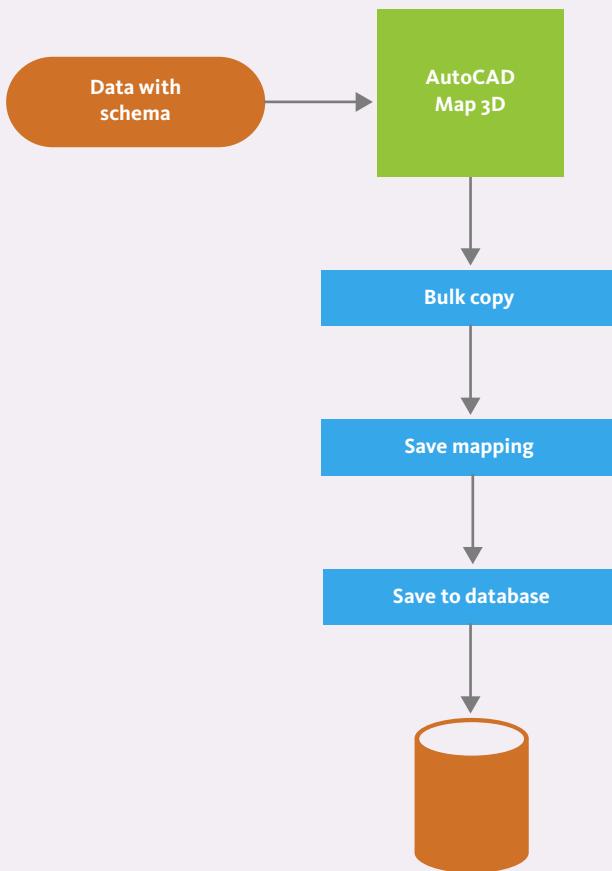
## Workflow: Convert one schema into another

This workflow shows how you can map the schema of one data store into another schema and then transfer data from one data store to another. Here is the scenario for this workflow:

- An organization's workflow is focused on a central Oracle database. However, spatial data is received from other departments in various formats, such as SHP files.
- The mapping manager wants to set up a process in which data coming into the department in one format or schema is converted into a standard Oracle schema so that it can be edited in AutoCAD Map 3D and distributed by Autodesk MapGuide Enterprise or MapGuide Open Source.

Here is the high-level flow diagram:

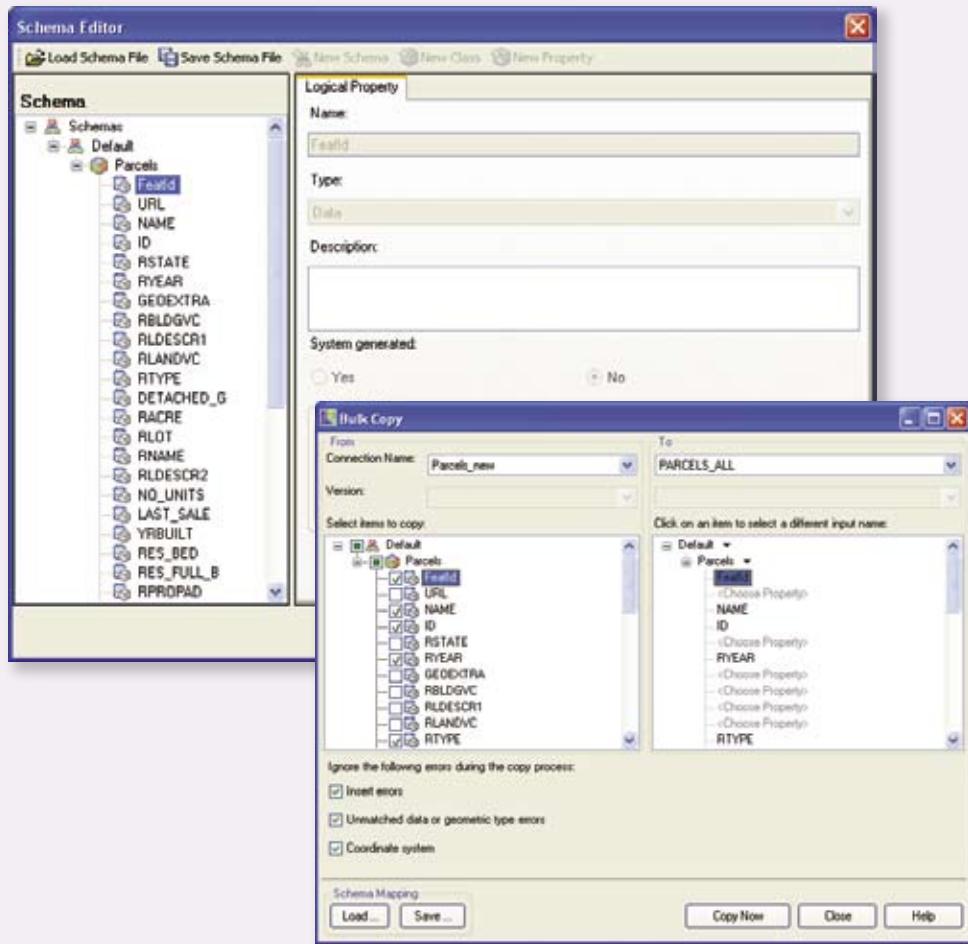
#### Convert one schema into another



Using the Schema Editor utility in AutoCAD Map 3D, the mapping manager connects to the SHP file and views the schema created by another GIS application (any data brought into AutoCAD Map 3D by an FDO provider can be viewed in this way).

## Convert one schema into another

Viewing a schema to check feature classes and properties



Mapping the properties of one feature class to the properties of another feature class

Then, continuing to use the Schema Editor, the mapping manager maps the feature classes and properties in the SHP schema to feature classes and properties in the Oracle schema used by the central database. For example, the SHP file may define data for poles as ID, NAME, MATERIAL, INSTALL\_DATE, while the Oracle database expects ID, Type, Material, Installation.

When the mapping is complete, the mapping manager uses the Bulk Copy command to transfer the data from the SHP file to the Oracle database. The mapping settings are also saved to a file for reuse in the future.

For an animated demonstration of steps in this workflow, see the following topics in *GIS Skills for Engineers* (available on the AutoCAD Map 3D Help menu):

- Bulk copy from a SHP file to an SDF file

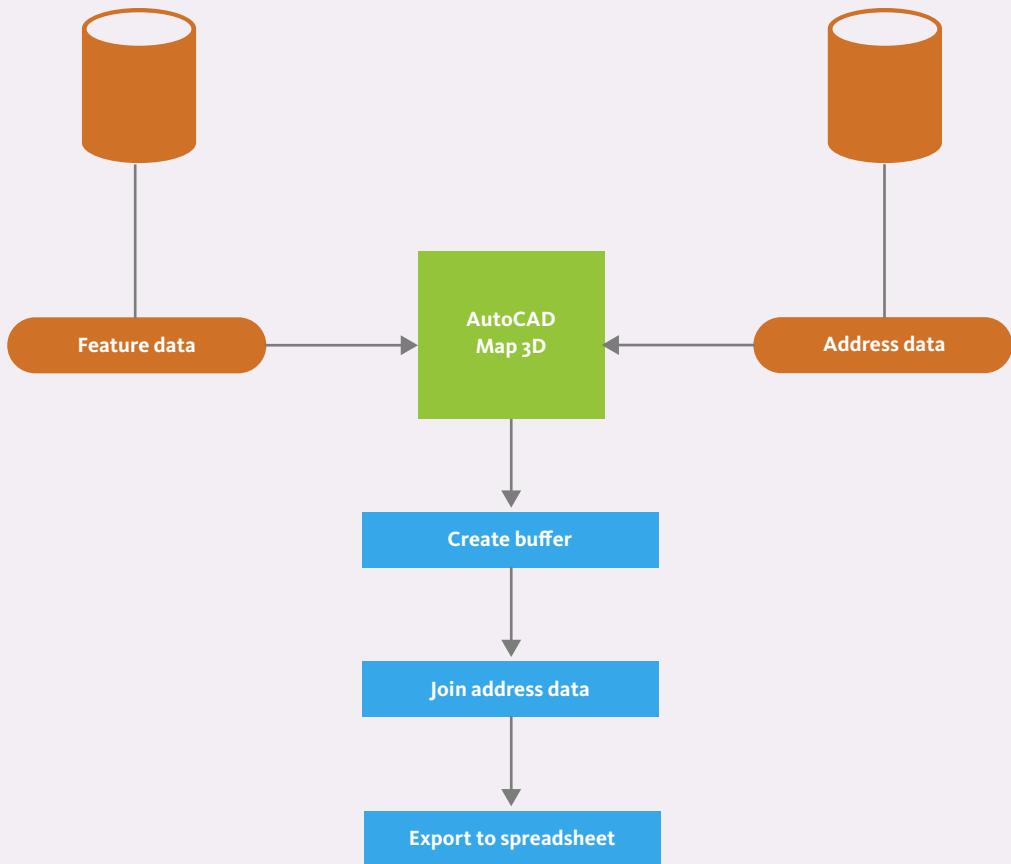
### Workflow: Notify neighbors within a certain radius of a parcel

This workflow shows how to use a buffer to select all of the addresses within a specific radius of a parcel. Here is the scenario for this workflow:

- The Public Works Department is planning to do some excavation and other work on the infrastructure in and around a particular parcel in the center of the city.
- Letters need to be sent to the addresses of the people living within 500 meters of the parcel to notify them of the potential disturbance.

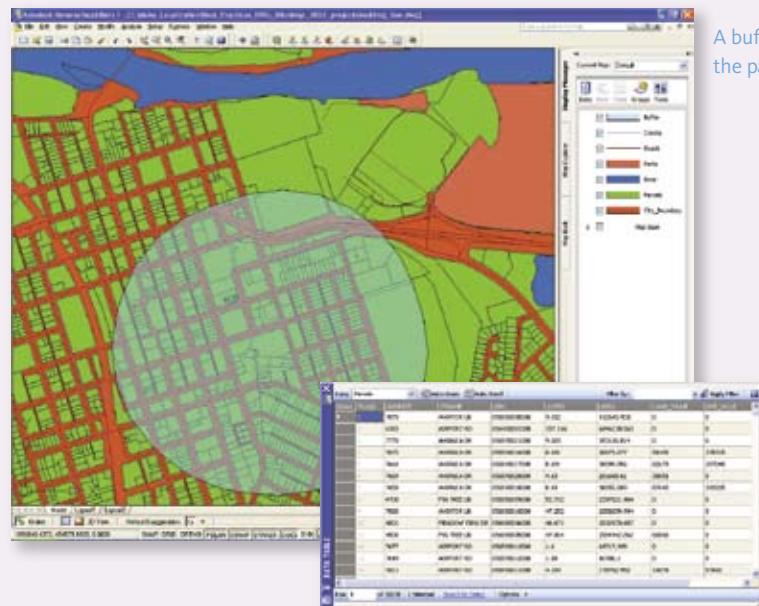
Here is the high-level flow diagram:

### Create buffer and join data



In AutoCAD Map 3D, the engineer selects the parcel where the work will take place and then creates a buffer zone around it. When she selects this buffer, the parcels within this zone are highlighted in the Data Table. Although the parcel ID and owner name are associated with the parcels, the full address is not present. To get this information, the engineer joins the parcel data to the address data, which is stored in the property assessor's database.

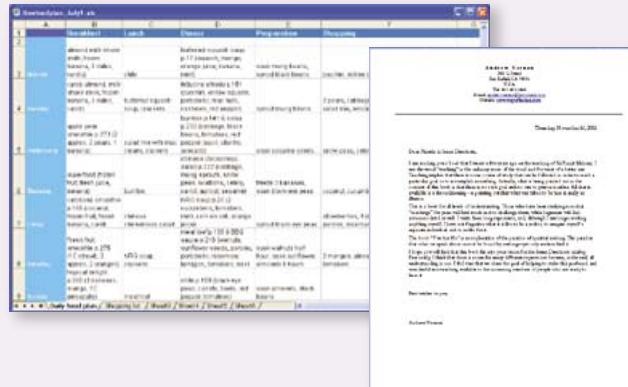
## Create buffer and join data



A buffer is used to select the parcels to be notified.



The address data is joined to the parcel data.



The joined data is exported to a spreadsheet program and used to provide the address for the notification letter.

After the address data is in the Data Table, the engineer exports the records to a spreadsheet, where a standard procedure will be used to generate the notification letter.

For an animated demonstration of steps in this workflow, see the following topics in *GIS Skills for Engineers* (available on the AutoCAD Map 3D Help menu):

- Select features by location using a buffer
- Join database tables
- Edit an existing schema (SDF)

# Handling Styles and Symbols

Features such as roads, parcels, or poles are generally stored in a database or data store as raw geometry; that is, they are simply georeferenced lines, polygons, and points (although they also have a non-spatial aspect, which consists of associated attribute data). When you want to create a compelling map for publishing, you will almost always want to style the raw feature data in some way. Styling is the process of assigning display characteristics (such as line color, line pattern, fill color, fill pattern, and so on) to the feature. In AutoCAD Map 3D, the style is actually applied to the layer and is stored as part of the layer definition. The underlying feature data is not changed in any way.

You can save a lot of time by sharing layer styles that have already been defined by other users for their maps and reusing them in your own maps. See the first workflow in this section for an example of how this process works.

Another aspect of styling is theming, which is the process of styling maps according to an attribute value, for example, creating a theme that colors polygons representing districts according to their population.  
(Theming is discussed separately, in [Analyzing Geospatial Data](#).)

You can style or theme maps in AutoCAD Map 3D and then use Autodesk MapGuide Enterprise or MapGuide Open Source to distribute those maps across your enterprise or externally on the Internet. MapGuide recognizes the styles and themes that you created in AutoCAD Map 3D; therefore, you do not need to reapply them when you want to publish your work to a wider audience. Because AutoCAD Map 3D and MapGuide use the same FDO providers to access features sources, when either program accesses those features in a layer that has styles defined for it, the layer appears with the correct styling and theming. This allows you to create Web-based applications in which edits to the central data are automatically reflected in MapGuide and become immediately available to users of the MapGuide application.

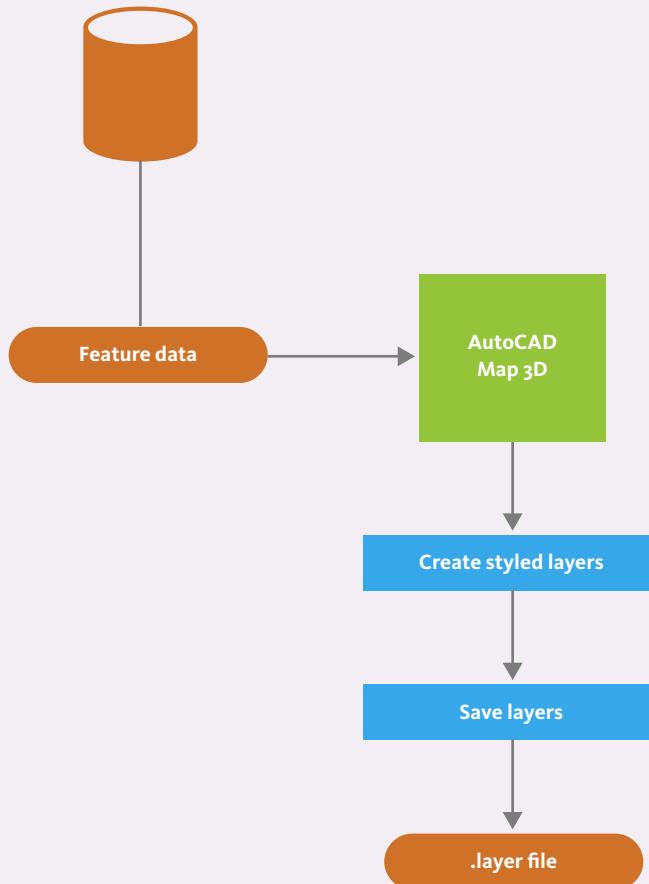
## Workflow: Share styles with other users

This workflow shows how you can create a set of styles for feature classes in your map and then share those styles with other users so that they see the features styled in the same way. Here is the scenario for this workflow:

- A mapping manager styles the layers in a map so that they follow certain standards and conventions of color, line weight, appearance at certain scales, and so on.
- He wants to distribute those styles to the mapping technicians on his team so that their maps are consistent.

