



Comparing Autodesk Civil 3D 2005 and Bentley GEOPAK

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Executive Summary

Bentley's GEOPAK[®] Civil Engineering Suite is a modular software package for roadway design that is widely used by Departments of Transportation in the United States. Bentley currently develops and has recently purchased many other design software products. Though not as widely used, Autodesk[®] Land Desktop provides tools similar to those in GEOPAK. New Autodesk[®] Civil 3D[™] software—a dynamic, model-based design application—is geared to replace GEOPAK as the software of choice for road and corridor design.

- Bentley has shown no sign that they intend to develop a single civil design solution to replace their current products. Instead, it appears that they will develop all civil products to the point where they look and feel like the same product.
- In contrast, new Autodesk Civil 3D software provides a complete civil engineering solution in a single application.
- GEOPAK uses Microstation[®] software as its CAD engine for road and site design and uses an external binary file called the GPK file for storage of design data.
- In contrast, Autodesk Civil 3D is fully integrated into Autodesk Map[®] 3D using AutoCAD[®] software as its CAD engine. All project design data is stored with the drawing.
- GEOPAK uses coordinate geometry tools to calculate and store design elements in the GPK file. Although this mechanism allows elements to interact with each other, this interaction is not dynamic.
- In contrast, the dynamic corridor object in Autodesk Civil 3D dramatically streamlines the design process by greatly simplifying changes.

This white paper covers the major differences between Autodesk Civil 3D and Bentley GEOPAK. Although both products can produce design plans, Civil 3D enables far greater accuracy and productivity than GEOPAK software.

Introduction

Bentley provides several civil engineering solutions. The GEOPAK Civil Engineering Suite is a modular package used primarily for roadway design. Three add-on modules—GEOPAK[®] Site, GEOPAK[®] Bridge, and GEOPAK[®] Survey—require a licensed installation of MicroStation[®] software.

Bentley also provides other products, such as InRoads[®], MX (Infrasoft), Civil Extension for InRoads, Civil Extension for GEOPAK, Bentley[®] PowerSurvey[™], and Bentley[®] PowerCivil[™]. PowerSurvey runs on top of Bentley[®] PowerDraft[™] and does not require a MicroStation license. GEOPAK[®] Survey[™] and PowerSurvey are basically the same product. PowerSurvey originated from GEOPAK's acquisition of C & G Software. PowerCivil is a civil engineering design software program for land planning, land development, and site modeling. As a stand-alone product, it does not require a CAD platform to operate and uses native DGN[®] and DWG file formats. According to Bentley sales personnel, PowerCivil is more directly comparable to Autodesk[®] Land Desktop than GEOPAK.

Nothing indicates that Bentley has any intention of developing a single, comprehensive civil design product. It appears that their strategy is to develop all civil products to the point where they look and feel like the same product.

Over the past 18 years, Autodesk's civil-engineering solution has evolved from DCA Software to Softdesk[®] to Autodesk Land Desktop 2005. Autodesk's latest civil engineering application is Autodesk Civil 3D software for subdivision design, site design, and road or corridor design.

Because Autodesk Land Desktop and Autodesk Civil 3D software operate side by side, functions such as pipe design can still be done in Land Desktop. Autodesk will continue to develop Land Desktop until Civil 3D becomes a complete replacement product. Even in its current state, however, Civil 3D software provides many advantages over any other civil design application on the market today.

The following table shows the modules in the GEOPAK Civil Engineering Suite and the corresponding tool in the current Autodesk product line.

GEOPAK Modules and the Equivalent Autodesk Tool

GEOPACK Feature	Autodesk Product
Digital Terrain Modeling	Autodesk Civil 3D surface object/Land Desktop terrain model
Geometry	Autodesk Civil 3D alignments object/Land Desktop alignments
Cross-Sections Earthworks	Autodesk Civil 3D corridor models/Land Desktop cross sections
Plans Production	Similar to Autodesk Land Desktop Sheet Manager tool
Design and Computation Manager	Combination of tool palettes and Detail Manager
Geotechnical	Points and XDREFs (not a complete equivalent)
3D Modeling	Corridor model, camera, and flyover
Drainage	Autodesk Land Desktop hydrology tools
Water and Sewer Layout Analysis	Autodesk Land Desktop pipe tools

