

Optimizing Design and Spatial Data Management using the Topobase API



Autodesk® Topobase™ software includes powerful application programming interfaces (APIs) for use in building custom applications and application extensions that can be added to the Topobase framework. This white paper focuses on understanding the Topobase architecture, components, technical features, and industry-specific application modules as well as the basics of the Topobase API.

Contents

Introduction	3
What Is Autodesk Topobase?	3
How Topobase Addresses the Data-Sharing Challenge	4
Topobase Architecture	4
Topobase Components	5
Topobase Client.....	5
Topobase Web	6
Topobase Administrator.....	6
Topobase Industry Modules	7
Topobase Technical Features	7
Topology.....	7
Long Transactions	8
Business Rules.....	8
Industry-Specific Data Models	8
Topobase APIs	9
Topobase Server API	9
Topobase Framework API.....	10
Topobase Scripts.....	10
Topobase Plug-ins.....	11
TBP File Format	11
Types of Plug-ins.....	12
Using the Plug-in Template to Create an Application Plug-in	13
Using Topobase Forms	14
Adding the Plug-in Menu to the Application Menu	16
Testing the Plug-in.....	16
Conclusion	17
Resources	17
Autodesk Developer Network	17
Learn More	17

Introduction

In today's world, most departments in public infrastructure, telecommunications, and utility organizations use and generate spatial information to carry out day-to-day processes. These processes need to be managed in an efficient and cost-effective way. However, doing so presents a challenge: most organizations find that data does not move smoothly from one process to the next, from one department to the next, or from one software system to the next, making it virtually impossible to see the big picture required for decision making. Departments within the same organization often work with different technologies, and data passing between them must be converted from one format to another, which is time-consuming and subject to errors. This approach can result in costly inefficiencies, including

- Duplication of work for specialists in different departments
- Inaccurate or outdated data driving decision making across the organization
- Unsynchronized systems that may not reflect the most current data available
- Information request backlogs and project delays
- Loss of information as data moves between formats
- Lack of access to vital asset information in some departments, such as finance

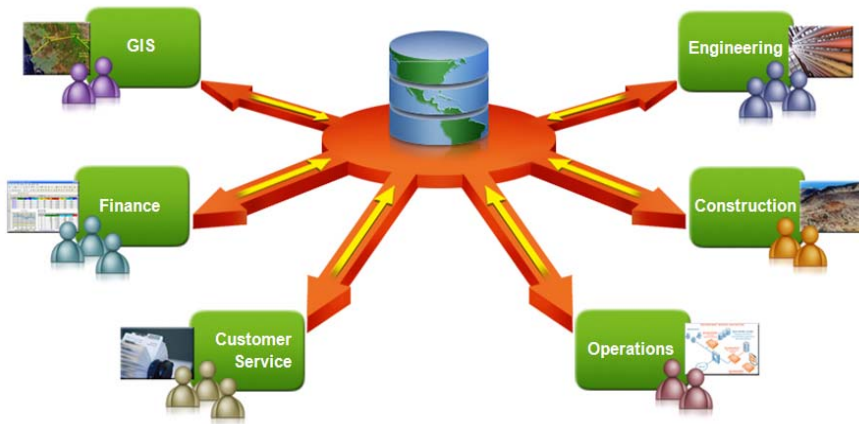


Figure 1. Organization-wide data access through Topobase

What Is Autodesk Topobase?

Autodesk® Topobase™ software is an infrastructure design and asset management solution that provides centralized, flexible, and secure access to spatial information for geographic information system (GIS), design, and business teams. Built on AutoCAD® Map 3D and Autodesk MapGuide® Enterprise software applications as well as the Oracle® database, Topobase offers comprehensive views of CAD, asset, GIS, and customer information; helps improve efficiency and data quality; and facilitates sharing spatial information between teams, customers, and partners.

How Topobase Addresses the Data Sharing Challenge

Autodesk Topobase software brings engineering design and geospatial data together in a centralized database environment so that organizations can share and use spatial information more easily. By integrating previously created CAD and GIS data into a common, centralized framework, Topobase enables organizations to improve the efficiency of business processes and reduce the redundancy of information. Organizations no longer have to go through a data conversion process between departments and re-create data because of incompatible formats. With Topobase, data is always available across the organization, and it is always synchronized. Topobase integrates CAD and GIS functionality along with an enterprise database. It enables organizations to use CAD tools to design and manage infrastructure, and while doing so, they automatically create information that contains attribute data associated with assets, which makes engineering design information GIS-ready.

Topobase comes with standard industry-specific applications that contain the most commonly requested and used database structures for the given industry—including data schema, database relationships, user-definable data constraints, and workflows—that are used to manage specific kinds of networks and assets, such as those for water and wastewater. In addition, each database structure contains industry-specific business rules to help protect the integrity of spatial information. Topobase integrates all relevant spatial and nonspatial tables in a centralized Oracle® Spatial database and includes the option to link into other IT and business systems.