Here is the high-level flow diagram:

### Share styles with other users

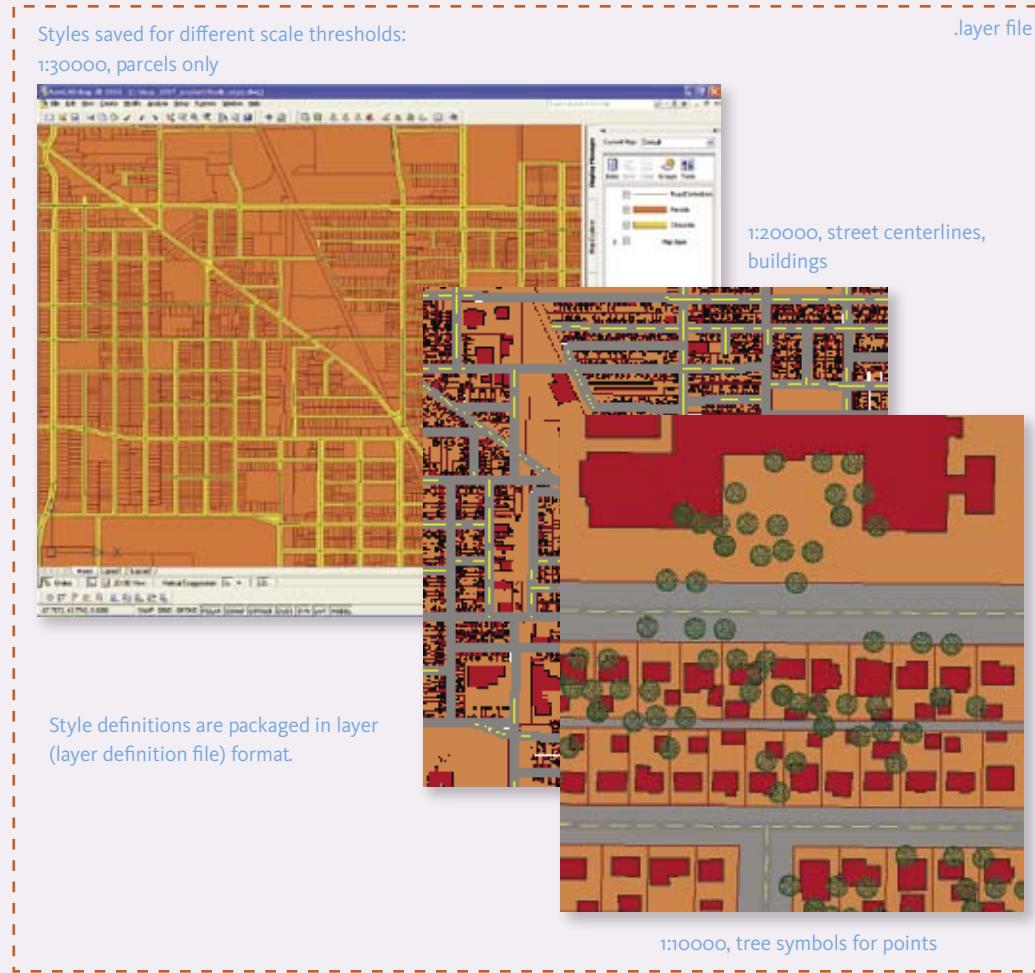


Using AutoCAD Map 3D, the mapping manager accesses the features that he wants to style. In Display Manager, he creates layers for each feature class, for example, parcels, street centerlines, and trees, and then uses the styling

interface to set default foreground and background colors for these features.

Some features should only appear when the map is zoomed in beyond a certain threshold (these are called scale ranges). For example, in the illustration below, at a scale of 1 to 30000, only parcels are visible. At 1 to 20000, street centerlines are turned on, using a composite line style. At 1 to 10000, trees are also turned on, using a symbol to represent the treepoints.

## Share styles with other users



When all the styles and the appropriate scale thresholds have been set up, the mapping manager saves the layer styling information to a .layer file (layer definition file). This file saves the style definitions as well as the paths to the data stores used by each layer. This is all that AutoCAD Map 3D needs to recreate the map with exactly the same appearance.

When the map technicians drag and drop the layer files to their maps, they will see the features styled with the conventions that have been established by the mapping manager.

In this scenario, the mapping technicians are all accessing the same data stores. If the mapping manager wants to send the map to someone who does not have direct access to the data, he can export the layer data to SDF format and write it to a CD, together with the layer files.

For an animated demonstration of steps in this workflow, see the following topics in *GIS Skills for Engineers* (available on the AutoCAD Map 3D Help menu):

- Share styles using .layer files
- Exchange data with other users by exporting to to SDF format

# Analyzing Geospatial Data

Many AutoCAD Map 3D users do not have a need to do much geospatial analysis, and so analysis tasks are often left to specialists. However, there are a few types of analysis that most users perform fairly frequently. The most common of these tasks is to create a thematic map. Most geospatial analysis involves creating a thematic map of some kind. Whether you are interested in the property values of a set of parcels, crime statistics in a neighborhood, or the year of installation of telephone poles, the workflow is very similar in all cases: you query spatial data and attribute data from the same source or from multiple sources, and then use the values of the attribute data to change the display characteristics of your map. The thematic map that results from this process gives you new information, allowing you to see patterns or trends that would not be visible in any other way.

AutoCAD Map 3D has always had powerful query tools for working with the content of DWG files. The addition of FDO providers has extended the scope of those tools and made a much wider range of data available for query directly into the program. You can use complex spatial queries with location-based criteria or SQL statements to find exactly the data you want from the data source. The styling and theming functions of Display Manager in AutoCAD Map 3D have been redesigned to make them easier to use and more flexible. If you are creating thematic maps for distribution over an intranet or on the Internet, you can publish maps directly to MapGuide Enterprise or MapGuide Open Source. A web page and the tools to interact with the map are generated for you automatically.

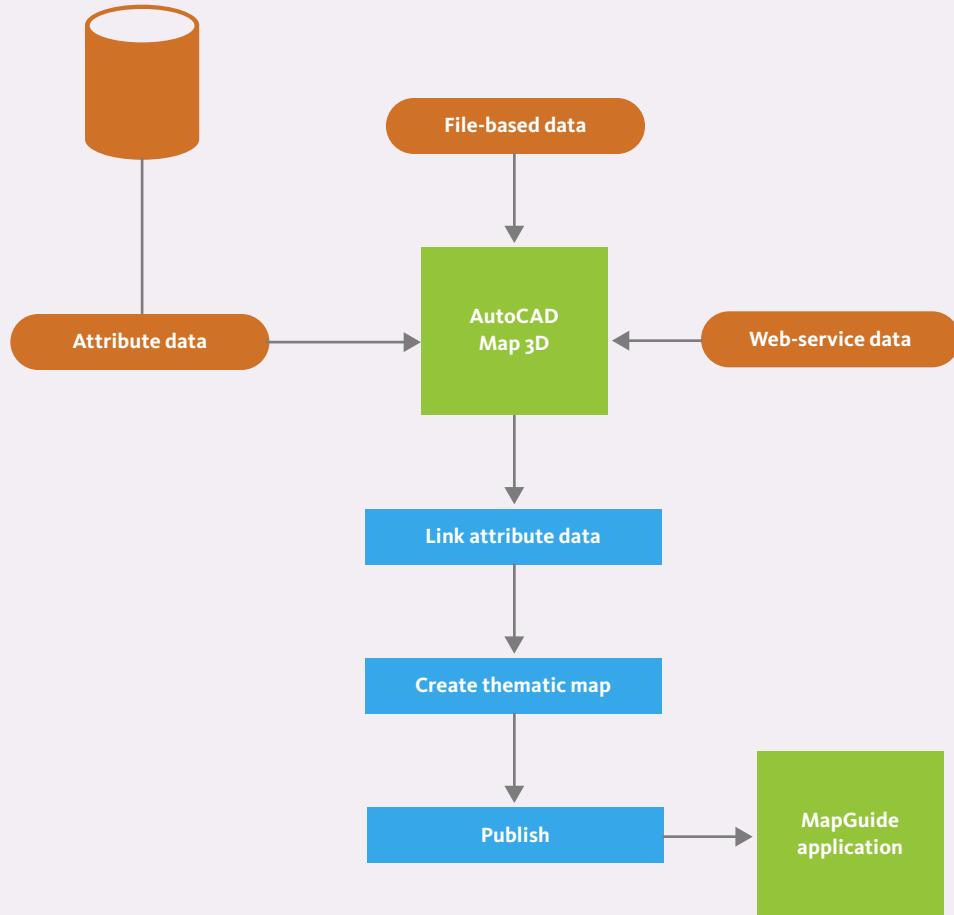
## Workflow: Create a thematic map for web distribution

This workflow shows how a typical thematic map is created in AutoCAD Map 3D and how it can be quickly published to a website. Here is the scenario for this workflow:

- A mapping technician has received a request to produce a set of maps analyzing the level of literacy by gender in every district of the country.
- The maps should also be made available for viewing on a website.

Here is the high-level flow diagram:

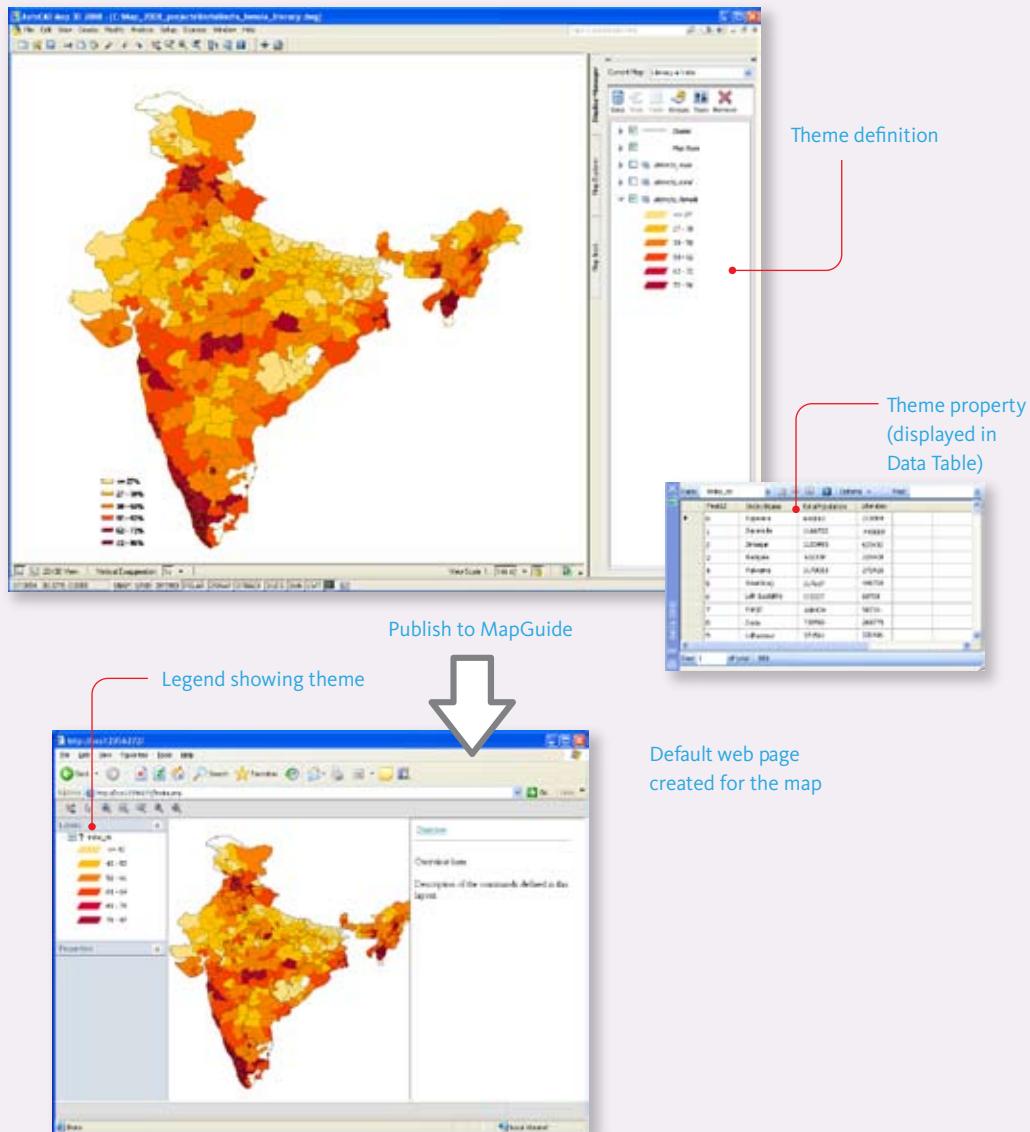
### Thematic map with Web distribution



The mapping technician locates a SHP file containing the district data and brings it into AutoCAD Map 3D. She then goes to the national census website and downloads a database file of the literacy figures by district. She uses the Data Table in AutoCAD Map 3D to view the properties of the district data to find an appropriate key field to link the district data to the literacy data. The district name is the best field for linking the data. Finding the names of the districts in the spatial data source and the attribute data source to be slightly different in a few cases, she uses the Data

Table to change the names of those districts in the spatial data. She then imports the SHP file into AutoCAD Map 3D and joins the spatial data to the attribute data.

### Thematic map with Web distribution



In Display Manager, she creates three maps, one for each theme: female literacy, male literacy, and total literacy. Using the Publish to MapGuide command, she sends the maps with their themes to the MapGuide server.

Using Autodesk MapGuide Studio, she views the maps and uses another simple process to create a set of default web pages. Each web page has a framework that includes tools for zooming and panning around the map, as well as a legend explaining the theme ranges. These pages require only a little work to prepare them for wider distribution.

For an animated demonstration of steps in this workflow, see the following topics in *GIS Skills for Engineers* (available on the AutoCAD Map 3D Help menu):

- Bring in a subset of features using a query
- Join database tables
- Publish a completed map to a MapGuide server

# Incorporating Raster Images and Surfaces

Modern cartography often makes use of surfaces to give a realistic effect to the landforms used as background imagery, especially in maps covering large areas. Such maps have a subtle three-dimensional quality that is very appealing, and they also convey an accurate impression of the terrain. AutoCAD Map 3D provides the tools to create these kinds of maps, with support for raster surfaces and draping.

AutoCAD Raster Design is an extension to AutoCAD Map 3D that contains tools for data preparation or editing. Typically, you would edit and prepare raster files in AutoCAD Raster Design and then build your presentation map in AutoCAD Map 3D. Both programs use common raster file formats to facilitate data sharing.

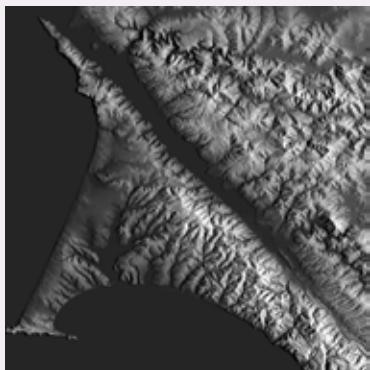
For example, AutoCAD Map 3D can read grid-based raster surfaces that have been clipped or resized in AutoCAD Raster Design, such as DEM, DTED, and ArcGrid. After you have placed a surface in AutoCAD Map 3D, you can manipulate it further using several functions:

- Exaggerate the vertical scale relative to the horizontal to emphasize the relief.
- Color the surface according to elevation, using a color ramp or predefined palette.
- Analyze the slope and aspect of the surface.
- Drape vector features or raster images on the surface.
- Generate contours.

It is also common practice to drape a raster image on a surface to create a visual effect or to show how the underlying terrain corresponds to the surface features. It is also useful to be able to drape features, such as roads, onto the surface so that they can be viewed in 3D. A 3D view can give a useful perspective on civil engineering projects and can serve as a starting point for creating realistic presentation maps, models, and flythroughs.

The following illustration shows some examples of how surfaces and raster images can be used in AutoCAD Map 3D.

## Surfaces and raster images



DEM surface with hillshading



DEM surface themed by elevation



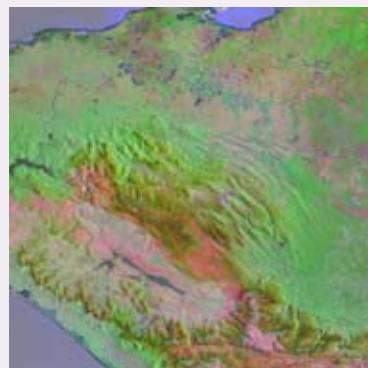
Raster image draped on a surface



Vector features draped on a surface



False-color Landsat image



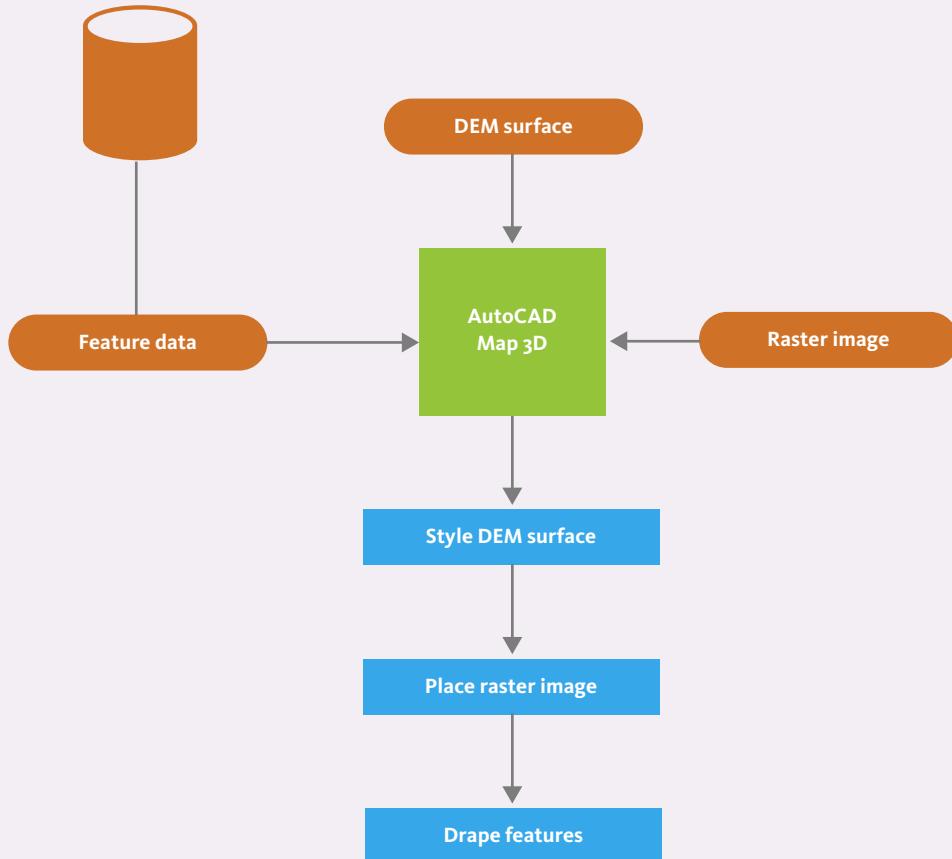
Composite of Landsat and DEM

## Workflow: Build a 3D map using surfaces and raster images

This workflow shows how a realistic three-dimensional map can be created with a combination of surfaces, raster images, and vector features. Here is the scenario for this workflow.