When comparing two similar products, especially competing products, it's easy to find many minor differences. Even AutoCAD® and Autodesk Land Desktop software provide many ways to perform the same operation. Autodesk Civil 3D not only offers advantages in its day-to-day tools but provides tremendous time savings in corridor design. GEOPAK software is for transportation network design and is used primarily by state and federal Departments of Transportation (DOTs), or by civil engineering firms that provide design services to DOTs. Civil 3D software's corridor design tools are the most powerful tools to date for designing any type of corridor. In this paper I focus on the major differences between Autodesk Civil 3D software and Bentley GEOPAK Civil Engineering Suite, particularly on project and drawing setup, general object creation, corridor design, design and drawing standards, labeling features, and survey features.

Project and Drawing Setup

GEOPAK uses the MicroStation CAD engine for graphical road or site design. The elements in the drawing (DGN) file are the primary source of information. To start the design process, you must have a DGN file open and choose the GEOPAK Suite from a pull-down menu. You then select the tools needed to perform the desired operation. Most of the tools in GEOPAK are accessed using icons or toolbars, thus requiring several steps just to get started. The toolbars take

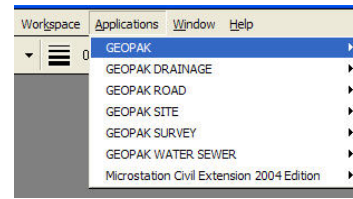
up a large portion of screen space, which may cause GEOPAK users to request multiple monitors to increase their drawing area.

The GEOPAK project includes not only the DGN file but also an external binary file called the GPK file for creating elements such as points, curves, spirals, chains (alignments), parcels, and profiles. When an element is created and stored in a GPK file, the design data is appended to the end of the file. The designer then uses this file throughout the design process and with the other software modules. Other team members can access this file to design their portion of the project.

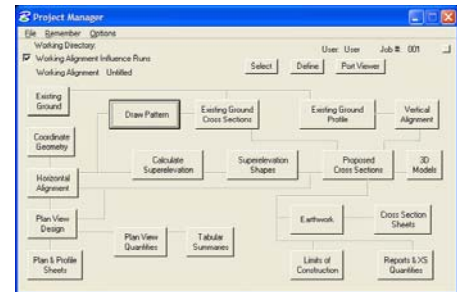
User preferences and working directories are accessible through pull-down menus and toolbars. The default variables for the user settings are stored in an external configuration file in the program installation folder. A company working for more than one transportation department or client would need separate configuration files for each. Because many transportation departments or clients have different GEOPAK setup, configuration, and criteria files, an experienced GEOPAK IT project administrator is sometimes necessary to ease project setup when switching clients. Generally, administrators set up GEOPAK projects by the state jurisdiction it is in. If a GEOPAK administrator is not available, the designer must manually replace the configuration file before starting a project. Alternatively, the company could have a general configuration file whose settings would be modified every time a new project is created. This process can be confusing and requires in-depth knowledge to set the application up correctly and efficiently.

Once a project has been created or opened, the Project Manager dialog box appears. It is designed to step a user through the design process.

Autodesk Civil 3D, which uses the AutoCAD engine, is fully integrated into Autodesk Map® 3D software. When Autodesk Civil 3D is launched, the designer is automatically in the application and does not need to load additional applications or licenses.



Pull-down menu to select the design tools. The flyout lists available toolbars.



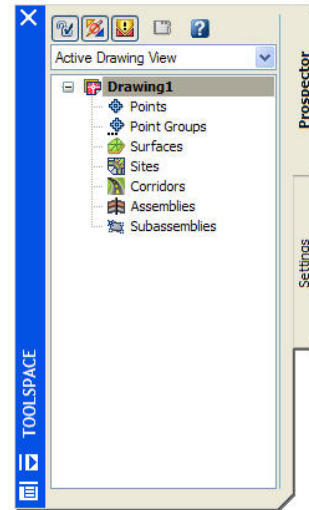
GEOPAK Project Manager

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The drawing file (DWG) in Autodesk Civil 3D contains graphical entities (elements) and design data. Civil 3D does not require external files to store the model; instead, the data is stored within the object itself. Objects are the main design elements and interact dynamically with each other. This capability is one of the major differences between Civil 3D and GEOPAK software. The graphical entities required to produce construction documents are essentially a by-product of the object and do not require any additional work.