With Topobase display model style templates, everybody in the organizational workflow gets a view into the organization's spatial data that is suitable to their work functions—both on the desktop client and on a web-based client. These display models enable users to work with their subset of the enterprise database efficiently. For example, a network engineer might want to access network data while simultaneously viewing land base information in the background, and an operations manager might want to view assets color-coded according to maintenance schedules.

Topobase Architecture

As discussed, Topobase is designed to store spatial data in a central database and to integrate with other business systems. It is built on AutoCAD® Map 3D and Autodesk MapGuide® Enterprise software and uses Oracle Spatial, the world's leading spatial database, to store spatial data. Based on open standards, Oracle Spatial provides vendor-neutral GIS capabilities, which enables organizations to use preferred applications to carry out geospatial analysis. It leverages Oracle Spatial's native GIS capabilities for storing spatial data and performing spatial tasks, and it includes Oracle's renowned and proven database management and tuning features, which help to ensure superior database performance over time. Organizations can use standard IT tools along with SQL to access information in Topobase for reporting, integration with business and IT systems such as customer relationship management (CRM) and enterprise resource planning (ERP), and use in GIS applications from other vendors.

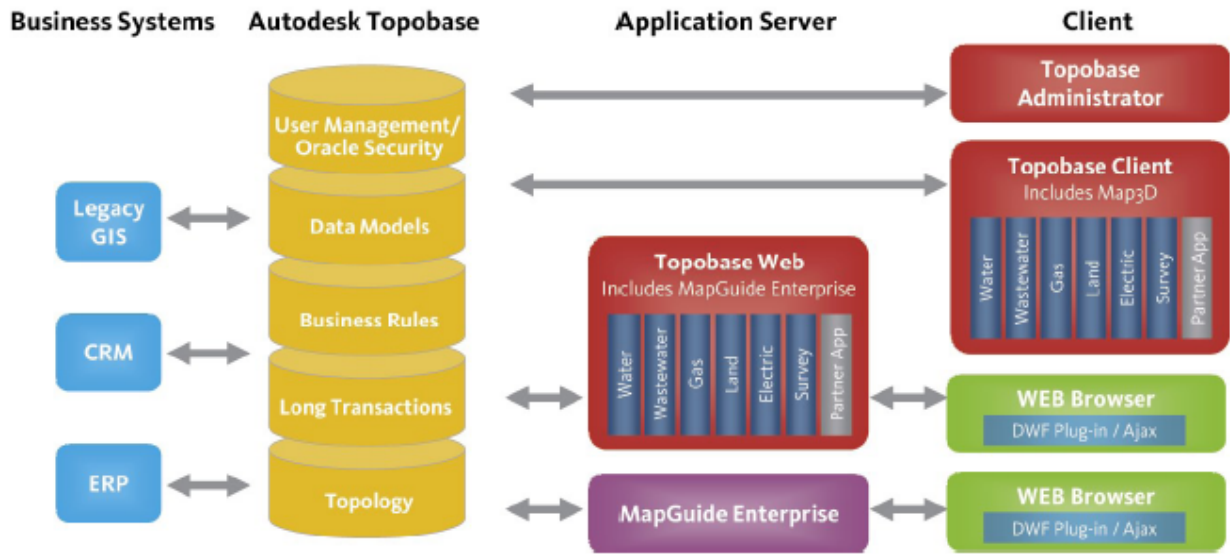


Figure 2. Topobase architecture

Topobase Components

Autodesk Topobase software is made up of the following set of standard components:

- Topobase Client—A desktop application that streamlines design within a familiar interface and automatically stores asset data in Oracle Spatial
- Topobase Web—A web application that uses Autodesk MapGuide Enterprise to share asset information over the web
- Topobase Administrator—An application that enables organizations to change or extend data structures in Oracle Spatial, create business rules, design user forms and reports, and regulate access to the Oracle Spatial database
- Industry-specific applications—Modules designed for managing specific types of infrastructure, such as electric, water, gas, wastewater, sewer, and land assets

Topobase Client

Topobase Client is the desktop component for creating and editing asset data. Built on AutoCAD Map 3D, the Topobase Client application delivers advanced GIS capabilities and CAD functionality based on AutoCAD® software.

The Topobase Client provides streamlined interfaces for connecting with Oracle Spatial, enabling users to design new infrastructure and edit data quickly. Within the Topobase Client data model, specialized symbols represent different object types, such as points, surfaces, and attributes. Features of Topobase Client include

- Automatic creation of attribute forms based on the data model
- Search and sorting of data based on attributes
- Use of preconfigured or custom formulas to calculate values

- Graphic connection to multiple data formats created by different applications, including those from Autodesk and other GIS vendors
- Posting of all changes and new objects to the central database
- Presentation of all defined objects according to the chosen data and representation model

Topobase Web

Built on the Autodesk MapGuide Enterprise platform, Topobase Web is a lightweight interface that enables users to access information in Topobase using a web browser. Authorized users can update attributes through the same browser-based interface they use to view infrastructure maps and other information. Because the web platform incorporates the same business rules and user forms for attributes as the Topobase Client, the same data standards are enforced. The underlying Autodesk MapGuide Enterprise engine also accommodates hybrid data environments where information can be linked with legacy GIS systems, as well as integration with other business systems via the web or web services.