- A company is making a series of online maps of the trails of the Western United States.
- The maps are intended for viewing in three dimensions to show the relative difficulty of each trail.

### Build a 3D map using surfaces and raster images



Here is the high-level flow diagram:

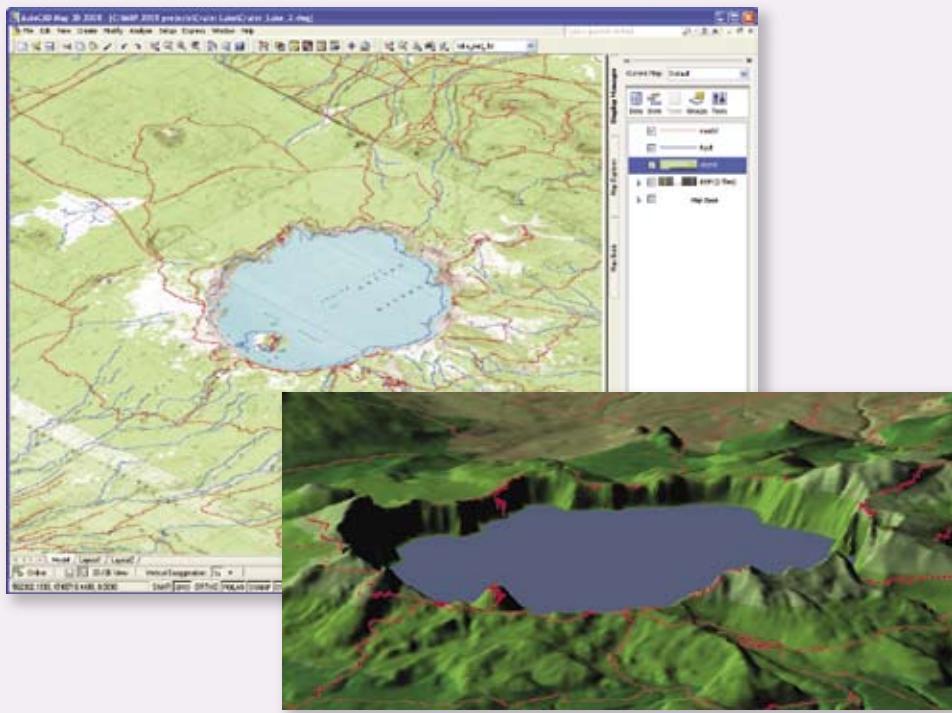
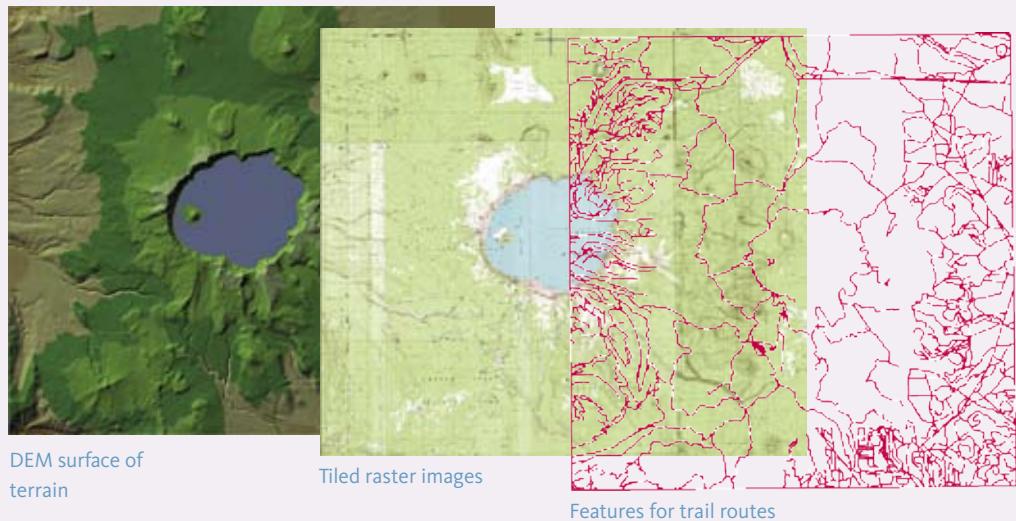
In AutoCAD Map 3D, the map author creates a layer and brings in a DEM surface. The DEM surface by default is black and white, and looks flat. He styles the surface by coloring it according to elevation using a standard palette. He also applies hillshading, which is an effect that makes the surface look like it is being illuminated by the sun. The map author then places a set of raster images of scanned topo maps on the surface and drapes them.

When the surface and raster images are in place, he queries the trails from an SDF data store and styles them with appropriate scale thresholds—thicker lines for closer views and finer lines when the map is zoomed out. The map is then ready for testing by viewing in three dimensions.

For an animated demonstration of steps in this workflow, see the following topics in *GIS Skills for Engineers* (available on the AutoCAD Map 3D Help menu):

- Color a surface by elevation and adjust hillshading
- View a site in 3D
- Drape raster and vector layers over a surface

## Build a 3D map using surfaces and raster images



# Publishing Geospatial Data

All of the hard work that goes into creating designs and maps is usually done so that the map can be published in some way and distributed to those who will use the map (its end users). Publishing geospatial data from AutoCAD Map 3D has two aspects:

- Publishing to a hard-copy format that end users can print or plot.
- Publishing to a Web-based format that end users can view and interact with.

Publishing therefore means packaging the data together with all of the styling, formatting, and layout that make up the complete design or map product. Also, the end users need to have the appropriate software to view and print the map. In the case of the Web-based format, the published map is sent to the MapGuide server, where it can be read by the client programs: MapGuide Viewer and Autodesk MapGuide Studio. For an example of publishing to MapGuide, see [Workflow: Thematic map with web distribution](#).

Using the Publish To MapGuide command in AutoCAD Map 3D, you can save all the layer styles as well as the references to the features sources used to build the map. Because AutoCAD Map 3D and MapGuide use the same FDO providers for data access, the map will appear in exactly the same way in both programs. For more about style sharing with layer definition files, see [Workflow: Share Styles with Other Users](#).

For hard-copy printing and plotting, AutoCAD Map 3D benefits from the robust layout, plot setup, and DWF publishing functions of the underlying AutoCAD application. Both the Publish To DWF command and the Publish To PDF command support multi-page layouts. The Publish To DWF command also has an option to enable layer and property control in the DWF file. This means that the recipient of the DWF file can view the properties and the layers that were in the original map.

A third output option is the map book. Map books are often used by mobile work crews in the field. The convenience of having a book of easy-to-manage sheets that covers the entire work area helps crews to complete their work orders in a timely fashion. The system works even better if the map books can be automatically refreshed on a regular basis from the most up-to-date data in the central data store.

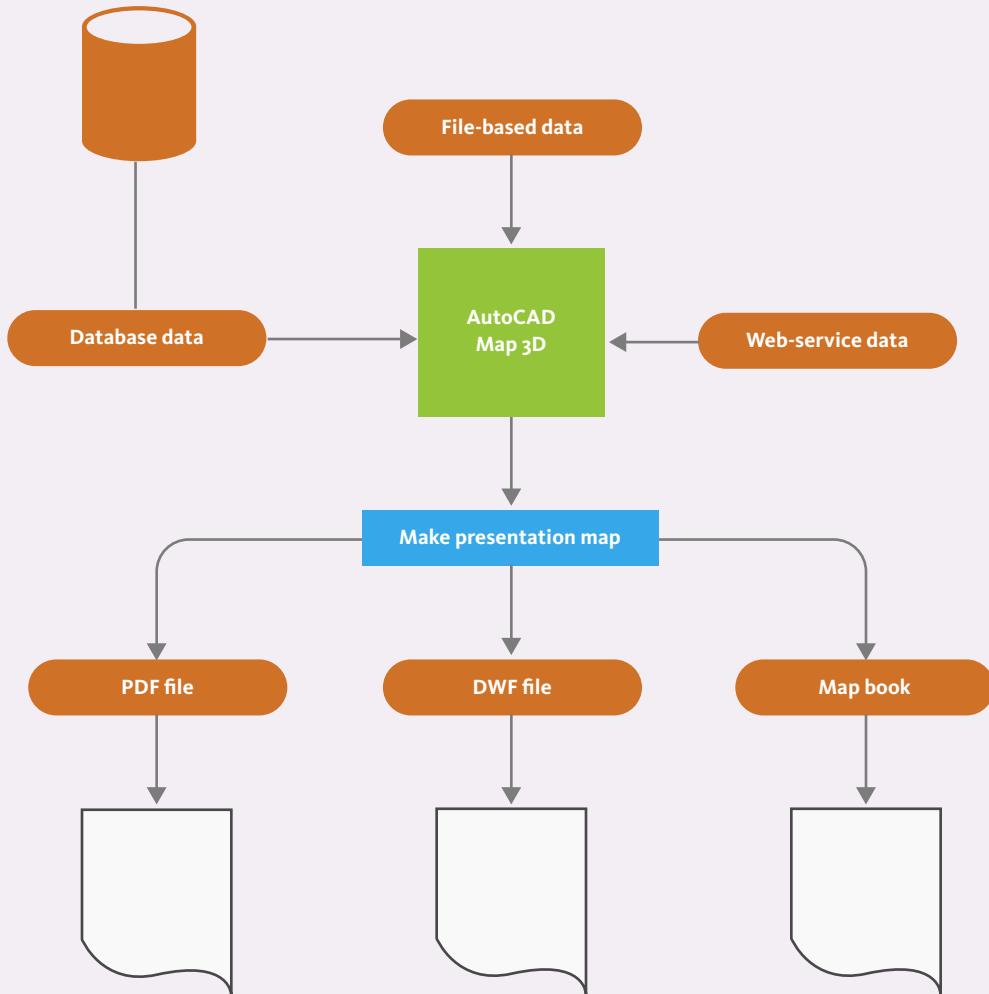
## Workflow: Publish for print or plot

This workflow shows how a presentation map is prepared for publishing in various output formats. Here is the scenario for this workflow:

- A mapping manager needs to prepare a series of maps that show state population data, plus an overview map of the state.
- Output is required as a series of sheets ready for plotting , and also in map book format for the convenience of field staff.

Here is the high-level flow diagram:

#### Publish for print or plot



The mapping manager puts together the map from various sources, including a central database, web services, and DWG files. He themes the feature data using population attribute data obtained from the census bureau. He then produces a series of thematic maps. (For a more detailed workflow about thematic mapping, see [Analyzing Geospatial Data](#)).

Using layout mode in AutoCAD Map 3D, he creates a set of large-size sheets suitable for wall display when they are plotted.

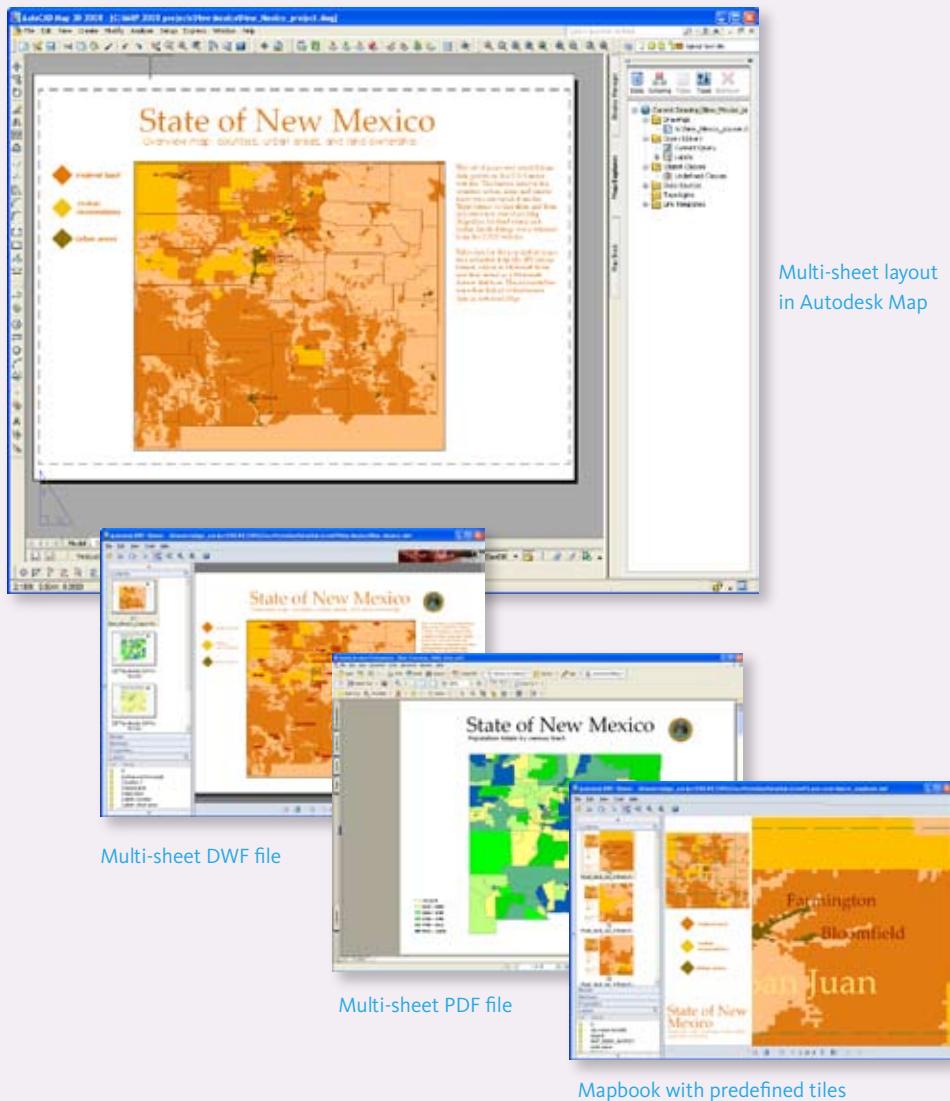
The mapping manager saves the layouts to three different formats:

- Autodesk DWF—DWF is a format that faithfully reproduces the layout and allows the recipient of the DWF file to review it in the free DWF viewer. The recipient can mark up and make comments directly in the DWF file. The DWF file can be published with georeferencing information to enable applications such as integration with GPS.
- Adobe PDF—He also saves the sheets to PDF, which is another standard format for optimizing print quality.
- Map Book—He uses the Map Book utility in AutoCAD Map 3D to create a map book that breaks the larger sheets into smaller tiles that can be easily printed on an office printer. Mobile workers will then have a book of indexed pages that they can use in the field.

For an animated demonstration of steps in this workflow, see the following topics in *GIS Skills for Engineers* (available on the AutoCAD Map 3D Help menu):

- Create a map book with appropriate-scale tiling
- Produce a multi-sheet DWF file for a map book

## Publish for print or plot



# Distributing Geospatial Data

The MapGuide technology is a popular platform for developing Web-based applications because of its performance, ease-of-use, and speed-of-deployment. MapGuide exists in both an open source version (called MapGuide Open Source, which is supported by the community) and a commercial version (Autodesk MapGuide Enterprise, which is supported by Autodesk). Autodesk MapGuide Enterprise and MapGuide Open Source are the successors to Autodesk MapGuide 6.5. They perform the same functions as Autodesk MapGuide 6.5, but they have a new architecture in which application development occurs on the server side rather than on the client side. The new MapGuide is also designed to run on Linux servers as well as on Windows servers.

Access to source data in MapGuide is handled through the same FDO providers used by AutoCAD Map 3D, which means that the two programs work well together. Many organizations already use AutoCAD Map 3D and Autodesk MapGuide together, with both applications accessing the same central data store. The goal of most of these implementations is to automate the distribution of data to end users across the organization, including field workers. There are examples of this type of implementation in [Chapter 4, Common Business Problems and Their Solutions](#).

The process of developing a Web-based application generally involves the following steps:

- Plan the application, determine the target users for the application, and design its functions.
- Load the source data to the server (the data could be features, raster images, DWG objects, or any combination of these types of data).
- Build layers that reference, style, and theme the data.
- Create maps by combining layers.
- Place the map on the Internet or intranet using a default web layout.
- Develop the full functionality of the web application, using the API (Application Programming Interface).
- Test the web application.
- Deploy the completed application to its end users.