All drawing and design settings are stored in a drawing template. To get started, the designer simply selects the appropriate drawing template or templates. As a result, Civil 3D is easy to set up and use. With minimal instruction, a CAD manager can get a company started using Civil 3D software right away.

Within a drawing file, the designer can modify the settings by using the modeless Toolspace dialog box, which provides easy access to all drawing and objects settings. It also provides an easy method for creating and editing objects in any open drawing. Users can even drag settings from one drawing to another. Collapsible dialog boxes keep the drawing space free from clutter. Having multiple monitors would be the exception rather than the norm with Autodesk Civil 3D.



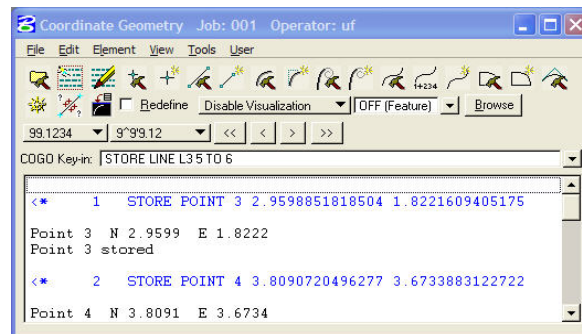
Autodesk Civil 3D Toolspace tab

General Object Creation

GEOPAK uses coordinate geometry (COGO) tools to calculate and store design elements in an external binary database (GPK file). This database is then used to calculate design information needed for the elements to interact with each other. During design, the user can edit and review this database. However, if any edits are made, the graphical elements must be reloaded into the DGN file. The interaction between the database and the graphical representation is not dynamic. If a change to an element affects any other object, then the affected geometry must be reprocessed—a multistep process that could require hours or even days of rework.

To create a design element (alignment, point, parcel, line, curve, and so forth) and store it in the COGO database, the designer must use GEOPAK drawing tools. GEOPAK tools are similar to MicroStation tools.

However, design elements drawn or edited with standard MicroStation tools do not update the GPK file. Users can key in the data to the COGO database, or they can use the tools from GEOPAK toolbars to automatically enter the data into the GEOPAK database. For the design elements to interact with each other, every entity must be in the database. This interaction, however, must be controlled by the designer. The data is displayed as shown in the preceding GEOPAK Coordinate Geometry dialog box. Notice that the COGO interface for reviewing data is not user friendly.

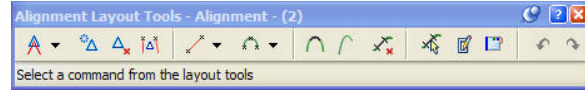


GEOPAK Coordinate Geometry dialog box

GEOPAK includes tools for drawing curves and lines that are tangent or have certain design criteria. However, once the entities are drawn and stored in the database there is no

mechanism to keep graphics in the DGN file from being modified, increasing the risk of errors on a project. Once the data is in the database, the designer can use GEOPAK's visualization mode to view the results of the data. This database also serves as the audit trail that enables designers to save and retrieve the data to restore design intent and review alternative designs. However, they must delete any entities in the drawing before doing so.

Autodesk Civil 3D software stores all the design data in the drawing itself. Objects such as alignments, parcels, profiles, and sections can be drawn using standard AutoCAD tools and converted to objects.



Autodesk Civil 3D Alignment toolbar

However, to take full advantage of Civil 3D software's capabilities, it is best to use the layout tools for each object. These tools enable users to draw a feature that maintains certain criteria. For example, objects designed to be tangent to one another maintain these characteristics, thereby reducing the chance for design errors. If an object requires modification, it can only be edited based on the design criteria. When the radius of a curve is modified, the geometry that defines the curve also changes. This dynamic approach maintains the integrity of the design and reduces design and drafting errors.

Autodesk Civil 3D objects are intelligent, interacting dynamically with other objects. For example, when an alignment intersects a parcel object, the parcel object is automatically subdivided into two parcels. When the alignment is modified, the parcels update automatically, eliminating the need to update each component individually and ensuring a level of quality control throughout the design process. In contrast, GEOPAK users must update or reprocess every component in the design. Deleting, trimming, and stretching lines can take many hours or even days. In Civil 3D an adjustment to any component is automatically replicated throughout the design, including labels and tables.