Features of Topobase Web include

- Interoperability with other business systems and the ability to access and display spatial data in a wide array of formats
- Interactive mapping with maps that scale, blend layers, and dynamically include information from business systems
- Flexible environment for creating display and attribute entry options tailored to an organization's processes
- Simultaneous connections to multiple database servers, such as Oracle Spatial and databases storing ERP data

Topobase Administrator

Topobase Administrator helps organizations set up, configure, and manage their data environment. It enables authorized users to edit data structures and rules for data stored within Oracle Spatial, modify the dialog boxes within the Topobase Client, and regulate access to the database. They can also create workflows, create or modify rules, and generate dialog boxes/forms through the user-friendly administration tools.

The Topobase Administrator includes tools to

- Administer multiple database schemas, display style templates, and define user groups in a way that allows employees to view data and use software in a manner relevant to their job functions and user profile
- Edit, create, and manage data models, feature classes, attributes, and feature relationships
- Create and manage long transaction/job templates and easily version-enable feature classes, topologies, utility models, and intersections
- Design forms to manage attributes and data constraints associated with feature classes using visual, drag-and-drop functionality
- Generate custom reports with the built-in report designer using drag-and-drop functionality, or invoke Crystal Reports® templates

- Manage business rules on the client and server, such as the automatic creation of fittings when a pipe object is created
- Optimize Oracle and manage database procedures and triggers

Topobase Industry Modules

Engineers, planners, and analysts have detailed requirements that are unique to their specialties, depending on which type of infrastructure system they are designing, analyzing, or maintaining. Topobase offers standard industry-specific applications that conform to the needs of organizations that manage different types of infrastructure, such as water, wastewater, or power and gas. These individual applications come preconfigured with industry-specific data models that are designed to capture the exact data needed within an industry. They are also configured to manage attribute information appropriate to assets common in the industry. In addition, these data models are designed to capture relations between features. For example, the water module is set up to manage features such as pipes, hydrants, and valves; the relationships between those features; and all the underlying attributes relevant to those features.



Figure 3. Topobase industry-specific application modules

Topobase Technical Features

Autodesk Topobase includes four key technical features designed to support the spatial data needs of infrastructure organizations: Topology, long transactions, business rules, and industry-specific data models. Combined, these features support optimal database performance, facilitate efficient design and data management, and enhance the integrity of network data.

Topology

Topology keeps track of assets, their locations, and their relationships with other objects. Topology is the ability to maintain spatial relationships between areas, such as parcels, and infrastructure features, such as a water network. These topologies are called Area and Network. Area topology is used to model land and other flat surfaces, and Network topology is used for modeling the way objects are connected to each other in networks.

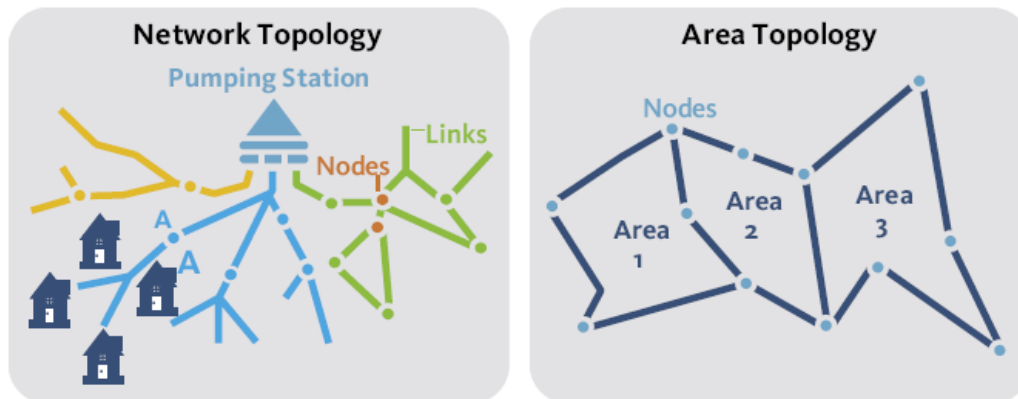


Figure 4. Network and Area topologies in Topobase

Long Transactions

A *long transaction* is a complex project or series of tasks that takes place over time and often involves several contributors. Topobase functionality for long transactions, also known as *jobs*, enables users to select an area of infrastructure that is being built or modified and keep the modifications separate from the base network information until the project is complete. Organizations can establish multiple long transactions on projects, allowing them to evaluate cost and design alternatives. As projects are completed, the Topobase approval functionality provides a streamlined way to update the database.

Business Rules

When implementing Topobase, organizations establish business rules and workflows to govern and streamline the way information is entered into the database, helping to enforce data quality. These business rules and workflows are essentially standards that reflect the organization's current business processes. Organizations can also predefine sets of materials in addition to establishing data standards. Standards and materials can both be linked to job types, for example, adding a new subdivision to the network or replacing old pipe. Once business rules are established, dialog boxes/forms within the Topobase Client include only valid elements for the designer to select from.