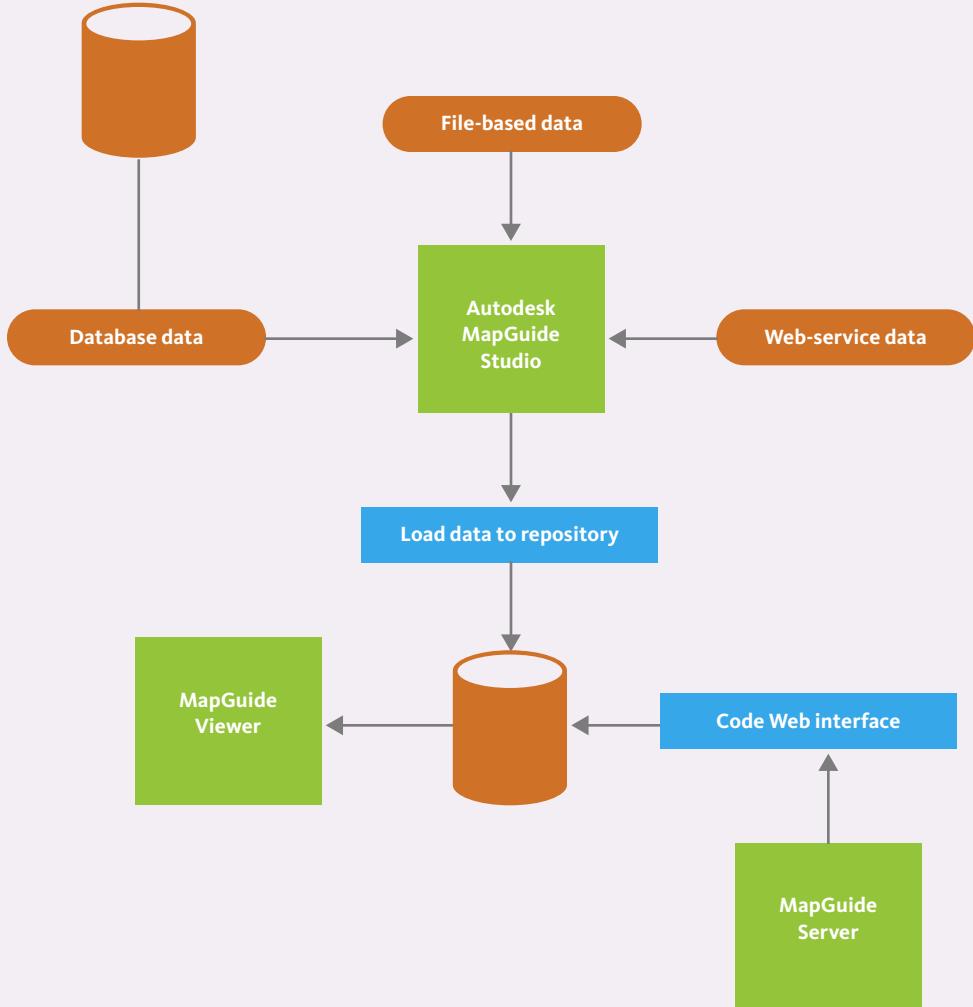
## Workflow: Create a Web-based application

This workflow shows how the various components of Autodesk MapGuide Enterprise or MapGuide Open Source are used to develop and deploy an application. Here is the scenario for this workflow:

- The GIS coordinator, CAD Manager, and city manager of a municipality agree to develop a pilot application to provide online maps of the city infrastructure with basic searching and reporting functions.
- Their goal is to have a “proof-of-concept” version of the application ready for testing within two weeks.

Here is the high-level flow diagram:

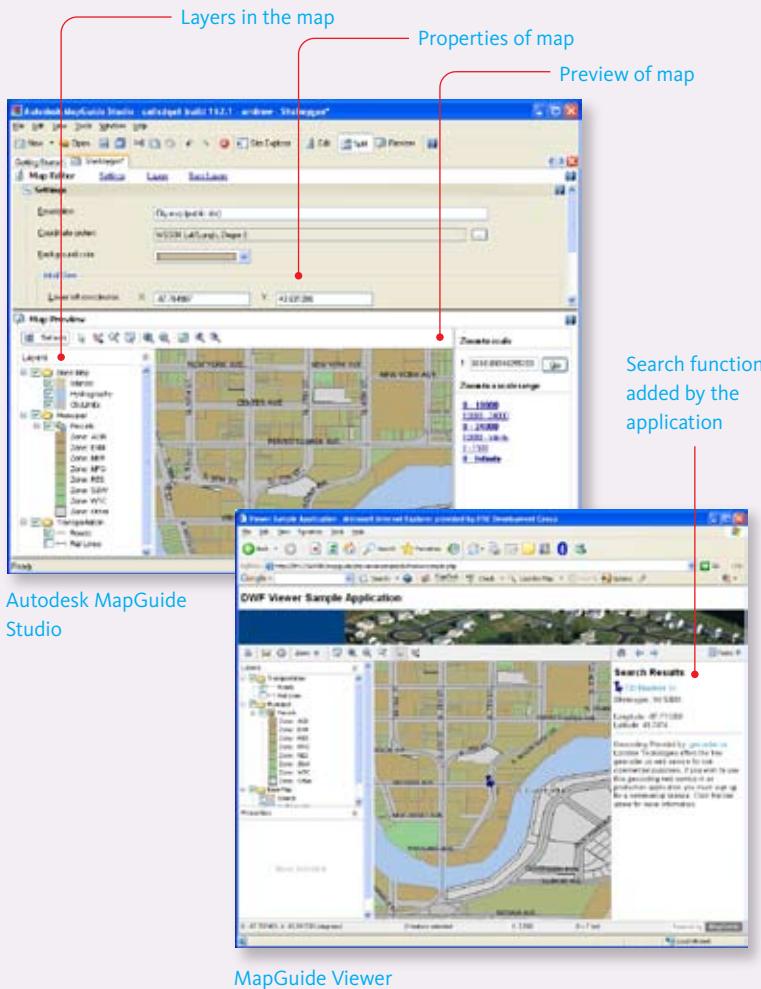
### Create a Web-based application



In the planning phase, decisions are made about the business process—how often the data will be updated and who will be able to access it. Preliminary designs for the interface and the user interaction are sketched out. While this is going on in the information technology department, CAD technicians and GIS specialists are preparing file-based data and feature data for use with the web application.

When the data is ready, Autodesk MapGuide Studio is used to load the data to the MapGuide Server, where it is stored as resources in the resource repository. In the illustration below, the tree on the left shows the layers based on the data in the resource repository.

### Create a Web-based application



Autodesk MapGuide Studio is also used for styling the layers, building the maps, and creating a basic framework for the maps, called a web layout. The map can now be viewed in a web browser using MapGuide Viewer. Once this web framework is in place, the map is “Internet-ready”. The remaining time is spent in programming to add the search and reporting functions for the prototype application.

For an animated demonstration of steps in this workflow, see the following topic in *GIS Skills for Engineers* (available on the AutoCAD Map 3D Help menu):

- Publish a completed map to a MapGuide server

Chapter 4:

# Common Business Problems and Their Solutions

This chapter contains examples of solutions to particular business problems, as implemented by a wide range of Autodesk customers.

# Government

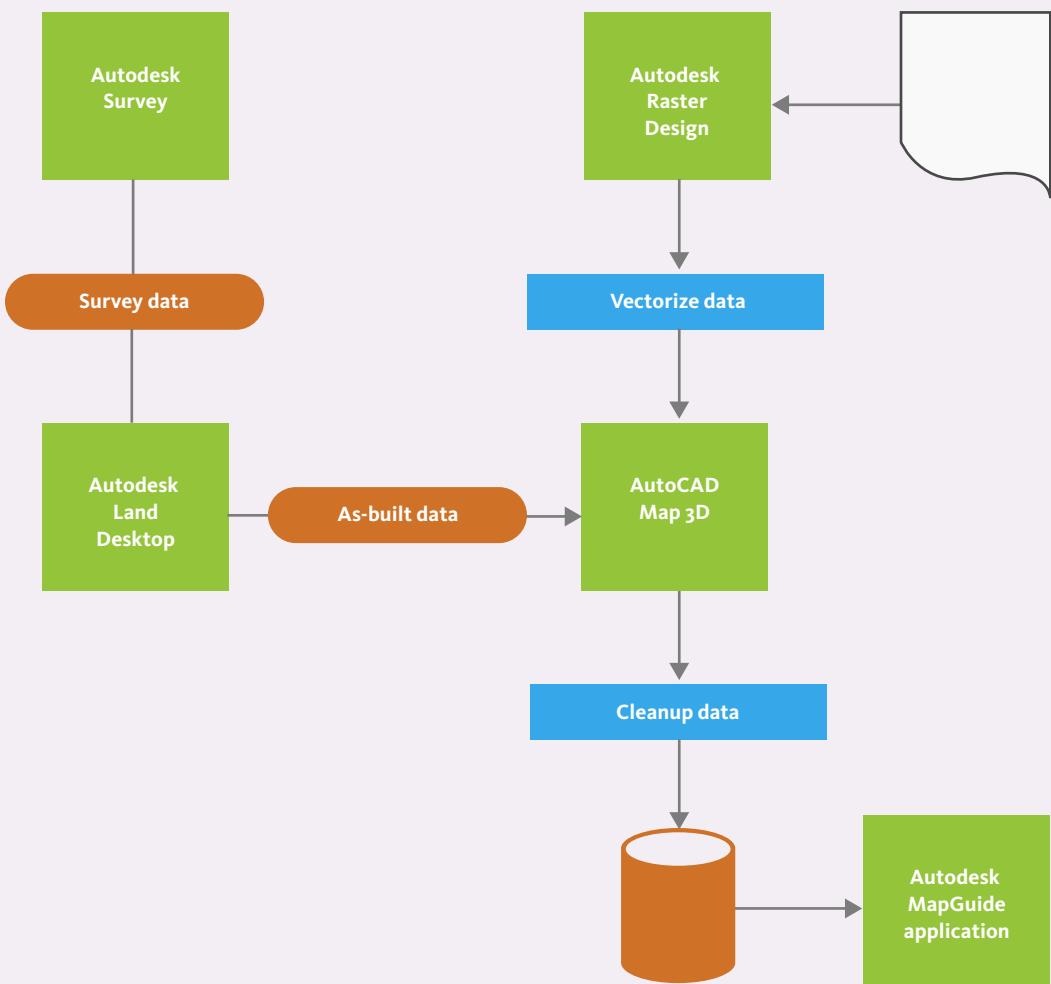
This section presents problems and solutions from government and public works.

## Managing raster-based drawings

The Public Works Department of the city of Tacoma, in Washington, USA, had several problems to solve when they implemented a departmental geospatial solution. One of the most pressing was integrating about 75,000 paper construction drawings into the system.

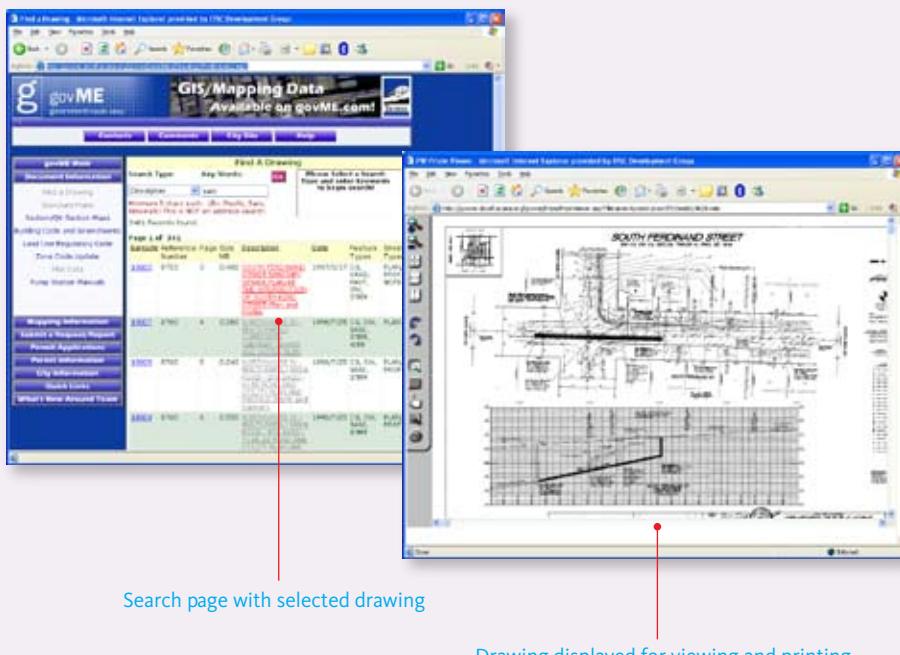
A central part of the department's workflow is AutoCAD Raster Design, which is an extension of AutoCAD Map 3D that is dedicated to managing and editing raster images. Autodesk Raster Design is often used, as in this case, to vectorize and clean scanned paper drawings. This is how the City of Tacoma gets its as-built construction data into the central data store. Engineers create construction drawings in Autodesk Land Desktop. The drawings are then digitized in AutoCAD Map 3D/Raster Design. Then, AutoCAD Map 3D is used to write the data to the Oracle Spatial database.

## City of Tacoma: managing raster-based drawings



Another significant aspect of this solution is the distribution of the scanned construction drawings by means of an Autodesk MapGuide application, which runs on the city's website. Property developers and other members of the public can search the entire collection of drawings online and access the ones that are relevant to their projects. The following illustration shows the search page and a sample drawing from the website (<http://govme.cityoftacoma.org/govme>):

## City of Tacoma: managing raster-based drawings



# The Utility and Telecom Industries

This section presents problems and solutions from different types of utility companies.

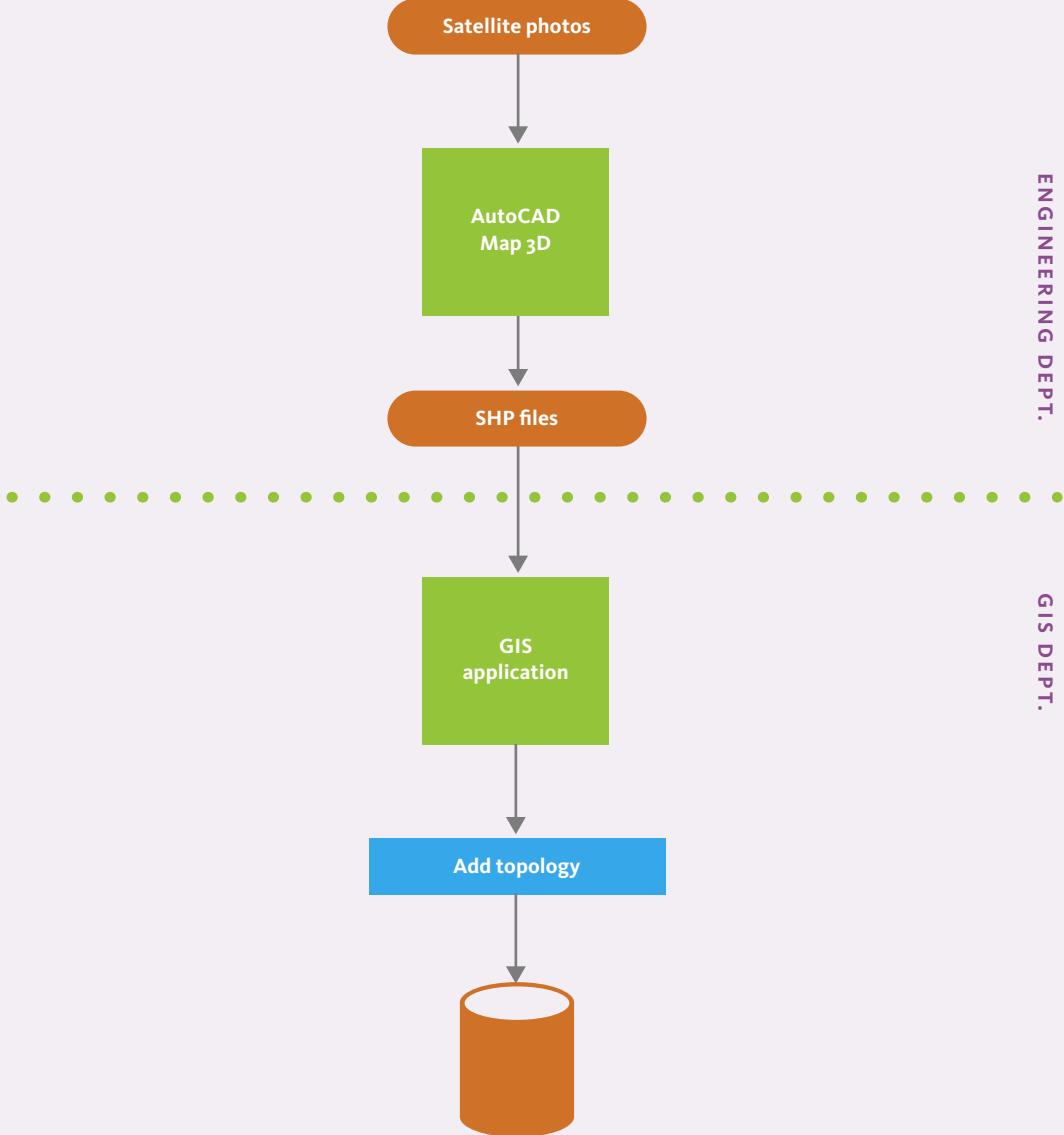
## Example solution #1: Mapping system

This example contrasts the old and the new mapping systems used by a telecommunications company in California, in the USA.

With the old system, a team of over twenty drafters used AutoCAD Map 3D to draw distribution areas for the telephone network on top of satellite photographs that showed the location of parcels and buildings. They only used a few functions of the program: some of the CAD drafting tools and georeferencing to place the photos. When the drafting was complete, the geometry was saved to SHP-file format and emailed to a small GIS team in another part of the country.