To create a design feature in Autodesk Civil 3D, the designer accesses the command from the pull-down menus and, depending on the method, uses a toolbar to create the desired feature. Some features can be created using the Toolspace dialog box. All features can be edited by right-clicking the object and choosing Edit. The straightforward interface and object technology in Autodesk Civil 3D means the user can easily explore multiple design alternatives in a single drawing session.

Corridor Design

GEOPAK uses MicroStation drawing elements as the base data for corridor design. As in most civil engineering products, a road design begins with a horizontal alignment and a digital terrain model (DTM). GEOPAK provide tools to create the DTM as well as lay out the horizontal alignment, which is stored in the COGO database and then processed against the DTM to create a vertical profile. This existing ground profile is then brought into a drawing from the COGO database to create a proposed vertical alignment. The vertical alignment is also stored in the COGO database and is used throughout the design. However, if either of these elements are modified, the designer must reprocess the information.

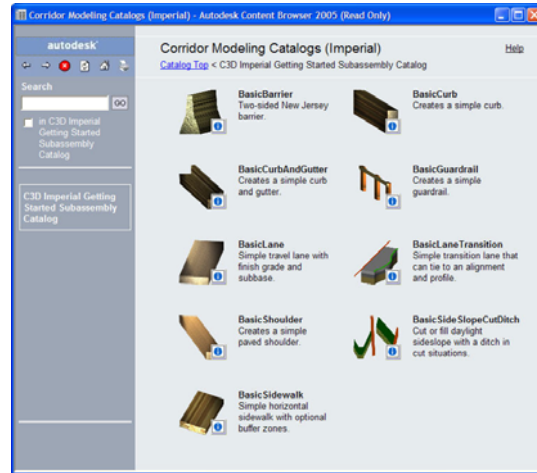
Existing ground cross sections are created using pattern lines—MicroStation lines stored in the COGO database. GEOPAK includes tools to create them automatically, or the designer can draw them manually. The proposed sections are computed from the graphics stored in the COGO database. Geometry for each component of the road must exist in the COGO database for the proposed cross sections to be displayed properly. The geometry also must have the proper characteristics applied. This is where the Design and Computation Manager is most important.

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GEOPAK software includes many tools for reviewing and editing geometry, such as tools to create medians, tapers, and pavement markings. However, the COGO database must contain all the design data. If any part of the design is modified, the remaining features must be reprocessed.

In sum, designing a corridor in GEOPAK requires many steps. Working with the COGO database can be time consuming.

Autodesk Civil 3D uses objects to create all types of corridors—subdivision roads, major highways, irrigation channels, and even railroads. The basic concept is the same as most civil design software applications, but the application in Civil 3D is by far the most comprehensive and simple. All the applications reviewed here required a horizontal alignment and DTM. With Civil 3D the difference is that all these components are dynamically linked. The horizontal alignment and DTM are both objects used to create the vertical profile. If either one is modified, the terrain profile is updated automatically. Creating the design profile for the corridor is done using a Profile Layout tool that has the same general features and functionality as the Horizontal Alignment Layout tool.



Autodesk Civil 3D Corridor Modeling Catalogs

The 3D corridor model consists of multilayer design cross sections connected by longitudinal feature lines. The model is created by extruding design assemblies that represent the engineering requirements along the road. Each assembly is built from subassemblies that contain design intelligence such as conditions that would mandate the use of a ditch or wall, or widening a lane. The subassemblies are predefined and are accessible from an easy-to-use catalog. They can be customized and new ones added to the catalog. The assemblies are also objects, changes to which dynamically update the entire corridor. Because the assembly is dynamic, the designer can swap out one subassembly for another. This simple change is reflected in the design cross sections and even the proposed finished ground surface. The application ships with subassemblies for rehabilitating roads, designing new roads, and even designing rail corridors.

Autodesk Civil 3D also enables designers to extrude the assembly along an alignment at a frequency that they control. The result is a model that reflects all associated design criteria. At any time, designers can generate output such as plotted cross sections directly from the corridor model. This process enables users to create an extremely accurate model for generating proposed surface contours, volumes, output to construction equipment, stakeout points, and visualization, yet still have the ability to plot construction sections at an increment that they determine. For example, designers can model the road based on a 5-foot increment, but then plot sections at every 50 feet.