Industry-Specific Data Models

Topobase offers standard industry-specific applications that conform to the needs of organizations that manage different types of infrastructure, such as water, wastewater, and power. These individual applications come preconfigured with industry-specific data models that are designed to capture the exact data needed within an industry. They are also configured to manage attribute information appropriate to assets common in the industry. In addition, these data models are designed to capture relations between features. For example, the water module is set up to manage features such as pipes, hydrants, and valves; the relationships between those features; and all the underlying attributes relevant to those features.

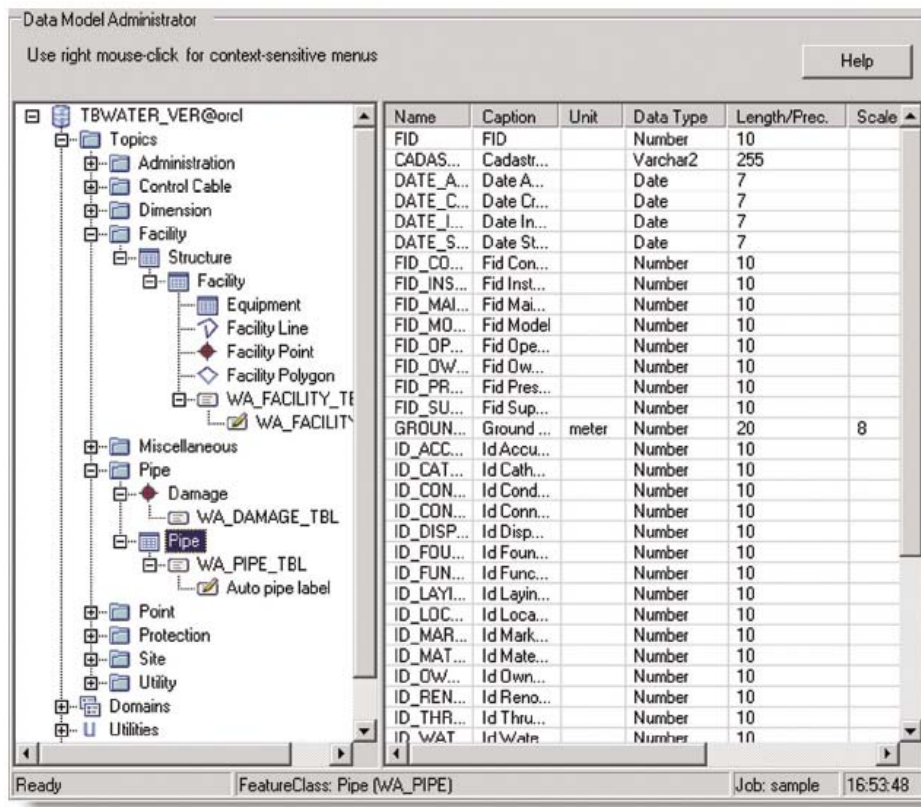


Figure 5. Topobase industry-specific data models

Data models can be customized with the Topobase Administrator to meet the exact data requirements of individual organizations.

Topobase APIs

The Topobase API has two major components:

- Server API
- Framework API

Topobase Server API

With the Topobase server-side API, you can set up server-side connections and load data to the Oracle database using Java[®] and PL/SQL programming languages. The Server API is developed in Java and PL/SQL and runs in Oracle[®] 10g database. It supports Topobase metadata model editing and feature rules. Data migration is one important use of the API.

The following is a code snippet for creating a topic and a feature class using the Server API:

```
var n number;  
call TBSYS.Topic.CreateTopic('MyTopic', 'MyTopic') into :n  
call TBSYS.FeatureClass.CreateFeatureClass(  
'MYPOINT', 'MyPoint', ,MyTopic', 'P', 2,  
0.0005, 'NULL', 'AnyInteract', 0,  
1000000, 1000000, 10000, -10, -10, -10)  
into :n
```

Because the Server API functionality is exposed through the Framework API, the Server API is not normally used for application development.

Topobase Framework API

The Framework API is the core component of the Topobase API for use in either the Autodesk Topobase Client or Autodesk Topobase Web application. It provides access to the Oracle database. ADO.NET and OraDirect.NET providers are used by the API for connecting to the database, executing commands, and retrieving results. With this API, users can create numerous customized applications and plug-ins to suit customized needs.

The Framework API components are as follows:

- Data Layer—Provides data access, metadata support, long transaction interface, and feature rules.
- Map Interface—Provides more than 50 map-related methods and works identically in the client (Map 3D) and web (Autodesk MapGuide) environments.
- User Interface Layer—Topobase offers its own forms and controls. The Topobase.Forms namespace includes many simple dialog boxes that give information to or receive input from the user. Unlike the Windows® form equivalents, these elements are compatible with Topobase Web Client.
- Other API components—Graphics, Utilities, Jobs, Logging, and so forth.