The GIS team then read the SHP files into a GIS application and added the connections and dependencies necessary to link the new objects with the existing network topology. The data was then saved in an ArcSDE database. This process took about two weeks from initial drafting to final storage in the database. The old workflow is shown in the following diagram:

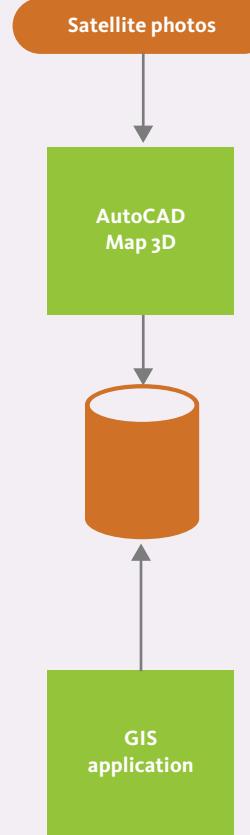
## Telecom company: old mapping system



The new system is much simpler and easier (see the following diagram). In this configuration, the drafting team, still using AutoCAD Map 3D, accesses the ArcSDE database directly to make additions to the network. The GIS team also accesses the

data directly to create and manage the topology. There is no longer any transfer of files by email. The process using the new system takes only a few hours.

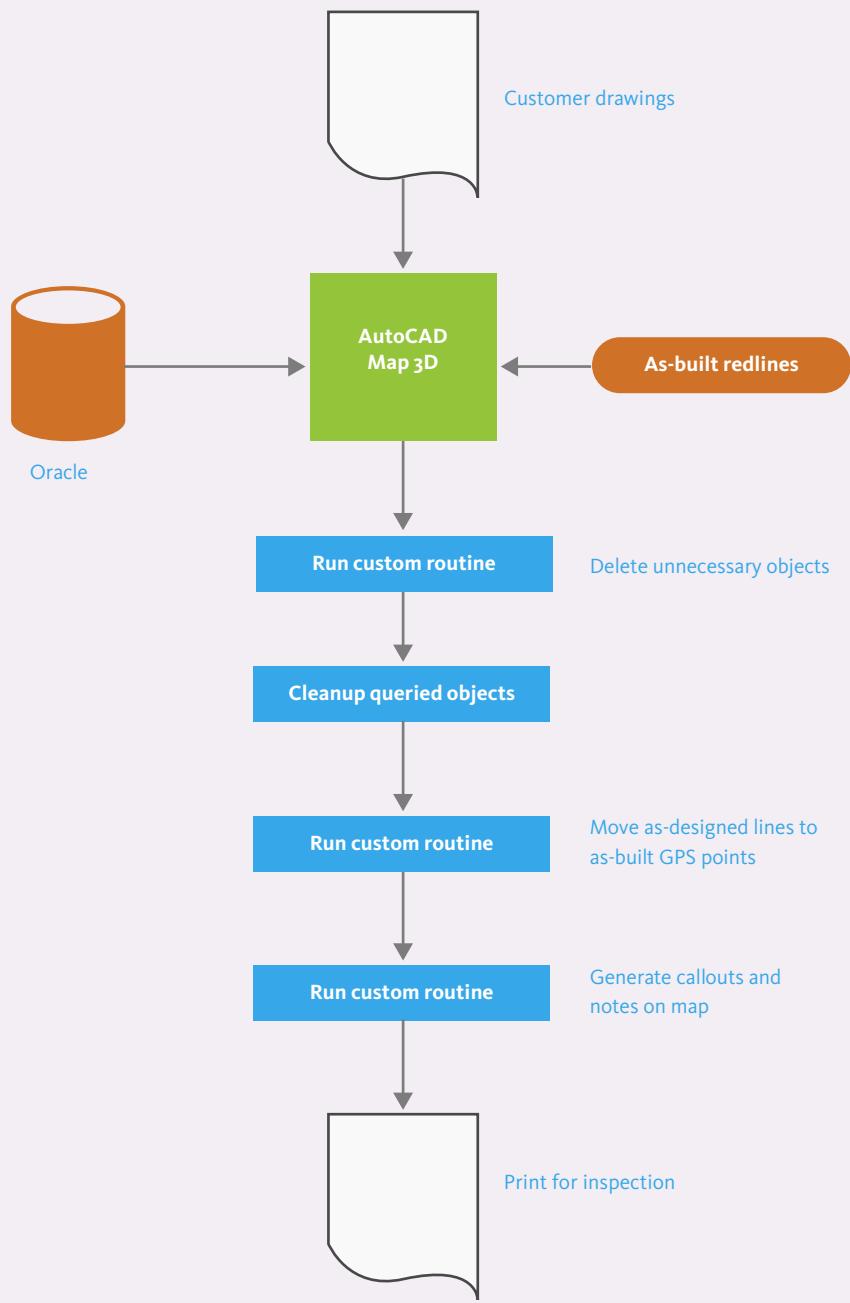
#### Telecom company: new mapping system



#### Example solution #2: Managing as-designed and as-built data

This example shows how a water utility company uses AutoCAD Map 3D with custom code to match as-designed drawings with as-built data. The workflow used by this utility company is shown in the following diagram:

## Water utility: managing as-designed and as-built data



The sequence of events shown in the workflow diagram begins when the design for new water service has been drawn and stored in the database, and construction is under way. When construction is 85% complete (at the redline stage), the process of converting the design into the GIS system is initiated. The utility company uses a number of custom routines, which have been programmed using the AutoCAD Map 3D APIs. These routines are run at certain points to process the spatial data, as shown in the diagram.

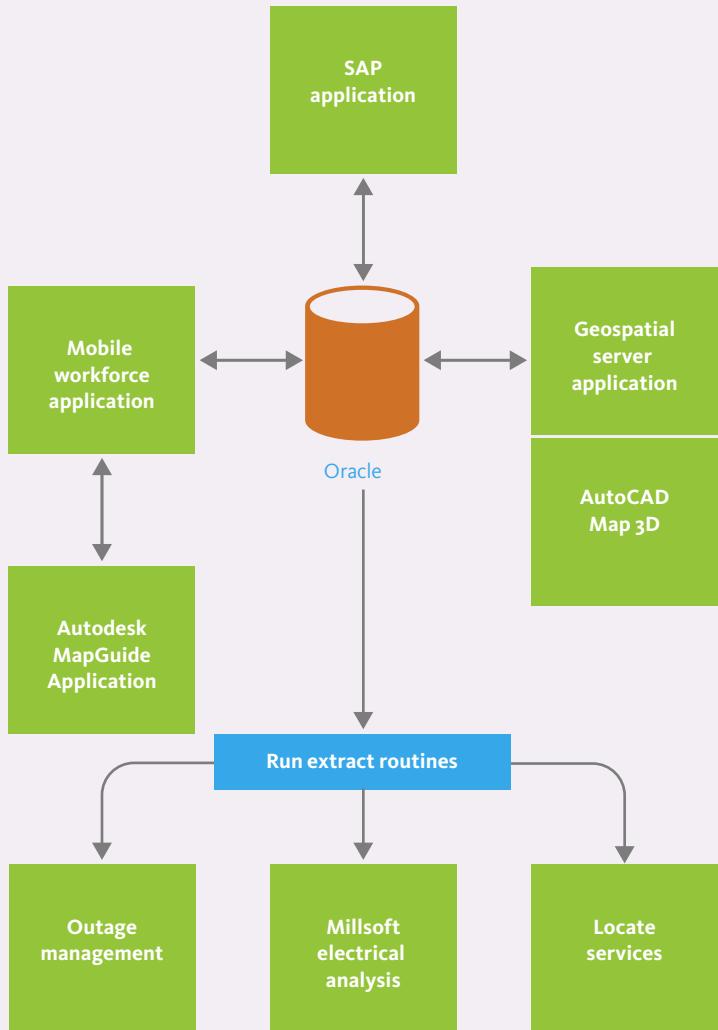
Data in the area of the project is queried into AutoCAD Map 3D, and the first routine is run to delete any objects that are not needed. Redline data, including GPS points, is also brought in, and the second routine is run to compare and move the as-designed linework to match the as-built GPS points.

The original customer construction drawings in scanned TIFF-file format are brought in at this point to serve as a background. A third routine adds callouts and other notes to the map. A copy is then printed for inspection and review. Once the review is complete and signed-off, the data is taken to be “as-built” and is saved to the database.

### Example solution #3: Work order management

This example focuses on one part of an enterprise-scale data management system implemented by First Energy, of Akron, Ohio, in the USA:

## First Energy: work-order management



Before adopting an Autodesk solution in 1996, First Energy designers and construction crews relied on paper-based data to fulfill their work orders. During the transition to a database system, roomfuls of paper maps and records were converted to digital format and stored on seven IBM AS6000 servers. Today, when a request for a new electric service is received, the SAP work order management system

generates a work order that includes all the relevant geospatial information.

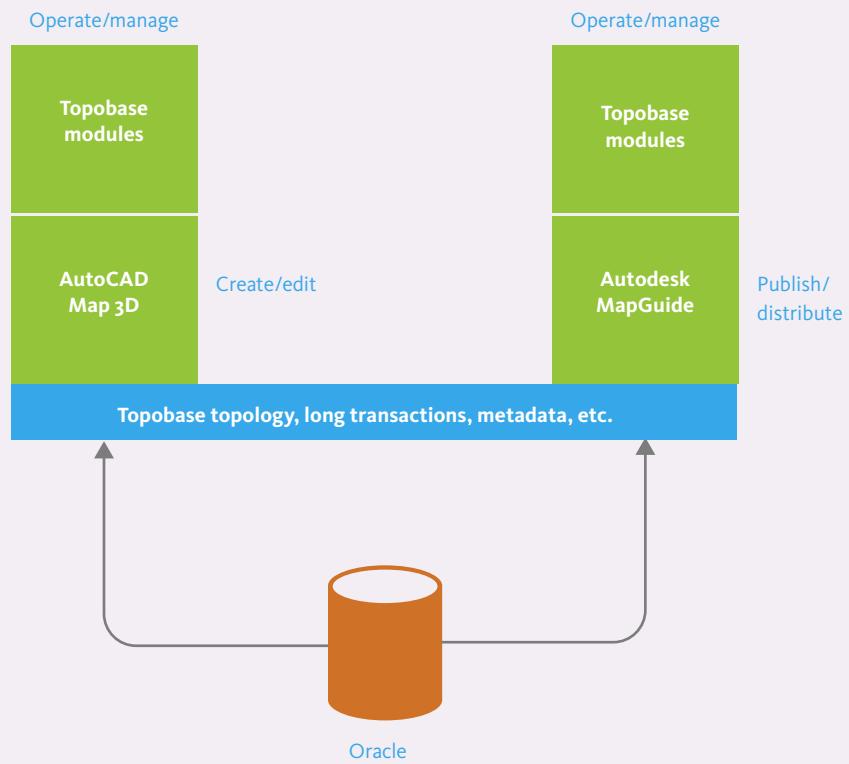
After the preliminary design of the facilities that will supply electricity to the new buildings is complete, the new information flows directly into the central database (Oracle Spatial). Oracle's versioning and long-transaction features allow engineers to track the stage of the design as it progresses through approval and construction to the as-built stage. Integration with the SAP customer information system means that designers can obtain customer data without having to query other databases.

The company operates a mobile field force with 8000 trucks to handle the construction and maintenance work. A routing application running on Autodesk MapGuide allows work crews to access the maps and records they need, with the assurance that the information is up-to-date. The application also allows employees in the field to update the central database directly with as-built information or to redline maps to alert the designers to potential problems.

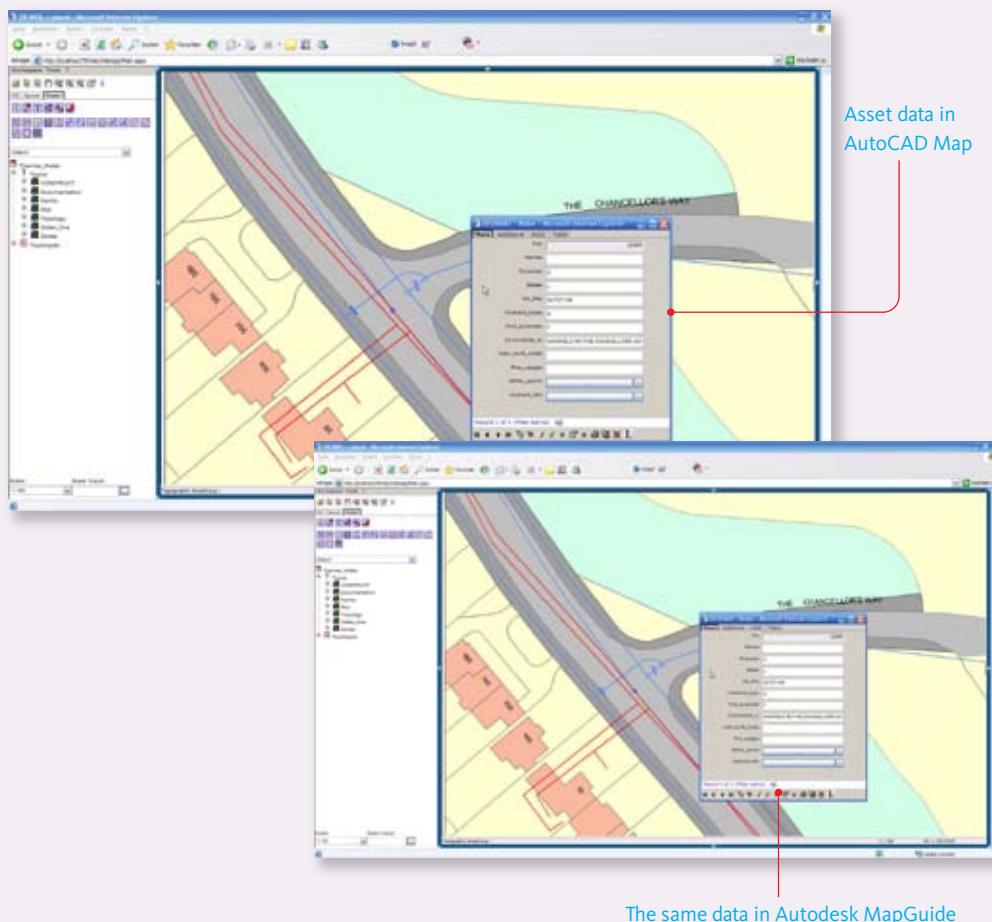
#### **Example solution #4: Asset management with automated distribution**

In this example, a large European water utility company has deployed the Topobase application, which is an infrastructure data management solution for utilities, municipalities, and engineering firms. Topobase adds a layer that provides functions such as topology, job tracking, and long transactions to the Oracle database. It works directly with AutoCAD Map 3D and Autodesk MapGuide.

## Water utility: asset management



## Water utility: asset management



Attribute data for a hydrant is being edited in AutoCAD Map 3D (upper screen capture). The lower screen capture shows data for the same hydrant displayed in a web browser using the Autodesk MapGuide Viewer. This particular implementation allows editing of the data in MapGuide as well as in AutoCAD Map 3D. Because both AutoCAD Map 3D and Autodesk MapGuide share access to the central Oracle data store, the data is updated in real time so that anyone working in the office or in the field always sees the latest updates. Locking mechanisms ensure that no two people can edit the same data at the same time.

# Other Industries

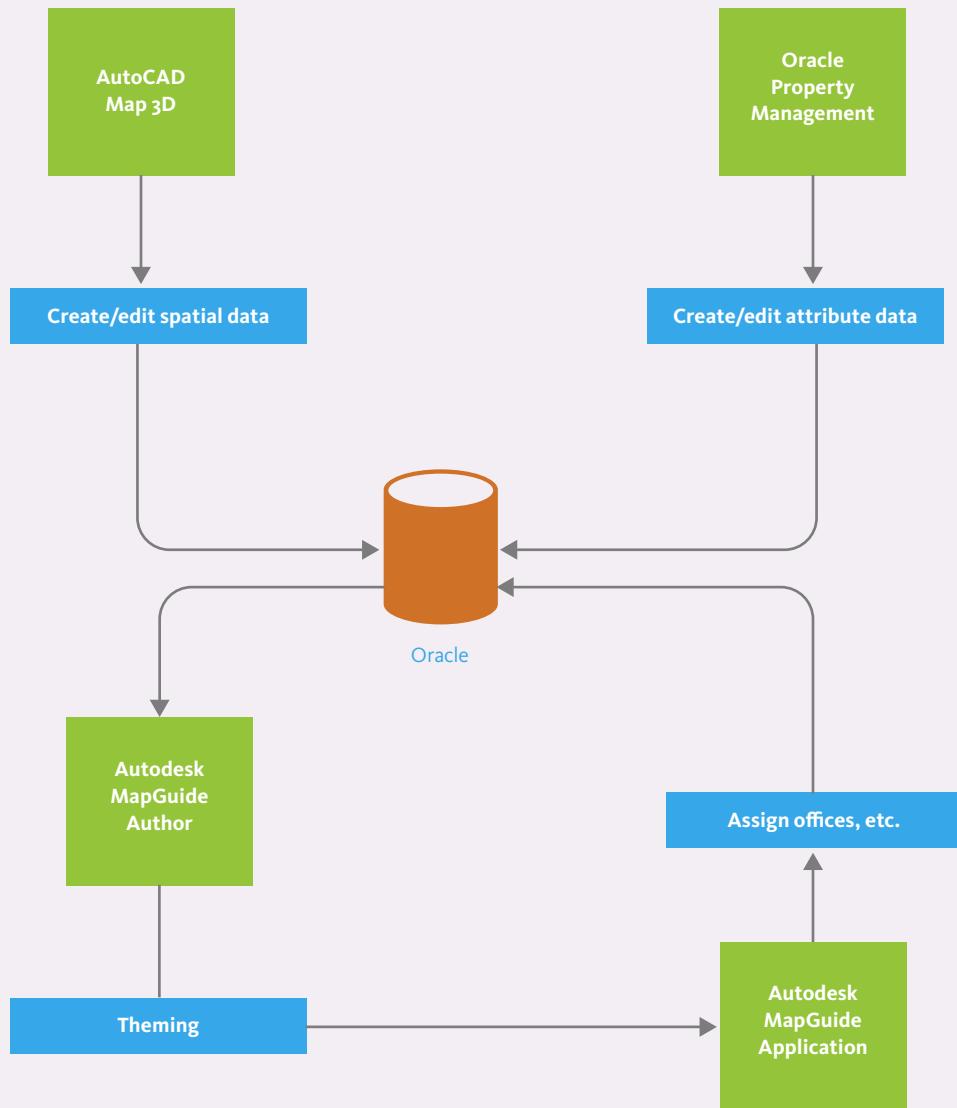
This section presents problems and solutions from companies in other industries besides government and utilities.