In Autodesk Civil 3D, users have several options for reviewing and editing corridor design. Since the model is in 3D, not only can it be used to report volumes and quantities but it can also be easily rendered for presentation purposes.

Design and Drawing Standards

GEOPAK uses the MicroStation *Seed* file to establish the DGN-specific settings. The Design and Computation Manager determines the settings for the presentation of the design elements. It is also determines what items are billable and calculates the quantity. It stores not only the display properties of an object but the design property standards as well. This information is stored in a hierarchical database that can be organized to fit the needs of a project or comply with company standards.

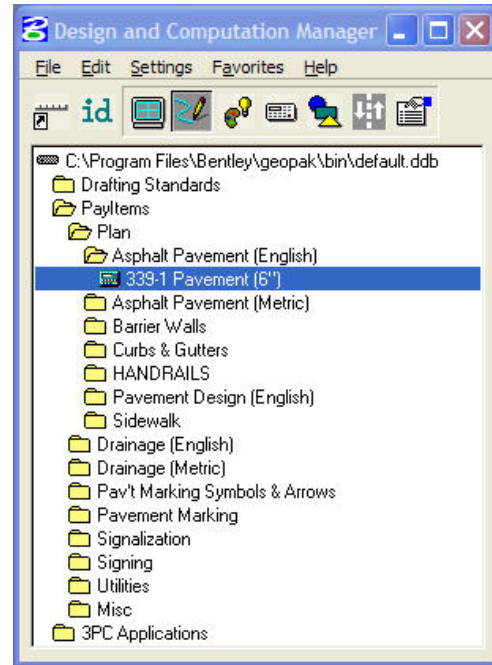
GEOPAK ships with a standard sample database. Most firms that use GEOPAK are required to do so by their local DOT projects. Most DOTs provide this database to the engineering firm to use in their design. Some DOTs may lock this database so the designers cannot deviate from the standard. However, a locked database becomes an issue for a project that requires a nonstandard design. For example, in Virginia the state owns most of the roads and sets the standards. However, if an urban project requires an eight-inch-wide curb, the designers must draw it manually because that item does not exist in the database. As a result, the software cannot calculate the quantity of curbing.

Making the task of locating objects even more difficult, the Computation Manager is set up using folders and subfolders that users must navigate to find what they are looking for.

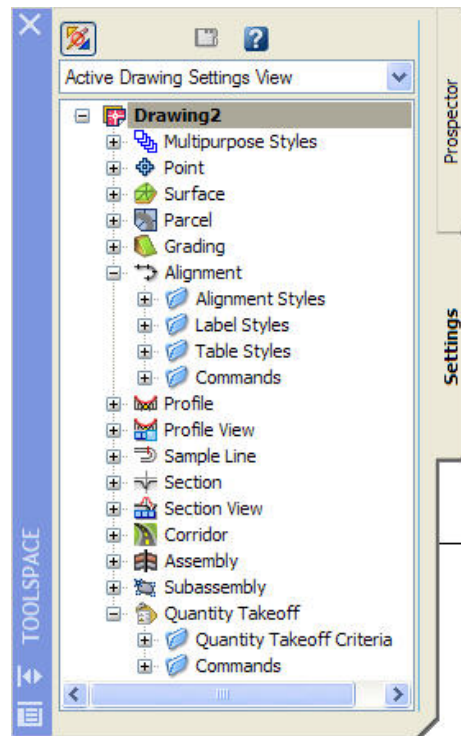
Autodesk Civil 3D uses the AutoCAD drawing template (DWT) to establish all drawing and design settings. Civil 3D objects use styles for design criteria and display representation. Each object has a style for properties as well as labels. All the styles are stored in the DWT.

When a user creates an object in Autodesk Civil 3D, a style is assigned to the object. The style controls the object's display characteristics. Some objects have design criteria that are also stored in the style. The designer can apply a style when the object is created and then change the style to a finished plan style to show more detail in construction documents. This capability enables the user to design without having all the labels or other information displayed. When the time comes to label the object, the designer simply changes the style.