There are two different ways users can extend and customize Topobase with the Framework API: creating custom plug-ins and using scripts.

Topobase Scripts

Scripting is one of the ways to extend and customize Topobase with new functionality. Topobase scripts are developed in VB.NET and used in workflows or attributive forms. Users can create new script workflows for each document using the Topobase Administrator. The definition is stored in the document in the system table TB_WORKFLOW. Use Script Button controls in the attributive forms to execute short scripts. Scripts work without plug-ins.

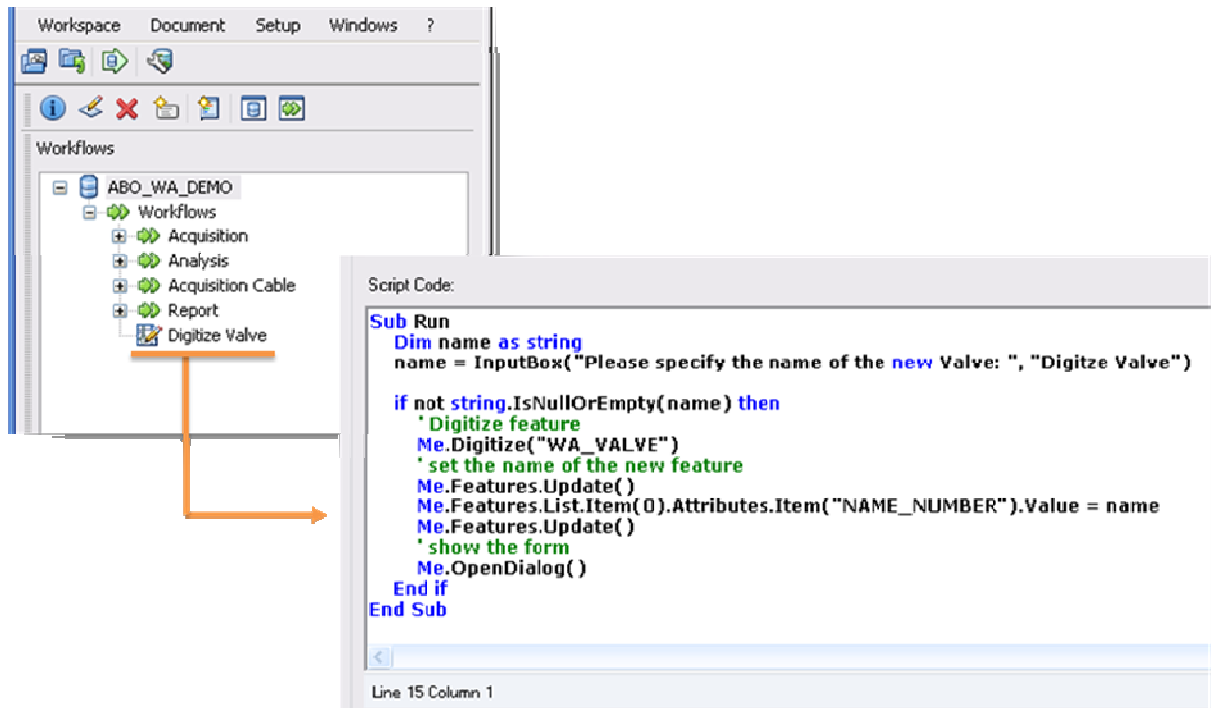


Figure 6. Create new dynamic workflows using scripts

Topobase Plug-ins

Plug-ins play an important role in Autodesk Topobase. They enable developers to extend and customize Topobase to fit specific organizational needs. For example, they enable rapid customization of the user interface, provide management of workspaces, and control how users interact with documents and workspaces. Many of the Autodesk Topobase components are built using plug-ins. This structure enables developers to extend Topobase for their own needs. To create a customized plug-in, create a DLL (dynamic link library) containing one or more plug-in classes and referencing a Topobase plug-in file (TBP format).

Plug-ins are .NET class libraries that contain user interface elements (application plug-ins, document plug-ins, dialog box plug-ins, application flyins, document flyins, and option pages) that are added to the Topobase Client environment. Any number of user interface elements can exist in a single library, but each must be listed in the TBP file that accompanies the library.

TBP File Format

The Topobase plug-in file tells Topobase how to handle your plug-in. The name of the TBP file must be the name of the DLL plus the extension *.tbp*.

The following example shows the contents of a sample TBP file:

```
<?xml version="1.0" encoding="utf-8"?>  
<Plug-in>  
<Default  
    AssemblyName="VbSample.dll"
```

```
Namespace="VbSample"  
DocumentKey=""  
MapName=""  
Priority="100"  
ExecutionTargetWeb="True"  
ExecutionTargetDesktop="True"  
Company="My Sample Company"  
Author="Hans Maiser"  
LicenseKey="Construction"  
/>  
  
<ApplicationPlug-in ClassName="MyApplication1"/>  
<ApplicationPlug-in ClassName="MyApplication2"/>  
<DocumentPlug-in ClassName="MyDocument"/>  
  
</Plug-in>
```

Use the Default tag to define properties that should be used by all plug-in tags of the file. You can also create one TPB file for two or more DLLs.

