

# Autodesk Civil 3D versus Bentley MX Software

## Executive Summary

This white paper compares two generations of software technologies. Bentley® MX, developed some 30 years ago and based on core technology written in the FORTRAN programming language used for mainframe computers at the time. The other, Autodesk® Civil 3D®, introduced in 2003 and designed to take advantage of all contemporary and future computing technologies such as dynamic 3D modeling, a graphically rich user interface, .NET development platform, 64-bit systems, and more.

These two design software packages have similar purposes but deliver functionality in different ways. This white paper discusses how MX and Civil 3D meet the business and technical requirements of design offices. If you work in the infrastructure design industry and feel increasing pressure to do more with less, then you have probably considered ways to meet these demands and stay competitive. It is not unusual to turn to technology for answers. Technology presents many opportunities, and the marketplace rewards those who are able to take advantage of technological advances.

The design industry is one of the most demanding when it comes to computer technology and design software in particular. All design firms are committed to the process of evaluating, revising, and deciding when and how to implement the best solutions available. In the process of evaluating and revising technology, how often do you ask the following questions about design software?

- Am I using the latest in design software technology?
- Is my system scalable enough to support varying project requirements?
- Does it provide the optimal environment for design team collaboration?
- How do designers spend most of their time? Developing the best possible design or doing file management, using text editors, and checking the drawing files after design changes?
- What is the cost of exchanging data between the design and drafting teams on each job, and how do late design changes affect profit margins?
- What is the future of my system? Will it keep growing with advances in technology and keep my firm at the forefront of the industry?

If these questions sound familiar, it's time to look at a new class of design software developed to address the needs of today's design industry, Autodesk Civil 3D.

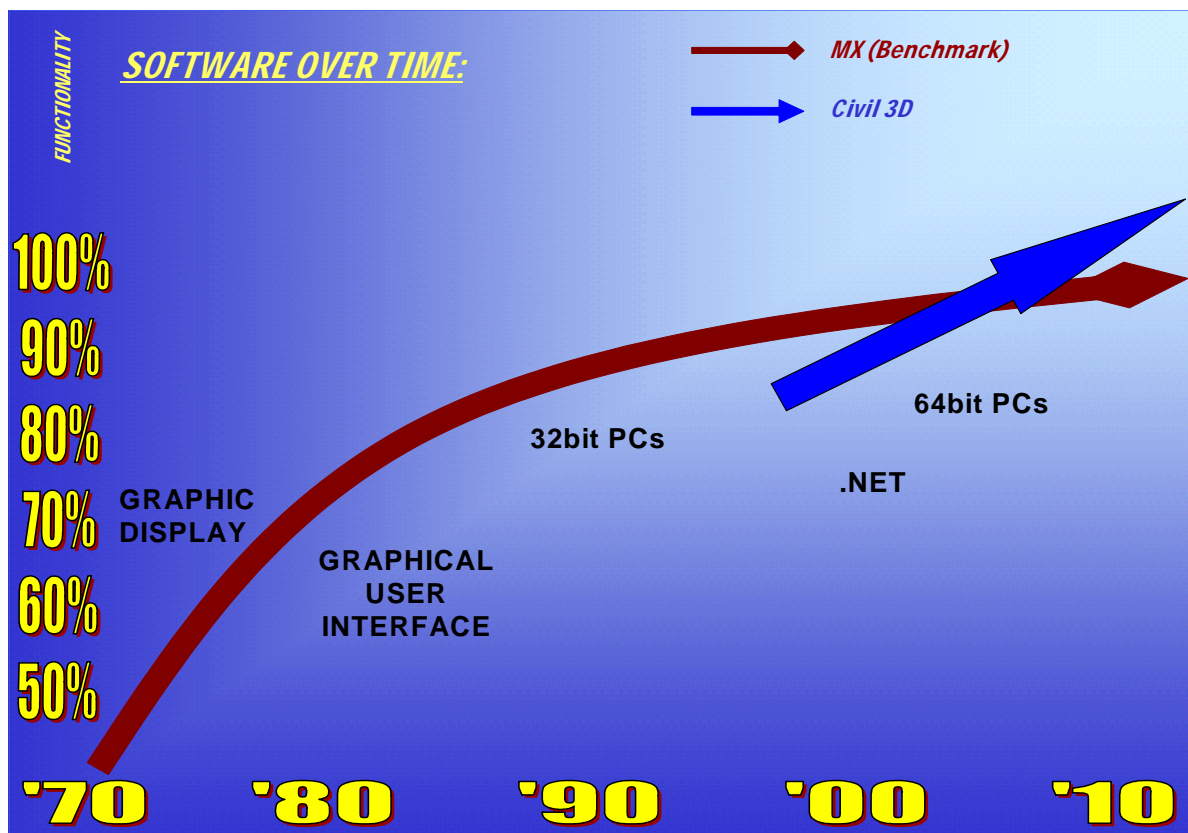
# Autodesk Civil 3D versus MX as Part of a Corporate Design Solution