An Autodesk Civil 3D object typically has an object style and a label style. Some objects have additional styles as well. For example, an alignment object has an object style, label styles,



GEOPAK Design and Computation Manager



Autodesk Civil 3D Toolspace Settings tab

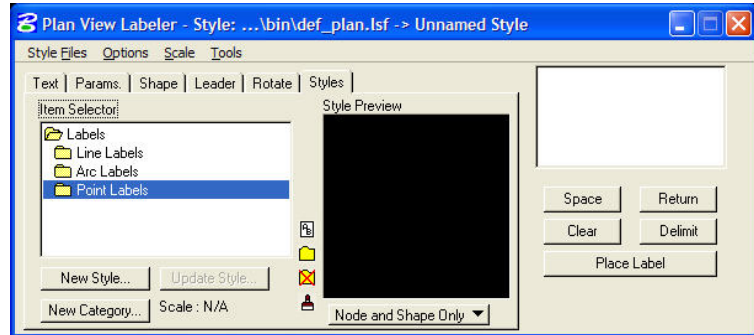
and a table style. The styles have settings for every component of the object.

Styles can be locked at different levels so that they can't be modified. The styles are also stored with the drawing template and enable any designer to work on any project with any design and drafting standard without having to modify the program setup or configuration. Styles can even be dragged from one drawing to another.

Labeling Features

GEOPAK provides tools to label designs for plan production purposes. The labels are set up and defined as styles that are then applied manually to the drawing geometry.

The Design and Computation Manager, along with the COGO database, aids in the labeling process. However, if any component of the design is modified, labeling must be reprocessed.



GEOPAK Plan View Labeler

Although the labels pull data from the database and the styles defined in the Labeler, GEOPAK software requires the designer to go through the labeling process. This labeling process can eat away at the project budget, and if the design changes, the labeling must be updated. Missed or inaccurate labels are a major factor in project errors and budget overruns.

Autodesk Civil 3D objects all have defined labels styles that can be stored in the drawing template. These labels are dynamically linked to the object, updating automatically if the object changes.

When designers create an object, they can attach labels to the object or they can create them later. This capability provides a simple mechanism to apply a design label style during the design phase and then simply change the style for construction documents.

Labels that update automatically help to eliminate many common errors in construction documents. By virtually eliminating the need to label objects manually, Autodesk Civil 3D software helps designers significantly reduce the errors that can cause cost overruns and problems in the field.

Survey Features

GEOPAK includes tools to edit and process survey data. The Survey Manager provides access to survey data in the COGO database and imports the survey data into the MicroStation file. The software enables users to create files for input into the DTM and provides an interface to import the survey data into the DGN file and a mechanism for editing points and alignments.

Autodesk Civil 3D software can import ASCII point data into a drawing. Trimble and Carlson are both working to provide tools that support the processing of survey data in Civil 3D.

Conclusion

The goal of this paper was to show the major differences between Autodesk Civil 3D and GEOPAK software. Both applications can produce the required information to design and build a transportation corridor. Civil 3D, however, has some distinct advantages. Although GEOPAK does provide a mechanism for the design elements to interact with each other through the COGO database, these elements are not dynamically linked as they are in Civil 3D. This dynamic interaction is what sets the products apart. The corridor model in Civil 3D software significantly reduces what can be a day-long project in GEOPAK. Furthermore, Civil 3D also provides a rich toolset and intelligent objects for land development projects, whereas GEOPAK is geared almost exclusively toward transportation design.

GEOPAK operations relies on dialog boxes, which take up a large amount of the drawing area. Moving between the drawing elements and the COGO database requires a lot of manual operations. In contrast, the Autodesk Civil 3D interface is straightforward and easy to use.

Both GEOPAK and Autodesk Civil 3D software require some setup time to configure the criteria files, styles, and other required files. However, the setup time and maintenance of Civil 3D is easier because most of the settings are stored with the drawing templates. There are also many localized style sets available for Civil 3D in different parts of the world. GEOPAK's criteria files and configuration files in some cases require a certified IT expert.

Autodesk Civil 3D provides more capabilities than GEOPAK for designing corridors. It is easier to set up, learn, and use. It is exciting, new technology that is going to change the way engineering firms operate. Implementing Civil 3D software requires forethought and planning, but the benefit is an almost immediate return on investment.

autodesk

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