Types of Plug-ins

Many different types of plug-ins can be created and used in the Topobase interface:

- Application Plug-ins—An application plug-in integrates into the application-wide toolbar or menu bar of the task pane. It is derived from the Topobase.Forms.ApplicationPlug-in class.
- Document Plug-ins—Document plug-ins modify the toolbar or context menus for the document-specific tabs within the task pane. Such plug-ins are derived from the Topobase.Forms.DocumentPlug-in class.
- Dialog Plug-ins—Dialog plug-ins modify the toolbars, menus, and other user-interface elements of dialog boxes. They are derived from the Topobase.Forms.DialogPlug-in class.
- Option Pages—An option page is a form within the Application Options or Document Options dialog box. A plug-in can be used to add new forms to these dialog boxes. An option page is based on either the Topobase.Forms.ApplicationOptionPage or Topobase.Forms.DocumentOptionPage class.
- Application Flyins—An application flyin is a movable window that can be docked within the Topobase application part of the task pane. All docking operations are performed automatically. Application flyins are derived from the Topobase.Forms.FlyIns.ApplicationFlyIn class.
- Document Flyins—A document flyin is a movable window that can be docked within the Topobase document tabs of the task pane. All docking operations are performed automatically. Document flyins are derived from the Topobase.Forms.FlyIns.DocumentFlyIn class.
- Dialog Flyins—A dialog flyin is a frame within a Topobase dialog box. Unlike other kinds of flyins, dialog flyins cannot be undocked and moved. They are derived from the Topobase.Forms.FlyIns.DialogFlyIn class.

Using the Plug-in Template to Create an Application Plug-in

An application plug-in integrates into the application-wide toolbar or menu bar of the task pane, highlighted in Figure 7.

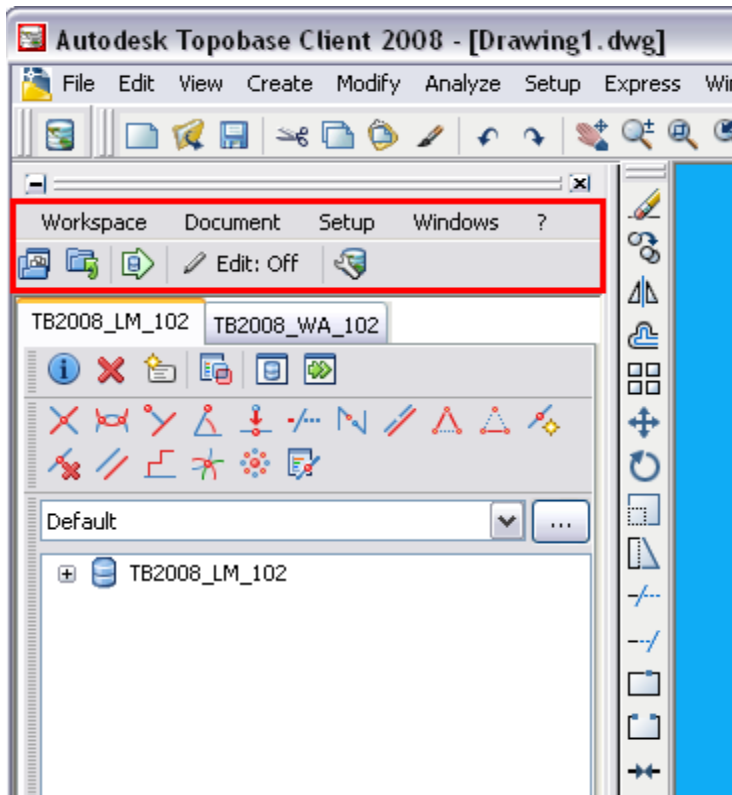


Figure 7. Sample Topobase plug-in

Such plug-ins are derived from the `Topobase.Forms.ApplicationPlug-in` class.

Use the following statement to inherit the customized plug-in class `MyApplicationPlug-in` from the application plug-in in C#.

```
public class MyApplicationPlug-in :  
Topobase.Forms.ApplicationPlug-in  
{  
  
}  
}
```

The TBP file for libraries that expose application plug-ins should have a line like the following for each plug-in:

```
<ApplicationPlug-in ClassName="MyApplicationPlug-in" />
```

Topobase includes a generic project template for creating plug-ins in Microsoft® Visual Studio® 2005. To install it, copy the project template named *CSSimpleTopobasePlug-in.zip* from the directory `<Topobase install directory>\Development\VS Templates\ProjectTemplates\Topobase\` to the Visual Studio custom template directory, usually `My Documents\Visual Studio 2005\Templates\ProjectTemplates\ Visual C#\`.