## Property Management

The company in this example is a large equipment manufacturer that uses AutoCAD Map 3D and Autodesk MapGuide for a property management application that covers some 50 of their campuses, with 25,000 employees, worldwide.

The company uses Oracle 9i/Spatial as the central data repository for this application. They also employ Oracle Property Manager, linked to the Oracle database. As part of the transition to a central data store, one of their objectives was to get rid of the thousands of DWG files that they had to manage separately, and instead store all their spatial data in Oracle.

## Manufacturing company: property management



AutoCAD Map 3D is used to create and edit geometry (mainly boundary objects representing facilities and offices) and to add global coordinates.

They use FME Workbench (from Safe Software) to convert and store the

DWG geometry in Oracle. The database is then accessed by Oracle Property Manager, where all the attribute data is input and edited (office numbers, who occupies them, and so on). This attribute data is then fed back into Oracle.

Autodesk MapGuide also accesses the Oracle database. Autodesk MapGuide Author is where all the styles/theming is applied (is the office occupied or vacant, what business unit/cost center does the occupant belong to, and so on). They do this in Autodesk MapGuide so that they can apply the same theming across all the various campus maps.

Autodesk MapGuide is also used by end-user business managers to view, analyze, and change office assignments. The Autodesk MapGuide application also provides an easy-to-use web interface with which the end-users can search, analyze, and make reassignments for their office space. Eventually the company also plans to link in a work order management application, such as Maximo, to manage any office moves and changes.

In this implementation they have clearly differentiated between AutoCAD Map 3D as the geospatial data creation tool and Autodesk MapGuide as the primary publishing and analysis tool for end users.

Chapter 5:

# Sample Maps

This chapter contains some examples of maps created with AutoCAD Map 3D and other Autodesk software.

# Maps Using Surfaces

## State of Washington relief map

To create this map, AutoCAD Map 3D was used to import GIS data for vector points and polylines. A USGS base map (1:500,000) was scanned full size and correlated with AutoCAD Map 3D for verification of features. The rendering of the terrain was accomplished using USGS DEM files and a program called Surfer (by Rockware). High resolution images were generated and then correlated and rubber sheeted (slightly) to match existing vector points.

## Yosemite trail map

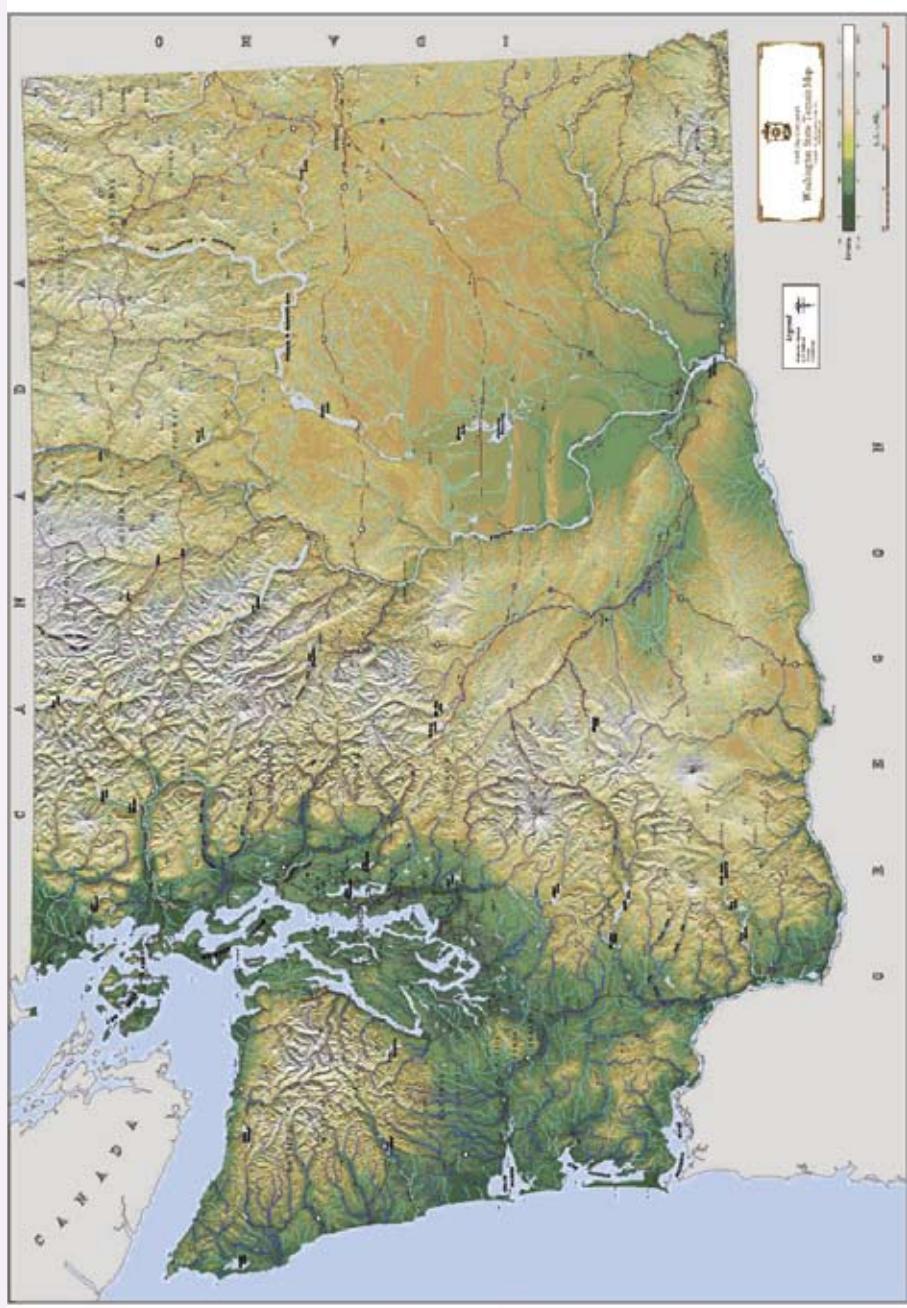
This map is composed of a USGS topo map in raster format overlaid on a DEM file. The DEM file has been colored by elevation in feet. The trail polylines come from Digital Line Graph (DLG) vector files, also from the USGS. The text heading and other details were overlaid in layout view.

## Marin County land use map

This map shows land use in Marin County, California, using data from the National Land Cover dataset. NLCD is a nationwide classification scheme for land use, consisting of raster images in which each pixel represents 30 meters. The NLCD data has been overlaid on a Digital Elevation Model (DEM) file to show the main relief features of the county.

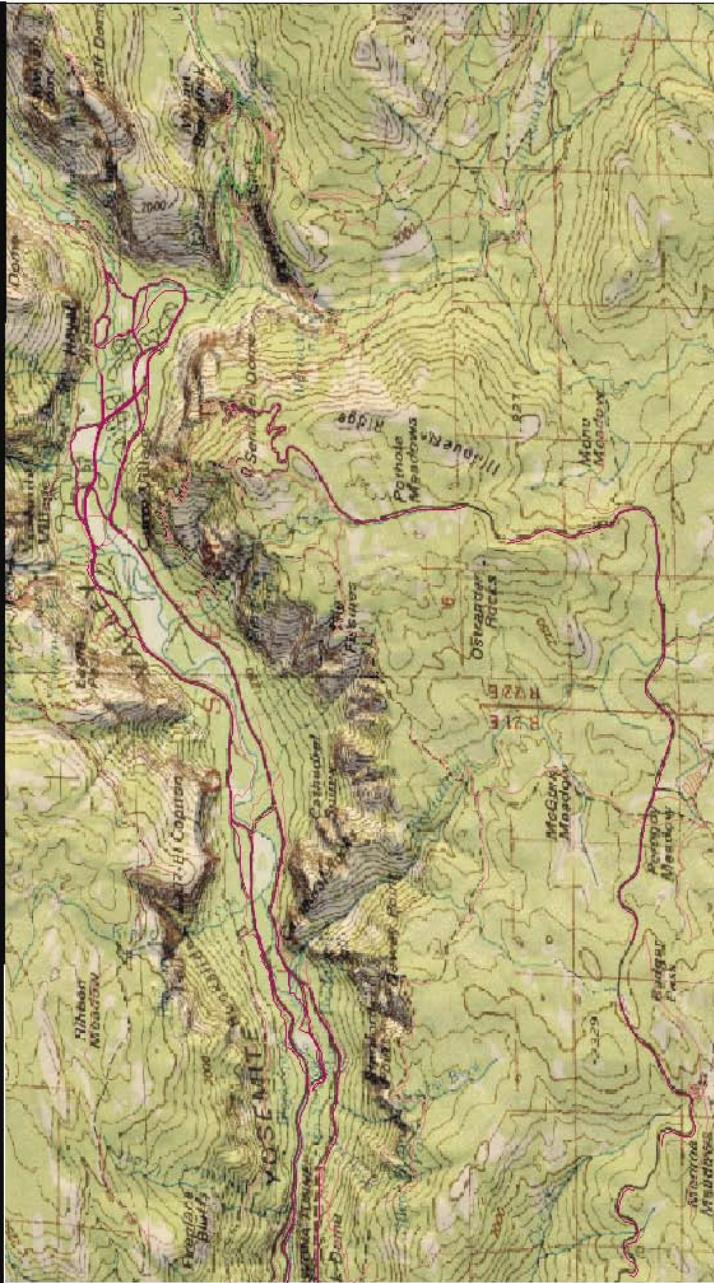
## Indian subcontinent wall map

In this map, the background relief is provided by a small-scale DEM file from the U.S. Geological Survey Earth Resources Observation & Science (EROS) satellite program. The original black and white DEM surface has been colored (themed) by elevation.



## Trails of Yosemite National Park

South of the Valley

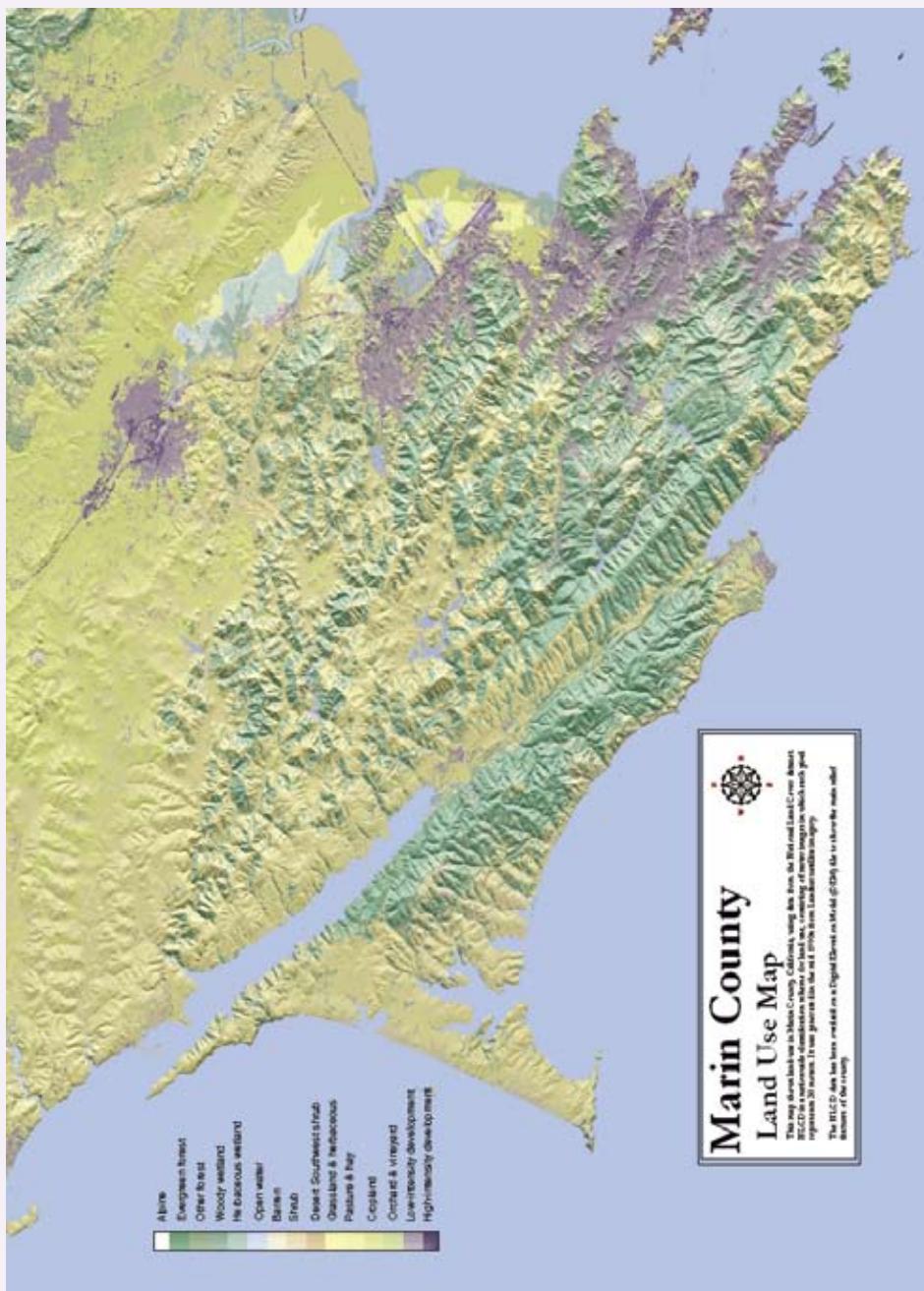


The key map on the previous sheet was created from USGS topo maps in raster format, overlaid on the DEM file shown on the other sheet. The DEM file has been vector files, also from the USGS.

The images on the right of this page come from Digital Elevation Model (DEM) files.

These files are surfaces that map elevation data in a very fine grid; each pixel has an elevation value assigned to it. The upper image is a 3D view and the lower is plain DEM. These images were created using another programs.

The map on this page is composed of a topo map of Yosemite Valley overlaid on the DEM file shown on the other sheet. The DEM file has been colored by elevation in feet. The trails are from the same DLG polyines.





# Thematic Maps

## Literacy in India

This map shows literacy rates by district, using data from the 2001 census of India. The three themes: female literacy, male literacy, and total literacy are created as separate maps, using Display Manager in AutoCAD Map 3D, but they all refer to the same feature data, which contains the polygons for the districts.

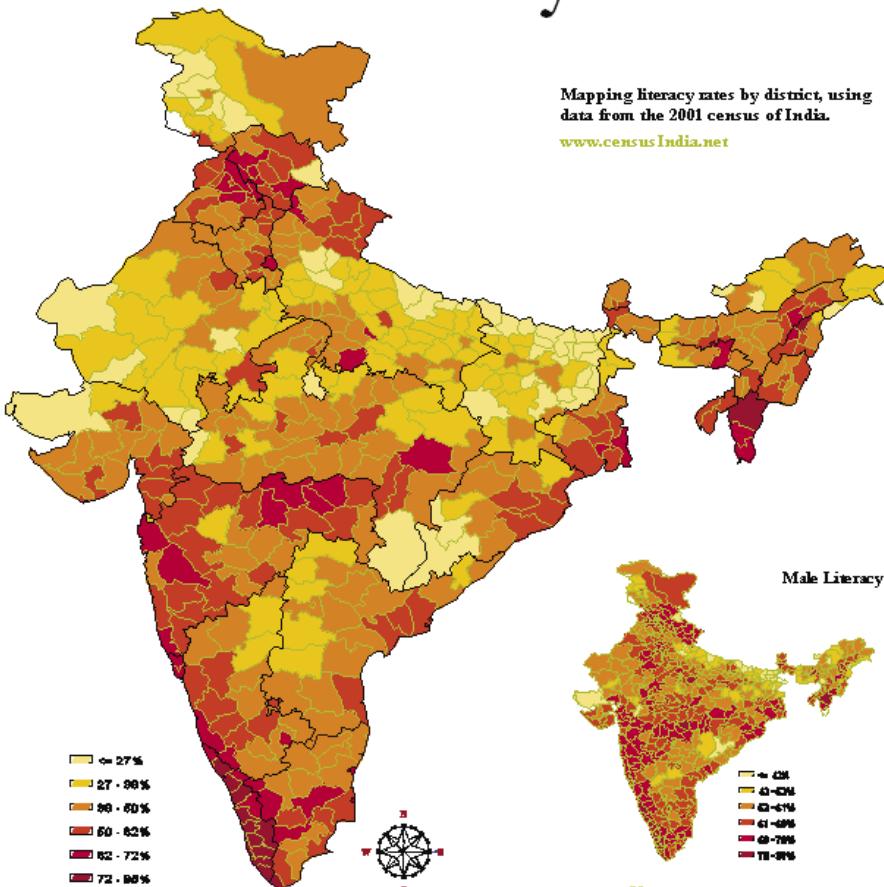
## USA geology map

This map is a large format wall map of the geology of the 48 states, with an inset map showing California fault lines and major earthquakes. The map combines SHP and SDF features. USA state boundaries come from the Navteq datasets in SDF format that are included with AutoCAD Map 3D. SHP files for the geology and earthquake data were downloaded from the National Atlas (United States Department of the Interior).