## Design Software Technology

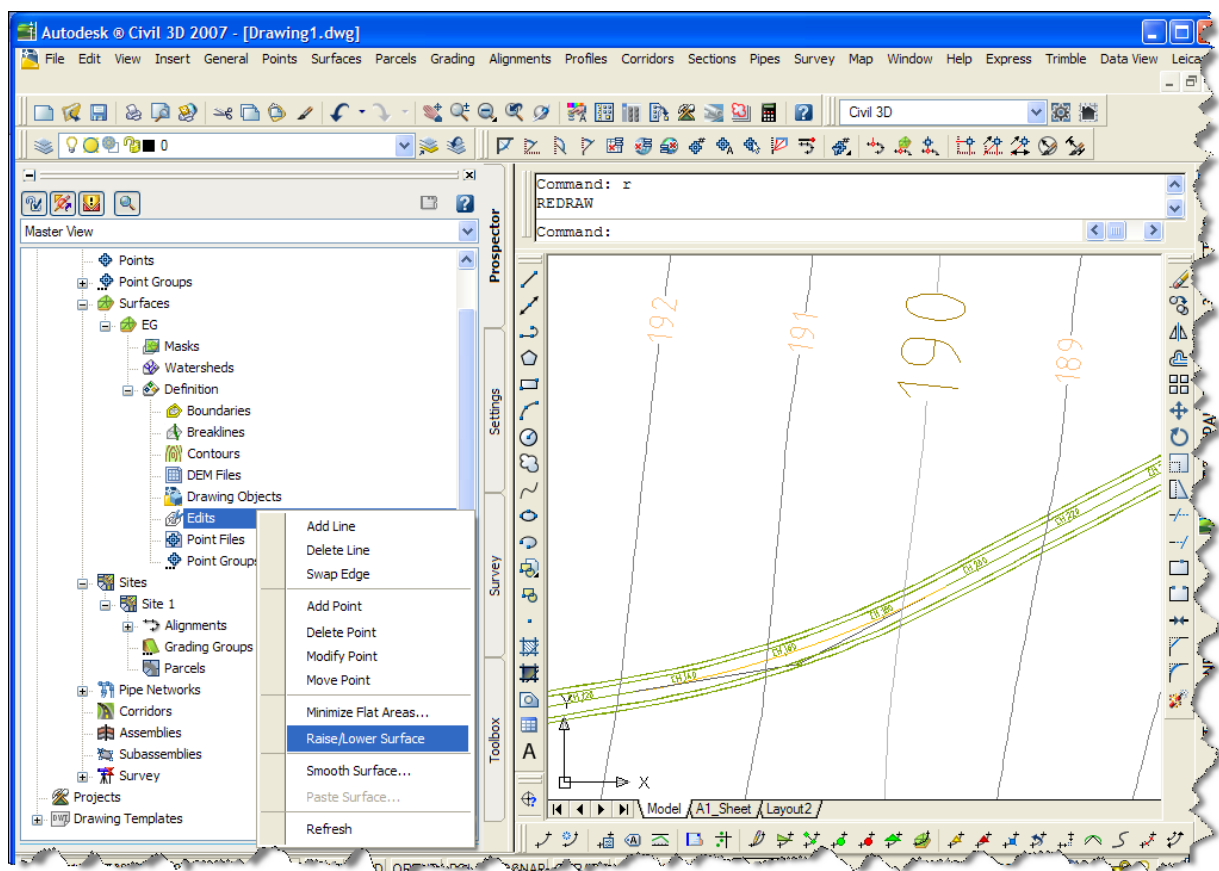
Software depends on underlying technology to deliver the best possible solution to its users. New functionality can be added to the software when new technology becomes available. For example, graphical presentation of data on computer screens became available only after the invention of graphical display processors and video cards. Before that users could display only textual information. Easy-to-learn programs with icons, menus, and graphical onscreen controls became available when the Microsoft® Windows® operating system was developed.

Software development can be a plateau of productivity until a new wave of technologies propels it to the next level. However, this cycle is self-limiting because software relies on the legacy components at the core of its system. It is those core technologies that eventually make it harder to maintain the product. Eventually, the software reaches the point where only a complete rewrite can take full advantage of new technology.