Use the following steps to create a plug-in based on the Plug-in template:

1. Start Visual Studio.
2. From the File menu, choose New>Project.
3. In the New Project dialog box, select the Visual C# project type.
4. Select SimpleTopobasePlug-in from the list of templates, and create a project by filling other details: name, location, and so forth.
5. Once the project has been created, check the project references to make sure that the references to the Topobase libraries are valid.

If the references not valid, you must add the following references by browsing to the location of the Autodesk Topobase Client bin folder.

Topobase.Data.dll

Topobase.Forms.dll

Topobase.Graphic.dll

Topobase.Map.dll

6. Configure the project to write the build outputs to the Topobase bin folder: Display the project properties, in the Properties tab click Build, and set the output path to *C:\Program Files\Autodesk Topobase Client <version>\bin*.
7. Create the plug-in and the TBP file.

Using Topobase Forms

Plug-ins can use regular Windows forms and user controls to interact with the user. However, any plug-in that does so will work only in the desktop environment, not for web clients. To create user interface elements that are usable in both environments, use form templates provided by Topobase. Forms created this way are limited to the controls provided in the *Topobase.Form.dll* library.

To install the templates, copy the item template files (all of which are compressed ZIP files) from the directory *<Topobase install directory>\Development\VS Templates\ItemTemplates\Topobase* to the Visual Studio custom template directory, usually *My Documents\Visual Studio 2005\Templates\ItemTemplates\Visual C#*. To add Topobase forms to your project, from the Project menu, choose Add New Item. Select the appropriate plug-in component type from the available items in the My Templates section of the template list.

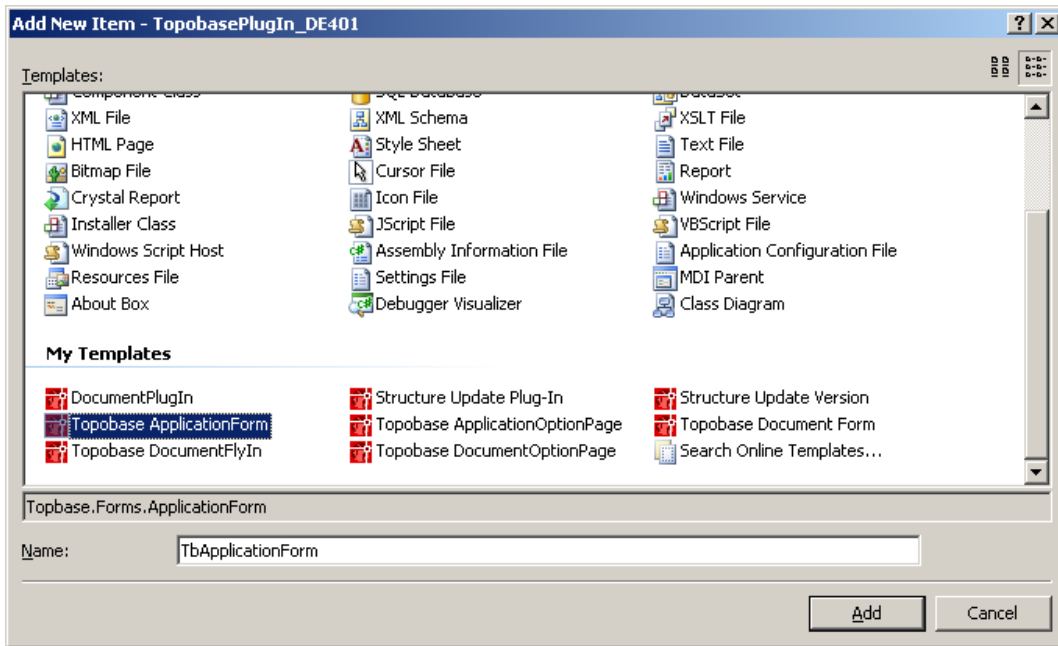


Figure 8. Creating a Topobase form

This section describes how to create a Topobase application form named TbApplicationForm. After the form is created, you can add Topobase controls to it.

1. If you are using the Topobase controls for the first time, you need to add them to the Visual Studio toolbox: Right-click in the Topobase tab of Toolbox and click Choose Items.
2. In the Choose Toolbox Items dialog box, click the Browse button.
3. From the *Topobase Client /bin/* directory select *Topobase.Forms.dll*.

You can then add Topobase buttons to the form and arrange them as appropriate. An example is shown at right.

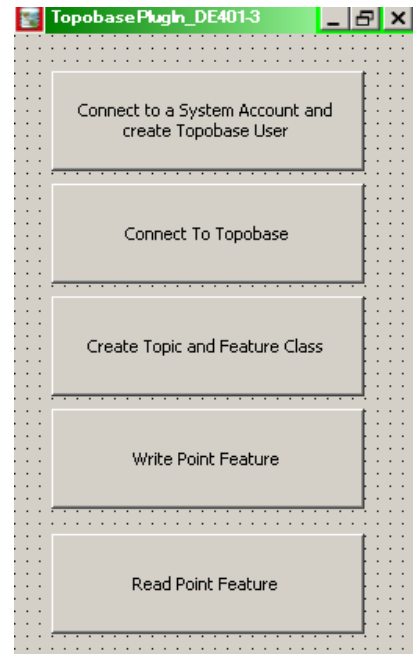


Figure 9. Sample Topobase form

Adding the Plug-in Menu to the Application Menu

You need to add a menu item in order to activate and display the form. In the class MyApplicationPlug-in, declare and create a menu item as follows:

```
public Topobase.Forms.MenuItem myMenuItem = new  
Topobase.Forms.MenuItem();
```