## New Mexico land ownership and population

This set of maps was created from data posted on the U.S. Census website. The feature data for the counties, urban, areas and census tracts was converted from the Tiger format to shape files and then imported into AutoCAD Map 3D. Shape files for the Federal and Indian landholdings were obtained from the USGS website. Table data for the population maps was extracted from the SF3 census format, edited in Microsoft Excel and then saved as a Microsoft Access database. The database tables were then linked to the feature data in AutoCAD Map 3D.

# Female Literacy in India



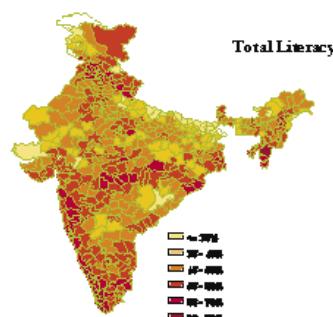
## Background: Women and Literacy in India

According to last census held in 2001, the percentage of female literacy in the country is 54.16%. Since Independence, determined efforts have been made towards the achievement of the Universal Literacy in India. Over the years there has been a very impressive increase in the rate of spread of literateans as well as enrollment of girls. But, the lower enrollment rate of girls is still a major concern in the Hindi belt, Bihar, Jharkhand, Rajasthan, Uttar Pradesh and Orissa. These states account for the majority of illiterate women in India.

Historically, a variety of factors have been found to be responsible for poor female literacy rate:

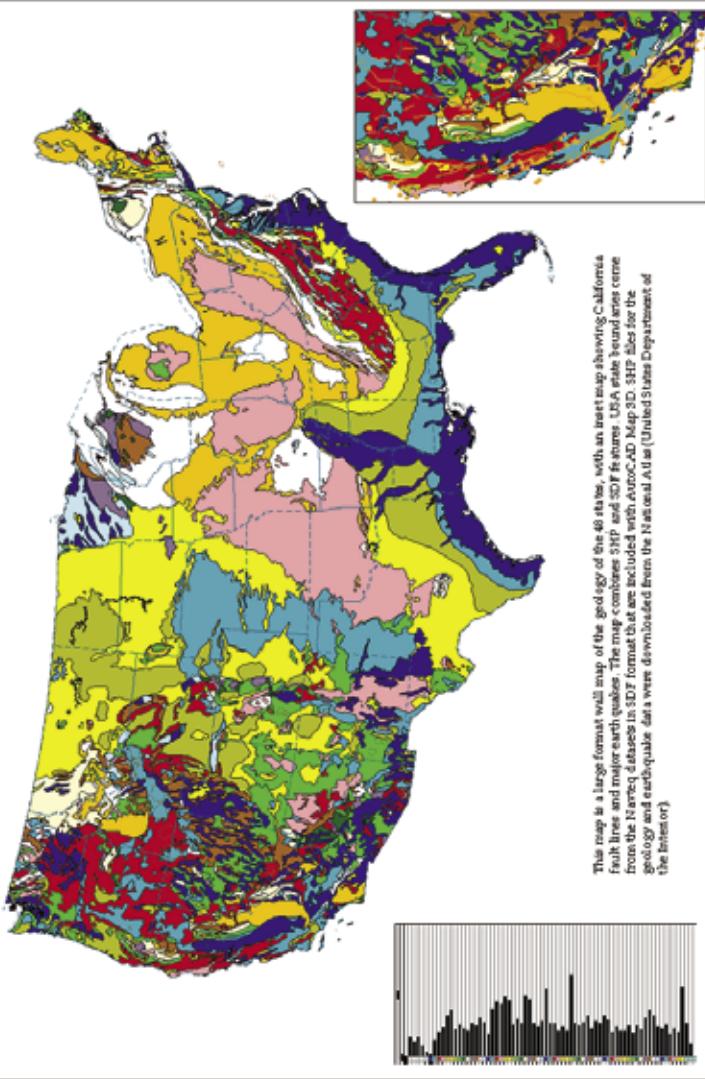
- Gender based inequality.
- Social discrimination and economic exploitation.
- Occupation of girl children domestic chores.
- Low enrolment of girls in schools.
- Low retention rate and high dropout rate.

The provision of educational opportunities for women has been an important part of the national endeavour in the field of education since India's Independence. Though these endeavours did yield significant results, gender disparity persists with unimproving scenario, more so in the rural areas and among the disadvantaged communities. This is not only a matter of concern for the government, but also for the concerned individuals. It is with this situation in mind, the Government of India launched the National Literacy Mission in 1988 for eradication of adult illiteracy. Since women account for an overwhelming percentage of the total number of illiterates, the National Literacy Mission is for all practical purposes a Mission of imparting functional literacy to women.



## Geology of the 48 States

Generalized polygon map of underlying bedrock with California fault lines and major earthquakes.



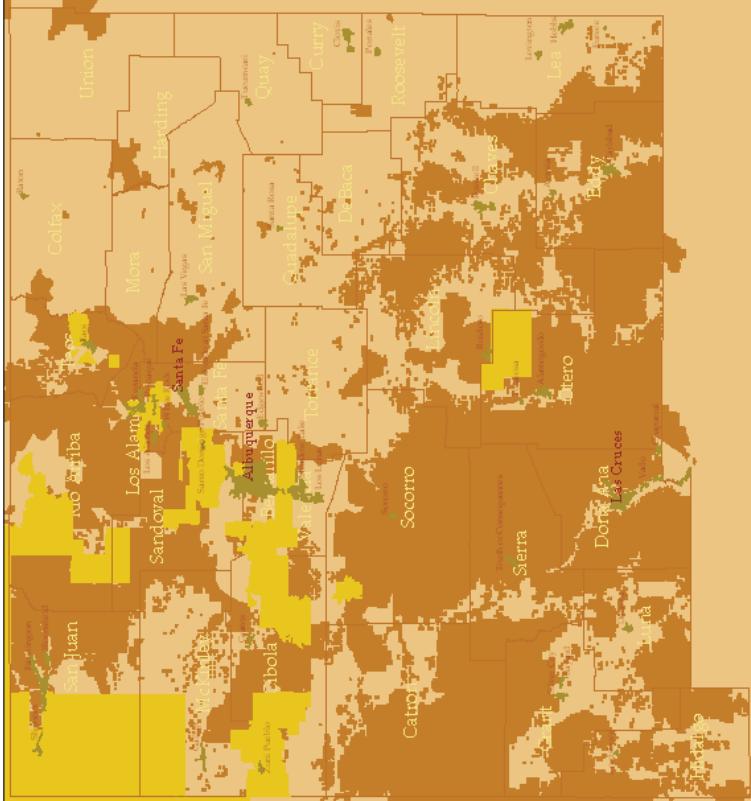
This map is a large-format wall map of the geology of the 48 states, with an inset map showing California fault lines and major earthquakes. The map combines SHP and SDI features. USGS Peirce area center from the Earthquake database in SDI format that are included with AutoCAD Map 3D 31SP files for the geology and earthquake data were downloaded from the National Atlas (United States Department of the Interior).

# State of New Mexico

## Overview map: counties, urban areas, and land ownership



- Federal land*
- Indian reservations*
- Urban areas*

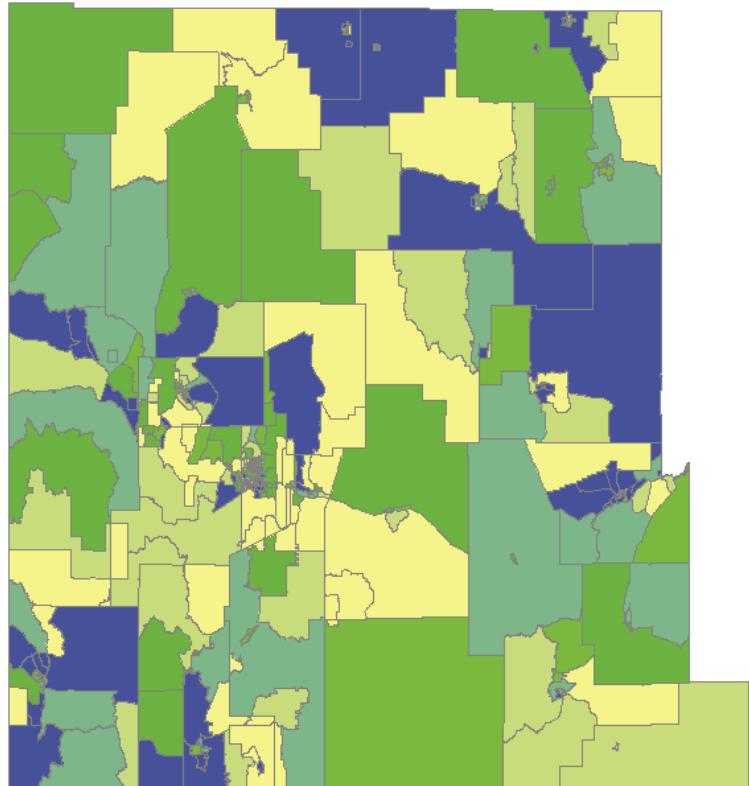


This set of maps was created from data posted on the U.S. Census website. The feature data for the counties, urban, areas and census tracts was converted from the Tiger format to shapefiles and then imported into Autodesk Map. Shapefiles for the Federal and Indian landholdings were obtained from the USGS website.

Table data for the population maps was extracted from the SF3 census format, edited in Microsoft Excel and then saved as a Microsoft Access database. The Access tables were then linked to the feature data in Autodesk Map.

# State of New Mexico

Population totals by census tract



<= 2176  
2176 - 2865  
2869 - 3795  
3795 - 4786  
4786 - 6011  
6011 - 11513

# Maps Using Raster Images

## Deforestation in Chiapas, Mexico

These two maps are based on Landsat shortwave infra-red satellite photographs, taken at 30-meter resolution (each pixel is 30 meters square). This type of image is sometimes called “false-color,” because the original image has been enhanced to show the contrast between different densities of vegetation (see the legend at the left of the map). Compare the image taken in 1990 with the image of the same area taken ten years later, in 2000. The overall coloration of the 1990 image is much greener than the picture from 2000.

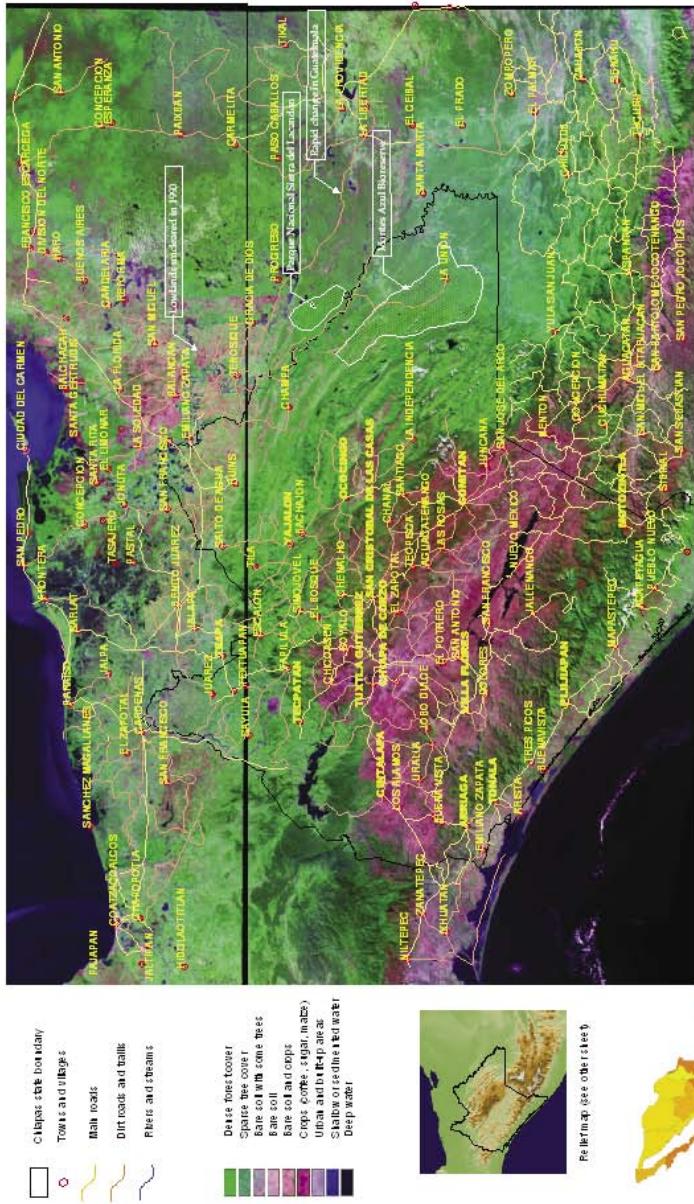
## Landsat mosaic

This map shows a mosaic of satellite images of the USA. The Landsat imagery is on a NASA web server, which is linked directly to the map. There is a lot of detail in the Landsat image layer, which is not visible at first. As you zoom into the map, the image displays more and more detail by streaming new data from the web server.

## New Orleans

This map overlays data from the Federal Emergency Management Agency (FEMA) on a map of the city of New Orleans to show the area that was flooded in September, 2005, following Hurricane Katrina.

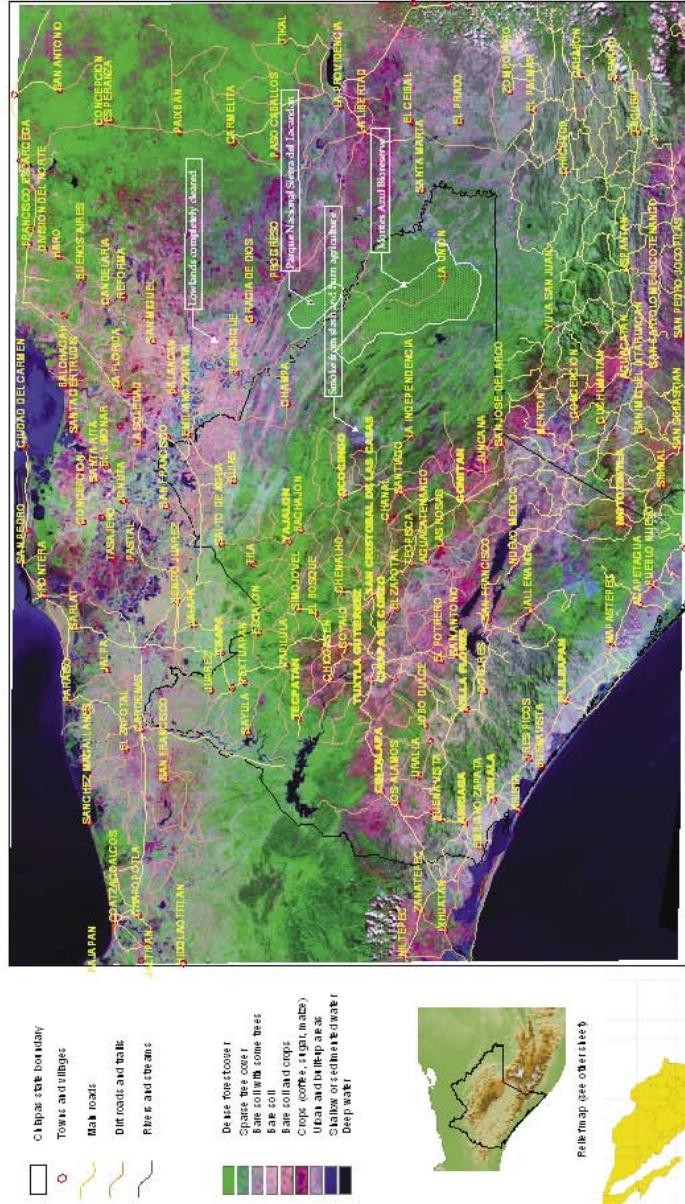
## Forest Cover In and Around Chiapas State, Mexico, 1990



This map is based on a Landsat earth wave filtered satellite photograph taken at 30 meters resolution (path 187, row 34). This type of image is called a "mosaic square". It does not have a scale bar, but it is approximately 10 km wide by 10 km high. The image has been resampled to a resolution of 10 meters. The legend on the left of the map has been kept the same as the original image, so the colors may not be exactly the same. The resolution of the image is high enough to allow you to zoom in closely to examine specific areas.

**Resampling rate**

## Forest Cover In and Around Chiapas State, Mexico, 2000



This map is based on Landsat satellite imagery and LULC classification. It is a derivative of a map from the Mexican government's National Forest Inventory. The original image is a color image called 'false-color' because the original image has been enhanced to show the contrast between different kinds of vegetation directly on the satellite image. Compare this image with the image of the same area taken in 1990. The resolution of the image is high enough to allow you to zoom in closely to examine specific areas.