The following graphic shows a simple historical analysis of the two different cycles of Bentley MX and Autodesk Civil 3D:



Over the past decades, Bentley MX has implemented new technologies, and every new technology provided a boost in performance. However, the ability to take advantage of new technologies diminishes for a product that was developed decades ago in the programming language of the time. One way to take full advantage of new technology is to completely rewrite existing software or create a new product based on today's technology and programming languages. Autodesk Civil 3D software has done just that. It implements the latest Windows-based technology and programming languages, and delivers the best combination of powerful features and a user-friendly interface for comfortable use and fast learning. This software is model based, object-oriented, and driven by styles. Autodesk Civil 3D implements logical, hierarchically structured features for the user interface, program settings, and design data, which it creates in a consistent way across the product. Users can control elements such as object styles, command parameters, and design labels either globally, accessing the top-level settings, or individually, modifying only the affected objects.



MX is also model based, but it is not object oriented. MX relies on design database files created in the background as the result of running functions and entering design parameters. Editing of design data relies on rerunning the whole set of instructions to re-create the model and database files. The drafting must then be updated as well. Even with the latest versions of MX, design changes have to be registered with the CAD objects and the drawing must be updated. In Civil 3D, design objects are CAD objects.

The main advantage of an object-oriented system is that the relationships between objects and constraints on design parameters are maintained by the software and not by the operator. This results

in greatly reduced time required to synchronize related components of the engineering model and produce the final output, automated synchronization between design and drafting, and overall improvement of project data integrity.

## Design-CAD Integration

Even though the MX interface is quite advanced, high productivity levels can be achieved only through the use of input files. Some users save the sequence of instructions in a Journal file. This file must be edited and its syntax corrected to be used as an input file. This technology was necessary because users had to rely on interpreting the output data to decide whether changes were required in the input data to recalculate the design. Another requirement for batch input files is the need to update all related strings after the master string is changed. The successful implantation of this process relies extensively on the knowledge of a few highly skilled, specialist operators, who understand the syntax of the input file command language.

MX still relies on CAD software to complete the design process. This is overhead in more than one way; even Bentley calls it the *CAD tax*.

The most recent versions of MX are integrated into MicroStation® software—Bentley's CAD application—but this is good news only for MicroStation users. Many MX users may need to learn new methods and be retrained. One obstacle is changing the way they work, using the familiar, but significantly modified tool set.

Many MX users use AutoCAD® software for their CAD work and require it to complete design documentation. It may be that for those users, relearning MX integrated into MicroStation will be a bigger challenge than learning how to use AutoCAD-based engineering design software.

Civil 3D uses the CAD environment in a way that enables designers to manipulate CAD objects without calling any functions from the menu or command line. This is possible because those CAD objects are design objects. Changes to design objects automatically update any annotation objects or labels. Production drafting sheets that reference those objects automatically update as well. The system is designed to integrate objects, labels, schedules, drawing sheets, and visualizations into a seamless project model.

## Project Collaboration and Data Management

Collaboration on an MX project is achieved by introducing the input files from the work done by a team member and using the text editor to introduce it into the master input file. Extremely careful file management must be instigated at the inception of every project. This process can be complex and time consuming on a larger project. MX users have indicated that file management and manipulation can take a significant amount of their design time. The use of input files for collaboration requires following string naming conventions, which have strict limitations in terms of the number of characters, making it very difficult for the non-expert user to interpret the meaning of existing strings and comply with the convention for naming new strings.

Optional project collaboration tools can be added to MX software, but at considerable additional cost. Even these tools only really add control and management of the files and models involved in existing workflows; they do not add true multi-user capabilities. The collaboration tools developed for MX were designed to support a single user, engineering design system developed decades ago. Since MX is changing, even the existing implementations of those components may have to be replaced.

Civil 3D, on the other hand, has integrated data management and project collaboration components that enable project managers and users to share design objects and receive instant notification of a change to a referenced component. These notifications are not delivered through messaging or email

systems but directly via the user interface by simply changing the color of the flag displayed on screen next to the shared object. As a result, more than one designer can work on the same job at the same time, ensuring all team members are working with the most up-to-date, accurate project data.

Major benefits that Civil 3D delivers through its project collaboration features include the following:

- Synchronization of design and drafting components throughout all project phases and across multiple project drawings.
- Real-time multi-user access to both design and drafting components.
- The ability to control versioning of data and drawings with easy roll-backs to a previous revision. Documents created with Microsoft® Office are also supported.
- Easy archiving of completed projects.
- User-level access control. Administrators can set a group or individual role policies. Restrictions to data access are used to control data security and eliminate accidental modifications.