You then need to override the ApplicationPlug-in.OnInitMenus() method in the class MyApplicationPlug-in in order to add the plug-in's menu in the application menu. The code is as follows:

```
public override void OnInitMenus(object sender, public  
override void OnInitMenus(object sender,  
Topobase.Forms.Events.MenuEventArgs e)  
{  
    // Add menu item to application menu.  
    Topobase.Forms.Menu menu =  
e.Menu.Item(Topobase.Forms.ApplicationMenuType.Tools);  
    menu.MenuItems.Add(myMenuItem, " TopobasePlugIn_DE401  
");  
    myMenuItem.Click += new  
Topobase.Forms.Events.MenuItemClickEventHandler(myMenuItem_  
Click);  
}
```

The handler function myMenuItem_Click will respond to a click on the menu item myMenuItem and bring up the form. The following is the code for the MenuItem_Click function:

```
private void myMenuItem_Click(object sender, private void  
myMenuItem_Click(object sender,  
Topobase.Forms.Events.MenuItemClickEventArgs e)  
{  
    // Bring up the dialog box.  
    TbApplicationForm theForm = new TbApplicationForm();  
theForm.Show();  
}
```

Testing the Plug-in

The final step is to test the plug-in:

1. In Visual Studio, build the solution and start Autodesk Topobase Client.
2. In the Topobase Login dialog box, click Options. Verify that the Topobase credentials are correct. For example, ensure that the default user name is TBSYS, the password is TBSYS, and the service name is orcl. Then click Connect.
3. In Open Workspace dialog boxIn this case, you don't need a workspace, so click Cancel.

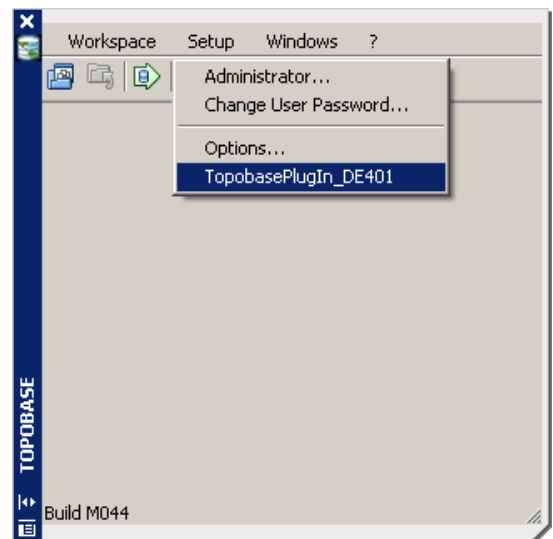


Figure 10. Topobase custom plug-in

4. In The Topobase task pane, click Menu Setup. The customized menu TopobasePlug-in_DE401 is displayed. Click it to open the form defined.

Conclusion

Infrastructure design and management affects all facets of infrastructure organizations. Most organizations today create and manage design and spatial data using disparate applications that generate data in proprietary formats and store data in independent, isolated databases. Lack of integrated asset management can result in duplicate work, increased risk of errors, a lack of visibility into assets as a whole, and a myriad of time-consuming workarounds, such as data conversions. Autodesk Topobase provides the architecture, components, and technology features that enable organizations to overcome these challenges and get a comprehensive view of the complete asset base. But the benefits do not stop here. By creating custom plug-ins, organizations can extend and customize Topobase to fit their specific needs.

Resources

Autodesk Developer Network

Whether you are a commercial or individual software developer, Autodesk Developer Network (ADN) membership provides the business, software, support, and training you need to meet your customers' needs. ADN provides valuable resources, whether you are developing boxed solutions, custom applications, or tools for internal use; providing consulting and systems integration services; performing research; or writing or publishing learning materials.

The Autodesk Developer Network includes API training programs on Autodesk Topobase. For more information visit www.autodesk.com/adn.

Learn More

For additional information about Topobase, visit the Topobase www.autodesk.com/topobase.

To learn more about enhancing the performance of Topobase, visit the Topobase Insiders Blog at topobaseinsiders.typepad.com.

Additional information about tuning Oracle can be found at www.oracle.com.

Autodesk, AutoCAD, Autodesk MapGuide, and Topobase are registered trademarks or trademarks of Autodesk, Inc., in the USA and/or other countries. Oracle is a registered trademark of Oracle Corporation and/or its affiliates. All other brand names, product names, or trademarks belong to their respective holders. Autodesk reserves the right to alter product offerings and specifications at any time without notice, and is not responsible for typographical or graphical errors that may appear in this document.