Loss of timber cover in Chiapas state and across the border in Central American countries. The first pair of data (in thousands of hectares) is for 1990 and 2000; then the percentage increased/decreased from other parts of Chiapas and other states. To examine the lost frontier of the Lacandon rainforest, click here to load both to the 'click and burn' technique of clearing land for subsistence farming, and to fire-fighting fortresses by logging companies. For a summary of the current situation, see the BBC news article <http://www.bbc.co.uk/2plusnow/chiapas.htm>

<http://www.fao.org/docrep/004/x5865d/x5865d02.htm>

## **LANDSAT MOSAIC**

Landsat satellite photographs for the USA displays a more detailed image as you zoom in.



State of Florida shows how the image automatically refreshes itself from the web service.



# New Orleans

## Extent of flooding

Map showing the extent of flooding of the city during September 2005, following Hurricane Katrina



# Glossary

This chapter defines terminology used in this book.

**as-built**

Data that depicts the final installed configuration (physical or functional). As-built data incorporates any field markups on the original construction drawings.

**as-designed**

Data that depicts the original plan for construction or installation, for example, the design for a new electric service or a new pipe installation.

**attributes**

Tabular data that describes the characteristics of a feature, for example, the number of lanes and pavement-type belonging to a road feature. See also feature, property.

**AutoCAD layer**

A layer in AutoCAD. An AutoCAD layer differs from the map layers you create in Display Manager. See also drawing layer, feature layer, layer, surface layer.

**Autodesk MapGuide Studio**

The MapGuide component that handles all aspects of collecting and preparing geospatial data for distribution on the Internet (except custom coding).

**blocks**

In AutoCAD or AutoCAD Map 3D, compound objects that have been saved for reuse in the drawing or in multiple drawings, for example, a North arrow. In Autodesk MapGuide Studio, blocks are converted into symbols when they are loaded. See also symbol.

**buffer**

A zone of a specific radius created around a selected feature. Used to select features within a specific distance of another feature.

**constraint**

In a database, a restriction specified for a certain feature class, which is validated when a new feature is added to that class. For example, a “minor road” feature class may have a constraint that specifies that the speed attribute must always be 25, 30, or 50 miles per hour.

**credentials**

The user ID and password needed to connect to a database.

**data store**

In FDO, a collection of feature classes contained in a single data storage location. The data store consists of an integrated set of objects, which are modeled by classes or feature classes defined within one or more schemas. Data stores can be either file-based, such as SDF, or a database, such as Oracle Spatial. See also FDO provider.

**Data Table**

In AutoCAD Map 3D, the FDO-based grid that allows you to view and edit attributes of selected FDO features, perform searches, and work with selection sets.

**DEM**

Digital Elevation Model. A file that contains a representation of surface terrain. The surface is stored as a grid in which each cell can have any one of several different meanings, such as elevation, color, density, and so on.

**Display Manager**

In AutoCAD Map, the component that handles the organization of layers and the styling and theming of features in a DWG file.

**DTED**

Digital Terrain Elevation Data.

**DWF**

Design Web Format. An Autodesk file format for sharing 2D, 3D, and spatially-enabled design data. See also georeferenced DWF, Design Review.

**Design Review**

The free viewer and editor for the DWF file format (formerly DWF Viewer).

**DWG**

Drawing file. The Autodesk file format for storing 2D, 3D, and spatially-enabled design data.

**draping**

The process of overlaying a set of features or a raster image on a surface so that the features or the image reflect the underlying terrain.

**drawing layer**

A layer in Display Manager that contains drawing objects from a DWG file. See also AutoCAD layer, feature layer, layer, surface layer.

**drawing source**

In AutoCAD Map, a drawing source is a drawing (DWG) file and also its associated information, such as attached drawing files, drawing-based feature classes, linked template data, and topologies.

**drive alias**

In AutoCAD Map, the mechanism that points to the folder where attached DWG files are stored.

**exaggeration**

See vertical exaggeration.

**expression**

An automatic calculation used to specify values for feature labels. For example, you might create a text expression that specifies a state name and population for a label. To express the population in millions, you might apply a number expression that divides the population value by 1,000,000.

**FDO**

Feature Data Objects. An Autodesk software standard and general purpose API for accessing features and geospatial data regardless of the underlying data store. See also feature, feature class.

**FDO provider**

An implementation of the FDO API that provides access to data in a particular data store, such as an Oracle or ArcSDE database, or to a file-based data store, such as SDF or SHP.

**feature**

An abstraction of a natural or man-made real world object. A spatial feature has one or more geometric properties. For example, a road feature might be represented by a line, and a hydrant might be represented by a point. A non-spatial feature does not have geometry, but can be related to a spatial feature that does. For example, a road feature may contain a sidewalk feature that is defined as not containing any geometry. See also attributes, FDO.

**feature class**

A schema element that describes a type of real-world object. It includes a class name and property definitions. Commonly used to refer to a set of features of a particular class, for example, the feature class “roads” or the feature class “hydrants.” See also FDO, property, schema.

**feature layer**

A layer in Display Manager containing features from a feature source such as SDF, ESRI SHP, or ArcSDE. Feature layers are brought in using Data Connect. See also AutoCAD layer, drawing layer, layer, surface layer.

**feature source**

In AutoCAD Map, a feature source is any source of feature data that has been connected by means of FDO.

**generalization**

A method of reducing the number of vertices in the source data by a specific percentage.

**hillshading**

The addition of shading to a surface to suggest three-dimensionality, shadow, or degrees of light and dark. Hillshading adds shading by casting the sun's light across a surface from the direction and angle you specify.

**georeferenced DWF**

A DWF file published by AutoCAD Map 3D 2008 or AutoCAD Civil 3D 2008 that contains a global coordinate system and defined latitude and longitude coordinates based on the WGS84 datum. See also DWF, Design Review.

**join**

A relationship that is established between attribute data and feature sources for the purposes of creating a new view of the data or for ad-hoc analysis.

**label**

Text placed on or near a map feature that describes or identifies it.

**layer**

In AutoCAD Map or MapGuide, a resource that references a feature source or a drawing source. The layer contains styling and theming information, and optionally a collection of scale ranges. In AutoCAD Map 3D, a layer of data in your map that you add using Display Manager. Specific types of layers in AutoCAD Map 3D are drawing layers, feature layers, and surface layers.

**.layer file**

Layer definition file. In AutoCAD Map 3D, a file that saves all of the information needed to recreate a layer, that is, the references to the source data and the styles that have been applied to it.

**LIDAR**

Light Detection And Ranging. A remote-sensing method that can be used to generate an image of a surface.

**long transaction**

A single atomic unit of changes to a data store. A long transaction allows an operation in a database, such as an edit/update, to be tracked over an indefinite period of time, for example during the process of creating and updating a design in the database.

**map**

A collection of layers displayed within a consistent coordinate system and extents.

**map book**

In AutoCAD Map 3D, a publishing option that divides a map into tiles

and formats them into pages with a legend and an index/key.

### **MapGuide**

A software platform for distributing spatial data over the Internet or on an intranet. Exists in two versions: Open Source, which is supported by the community ([www.mapguide.osgeo.org](http://www.mapguide.osgeo.org)) and Enterprise, which is supported by Autodesk ([www.mapguide.com](http://www.mapguide.com)).

### **MapGuide Server**

The MapGuide component that hosts the MapGuide services and responds to requests from client applications through TCP/IP protocol.

### **MapGuide Viewer (DWF Viewer)**

The version of the MapGuide Viewer component that is based on a Microsoft ActiveX Control and has full support for the DWF format. It works with the Microsoft Internet Explorer browser only.

### **MapGuide Viewer (AJAX viewer)**

The version of the MapGuide Viewer component that does not need a download (also known as “zero-client viewer”). It works with Microsoft Internet Explorer, running on Windows, or with browsers such as Firefox on other operating systems, such as MacOS or Linux.

### **MapGuide Web Server Extensions**

The MapGuide component that exposes the services offered by the MapGuide Server to client applications over the Internet or on an intranet using HTTP protocol.

### **metadata**

Data about data. In the GIS context, metadata consist of information about geospatial data sets. Metadata are usually stored in a separate text or xml file that accompanies the data source. The purpose of the metadata is to describe the essential characteristics of the data set.

### **OGC**

Open Geospatial Consortium. A non-profit, international, voluntary consensus standards organization that leads the development of standards for geospatial and location based services. ([www.opengeospatial.org](http://www.opengeospatial.org))

### **OSGeo**

Open Source Geospatial Foundation. A foundation created to support and build the highest-quality open source geospatial software. The foundation's goal is to encourage the use and collaborative development of community-led projects. ([www.osgeo.org](http://www.osgeo.org))

### **property**

A single attribute of a class. A class is described by one or more property definitions. For example, a Road feature class may have properties called Name, NumberLanes, or Location. See also attributes, feature class.

### **query**

In AutoCAD Map 3D, executable statements that retrieve specific objects. For example, a layer-based query that displays only the objects on the layers that contain state and district boundaries.

### **reference point**

For a symbol, the point that controls the position of a symbol over a feature in a map. The default reference point is the center of the symbol.

### **resource**

In MapGuide, a feature source, drawing source, or application component that is stored in the resource repository and can be reused and shared.

### **resource repository**

In MapGuide, an XML database that stores the resources created either by loading file-based data or by connecting to databases.

### **schema**

The definition of multiple feature classes and the relationships between them. A schema is the logical description of the data types used to model real-world objects, and does not reference the actual data instances (a particular road or land parcel). Rather, it is metadata. See also feature class.

### **SDF**

Spatial Data File. An Autodesk format for storing both geometry and associated attribute data. The SDF format is a GIS-oriented alternative to DWG. Each SDF file can contain multiple feature classes or types of data stored in tables with attributes and geometry.

### **SDF 2**

The native file format for Autodesk MapGuide (the last release was Autodesk MapGuide 6.5). Each SDF 2 file contains one type of data, for example points, lines, polygons, or text.

### **sheet**

In a DWF file, a plot layout containing a specific view of the original data.

### **site**

The collection of servers that process MapGuide requests.

### **Site Administrator**

A Web-based application, installed with MapGuide

Server, for managing a site and its servers.

### **Site Explorer**

The tree view in Autodesk MapGuide Studio that displays the resources stored in the resource repository.

### **spatial context**

The general metadata or parameters within which the geometry for a collection of features resides. In particular, the spatial context includes the definition of the coordinate system, spheroid parameters, units, spatial extents, and so on for a collection of geometries owned by features.

### **Spatial Data File**

See SDF.

### **style**

In AutoCAD Map 3D or MapGuide, pre-defined style elements stored in the Display Manager, for example, a polygon style that makes parcel polygons 50% transparent and which appears at a scale of 1:50000.

### **styling**

The process of assigning display characteristics (such as line color, line pattern, fill color, fill pattern, and so on) to a feature (points, polylines, polygons). See also theming.

### **surface layer**

A layer in Display Manager containing a raster-based surface such as a Digital Terrain Model (DEM), an ESRI Grid file, or Digital Terrain Elevation Data (DTED). A surface layer is brought in using Data Connect. See also feature layer, drawing layer, AutoCAD layer.

### **symbol**

A bitmap or vector image that is used to represent a point.

### **symbol library**

In Autodesk MapGuide Studio, a collection of related symbols. Image files are converted into symbols when they are brought into the symbol library. The symbol library is stored in the resource repository.

### **theme**

In AutoCAD Map 3D, pre-defined thematic elements stored in the Display Manager, for example, a theme that colors district polygons according to their population.

### **theming**

The process of styling features according to an attribute value. See also styling.

**task pane**

In Autodesk Map 3D, the area of the interface that contains Display Manager, Map Explorer, or Map Books.

**topology**

A set of relationships between lines, points, or centroids. The topology describes how features connect and relate to each other, which forms the basis for functions such as network-tracing and other kinds of analysis.

**Topobase**

An Autodesk data management solution for utility companies, municipalities, and engineering firms. Autodesk Topobase consists of a set of industry-specific modules built on AutoCAD Map 3D and MapGuide, all of which use Oracle as the central data store.

**versioning**

A database function that allows multiple copies of a spatial dataset to be stored and tracked by date of creation, data of change, and so on.

**vertical exaggeration**

An increase of vertical scale relative to horizontal scale, used to make elevation changes easier to differentiate.

**web layout**

A template for customizing the appearance of the MapGuide Viewer and for specifying which toolbar commands will be available.

**web surround**

In Autodesk MapGuide Studio, the extra functionality that is automatically built for a web layout, which resides outside of the map itself.

**WebAgent**

The component of the MapGuide Server Web Extensions that processes requests and forwards them on to the server.

**WFS**

Web Feature Service. A web service based on the specification defined by the OGC. Acts as a source of feature data.

**WMS**

Web Map Service. A web service based on the specification defined by the OGC. Produces an image (for example, a PNG or JPG image) of geospatial data.

**zero-client viewer**

See MapGuide Viewer (AJAX viewer).



# Index

## A

accessing data  
  workflows for 34  
analyzing data  
  workflows for 69  
ArcSDE  
  workflow using 91  
as-built data  
  and as-designed 93  
  from paper maps 88  
asset management  
  example solution for 97  
attached DWG files  
  example of 51  
attribute data  
  and SDF files 20  
  associated with features 24  
AutoCAD Civil 3D  
  as-built workflow 41  
  new-design workflow 45  
AutoCAD layers  
  export to GIS format 55  
AutoCAD Map 3D  
  and raster images 73  
  database flexibility 28  
AutoCAD Raster Design  
  solution using 88  
  used to prepare data 73  
Autodesk Geospatial 2  
Autodesk MapGuide Studio  
  used to create maps 72  
  used to load data 85  
automate DWG export 54

## B

Base Map layer 51  
buffer  
  workflow for 61  
bulk copy  
  workflow for 44

## C

check-in, check-out 39  
civil engineering  
  as-built workflow 41  
  new-design workflow 44  
clean up drawing  
  paper maps 88  
  used in workflow 53  
color mapping a surface 73  
contours, generating 73

convert DWG objects  
  workflow for 51, 54  
create and edit  
  workflow for 36  
create feature from  
geometry 54

## D

data sources  
  list of 34  
Data Table  
  compared to Data View 24  
  used to edit data 70  
DEM files  
  used in workflow 73  
digitized paper maps 88  
Display Manager  
  Base Map layer 51  
  used to create themes 72  
distributing data  
  workflow for 83  
draping  
  explanation of 73  
drawings, paper 88  
DWF, publish to 78  
DWG files  
  and features 48  
  compared to SDF files 20  
  optimal way 20  
  workflows for 48  
DWG objects  
  converting to features 48  
  export to GIS format 54

## E

electric utility  
  example solution for 95  
  workflow example 51  
engineering GIS 2  
exaggerate vertical scale 73  
export to SDF 42

## F

FDO  
  what is it? 22  
FDO data stores  
  schema editor for 58  
FDO providers  
  for Map, MapGuide 78  
  list of 34  
feature classes

and schema 26  
from AutoCAD layers 55  
mapping properties 60

features  
  converted from DWG 54  
  example of check-out 39  
  migration options 48  
  what are they? 24  
file based data stores 34  
FME Workbench  
  used in workflow 101

## G

georeferenced DWF 80  
GPS points  
  used in workflow 95

## H

hillshading example 76

## J

join database tables 62

## L

layer file  
  used to share styles 68  
layers  
  creating maps with 34  
  DWG and feature 49  
layers, AutoCAD  
  and feature classes 55

## M

map books, publish to 78  
MapGuide  
  open source version 82  
  publish to 72  
  Server repository 85  
  sharing styles with Map 78  
  used to build maps 72  
  used with Topobase 99  
Viewer, showing map 85  
workflow for 82  
maps, creating 34  
maps, sample  
  thematic maps 109  
  using raster images 114  
  using surfaces 104  
mobile field force  
  example solution for 97

- N**  
notification workflow 61
- O**  
open source MapGuide 82  
organize, manage data  
  workflows for 58
- P**  
parcels  
  as-built workflow 41  
  new-design workflow 44  
PDF, publish to 78  
performance  
  of SDF files 20  
printing and plotting 78  
property management  
  example solution for 100  
providers  
  list of 34  
Public Works Department 88  
publishing data  
  workflows for 78  
publish to MapGuide 72
- R**  
raster images  
  sample maps 114  
  solution for managing 88  
  workflows for 73  
redline data  
  used in workflow 95
- S**  
scale ranges  
  what are they? 67  
schema  
  what is it? 26  
  workflow for 58  
SDF  
  as data store 125  
  exported from Civil 3D 42  
  exported from DWG 54  
SHP files  
  and ArcSDE 91  
  workflow using 71  
solutions  
  government 88  
  other industries 100  
  utility and telecom 91  
Spatial Data File 20  
styling  
  Map and MapGuide 78  
  polyline example 51  
  workflows for 65  
subdivision  
  as-built workflow 41
- new-design workflow 44  
surfaces  
  sample maps 104  
  workflows for 73
- T**  
telecom company  
  old and new workflow 91  
theming  
  polygon example 49  
  sample maps 109  
  workflow for 69  
Topobase  
  in the enterprise 30  
  solution using 97  
transparency  
  theming example 49
- W**  
water utility  
  as-built example 93  
  asset management in 97  
Web-based application  
  developing 82  
  workflow for 83  
web services  
  providers for 34  
  sample maps using 114  
workflows  
  asset management 97  
  convert DWG to features 51, 54  
  create and edit features 36  
  DWG and feature data 48  
  export DWG to SDF 54  
  import from Civil 41  
  managing paper maps 89  
  mapping system (new) 93  
  mapping system (old) 92  
  notify neighbors 67  
  property management 100  
  publish for print 78  
  schema editor 58  
  share styles 65  
  start new design 44  
  thematic map 69  
  use raster images 75  
  Web-based application 83  
  web distribution 69  
  work order management 95  
work order management  
  example solution for 95