Design teams require data from major data repositories. Geographic information system (GIS) data stores contain valuable data that can be used on the project. Civil 3D is able to reference GIS data by importing and exporting data extracted from a GIS or by establishing a direct link to data stores for interactive viewing or editing of objects. One such example is connecting to ESRI® ArcSDE® software with either an Oracle® or an SQL Server, without the need for buying expensive additional software.

### Scalability

A flexible system that works for either a single user or a large design team is one of the requirements that can be delivered only by a modern system.

For many years, this requirement was met by splitting the software's functionality into smaller (and less expensive) modules. To complete the solution, users had to purchase all modules, particularly larger organizations where teams are multidisciplinary. So the question remains: who benefited the most from modular solutions? The users or the vendors?

Civil 3D solves the scalability requirement in a different way. A single version of Civil 3D delivers the full set of functionality that any design office may need, including the following:

- |                         |                                  |
|-------------------------|----------------------------------|
| • CAD                   | • Pipe networks design           |
| • GIS and mapping       | • Plan production and publishing |
| • Survey analysis       | • 3D visualizations              |
| • Site modeling         | • Network licensing              |
| • Corridor-based design | • Data and document management   |

As a result, users have the choice to implement this system in a way that best suits their needs and later extend it to the next level without having to purchase more software.

So scalability is achieved through different implementation models. For example,

project collaboration tools do not have to be deployed until they are needed. However, they are a standard part of the system and not an optional extra. Live data exchange with GIS systems such as ArcSDE can be implemented when the supporting infrastructure is in place and the work processes have been developed to take advantage of this component.

No time or resources are wasted on components or procedures that have to be reconfigured, replaced, or phased out. Civil 3D allows for a natural migration to the collaborative level by publishing required components from drawing files. Companies can start small, implementing the one designer-one project-one model environment and then start publishing components of that model as the project grows or more designers join the team.

## **What the Future Holds**

It would seem that many MX users should feel uncertain about what the future holds for their design tool. Will Bentley continue to develop the software? If so, will the new technology look and feel anything like the Bentley MX software of today? In the long term, will MX users have to learn a new system? When will this all happen? What does the future hold for MX users? Only time will tell.

These questions about what the future holds for MX users may have many MX users looking to Autodesk Civil 3D. Civil 3D software is one of the most modern and capable dynamic 3D modeling software products available today.

## **Conclusion: Civil 3D vs. MX as Part of a Corporate Design Solution**

Technology plays a key role in staying competitive in today's world. Design software needs to be built on the latest technology and that means utilizing dynamic 3D modeling. Time is money and that means your design teams need parallel access to design data throughout the entire project cycle. Bentley MX software's core technology was developed some 30 years ago whereas Autodesk Civil 3D is new, dynamic 3D modeling technology. As an object-oriented design system, Civil 3D delivers on the promise of CAD and design integration, project collaboration, and electronic data management in a multi-user environment. On the other hand, with Bentley MX software, design changes have to be registered with the CAD objects and the drawing updated.

Autodesk is the fourth-largest software developer in the world, a \$1.5 billion a year company that invests an average of 20 percent of its revenue in research and development. That translates to \$300 million a year, which is almost as much as the annual revenue of its closest competitor. Autodesk's commitment to delivering the best possible design solution is huge.

More than 6 million design professionals worldwide use Autodesk software. More than 30,000 of those users have Civil 3D on their desktops, making it the fastest growing Autodesk product. Autodesk Civil 3D also has an established support system for its users including a Civil Engineering On-line Community (<http://civilcommunity.autodesk.com>), an active Discussion Group ([www.autodesk.com/discussion](http://www.autodesk.com/discussion)), and, as of October 2006, more than fifteen active Civil 3D blogs, both from internal and external sources, and that number's growing. On the other hand, MX users will have to search hard for a Bentley On-line Community, active discussion groups, and MX blogs.



# Civil 3D versus MX as a Technical Design Solution

Imagine a design system that can take information from virtually any source and turn it into a reusable information resource you can share throughout the whole project lifecycle. Imagine a design system that can bring together an extended team of surveyors, land planners, engineers, designers, and drafters and help them synchronize their efforts, even work on parts of the same project at the same time while being aware of any changes made by other members of the team in real time.

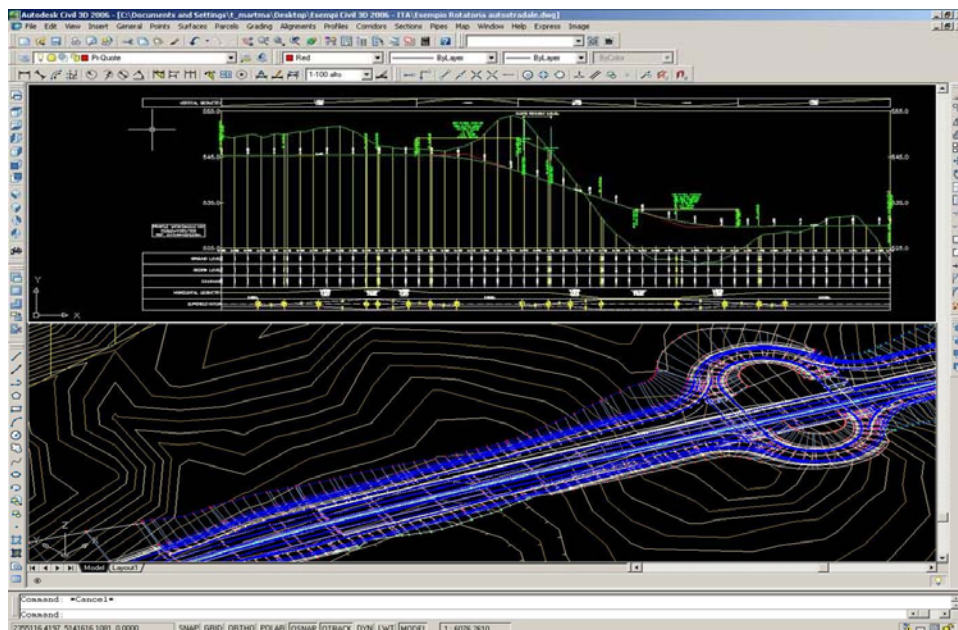
Imagine no more, Autodesk Civil 3D is that design system. It is model based, object oriented, and driven by styles.

## Model Based, Object Oriented, Style Driven

**Model based** means that the final product of the design project is an interactive engineering model that designers can use to derive a set of drawings, generate reports for stakeouts, and extract data for machine-controlled construction. It can make both local and global amendments to any part of the model and automatically update all affected objects without re-creating the whole model, including labels and drawing sheets.

Civil 3D is **object oriented** because the main building blocks of the model are graphical, parametric design objects that follow the general design rules and constraints set by designers. Users can modify objects by simply clicking them onscreen and moving their components. These objects respect design constraints and display instant feedback about the current value of crucial parameters.

Civil 3D is **driven by styles** because objects are controlled by sets of parameters packaged in a style. Parameters can be changed individually, or the complete set can be changed by simply assigning a different style to the object. Users can modify the whole collection of related objects by simply amending the applied style's parameters. Civil 3D offers many styles that match local standards, and in fact offers



Profile of alignment through intersection drawn in an Italian style

country specific styles for the following: Austria, Czech, English UK, French, German, Hungarian, Italian, Japanese, Poland, Russian, Spanish, and English.

**Styles** play the most important role in the production and publishing of design drawings and construction documentation. Users have full control over what comes out on paper. The content, text heights, and layout styles are flexible. Once set up, the design drawings appear consistent and conform to exact drafting standards. Users simply decide which output style they want to use, and Civil 3D delivers the output they need. It's a common practice to output to one style for design check plots and to use a different style for final documentation drawings.

### **Annotation**

A high level of automation makes the production of project documentation easy: text and symbols scaling is set in the paper space viewport so all objects scale accordingly if users change the viewport scale. This concept also applies to rotation. If users need to display the north arrow pointing down, all affected labels rotate automatically without the user having to change anything in model space.

### **Dynamic changes**

Some Civil 3D features can be fully appreciated only through a live demonstration. One such feature is the ability of the ground surface to automatically update its contours as its highway component is moved away and the building platform's elevation is adjusted to balance the cut and fill volumes.

### **Project data sharing**

Using project data management and collaboration tools, points, surface models, alignments, profiles, and more can be published as reference data to any number of users. If the referenced component changes, all users receive instant notification and the graphical representation of that object updates along with any annotation. This is easy to achieve in Civil 3D because the 3D objects in the drawing *are* the design data.

To accomplish the same thing, MX users must deal with the string naming conventions, file management, and maintenance of the Journal or master input file, spending a lot of time away from the task at hand: improving the design model.

## **Feature Comparison**

Here is a comparison of some of the most prominent features of Bentley MX and Autodesk Civil 3D:

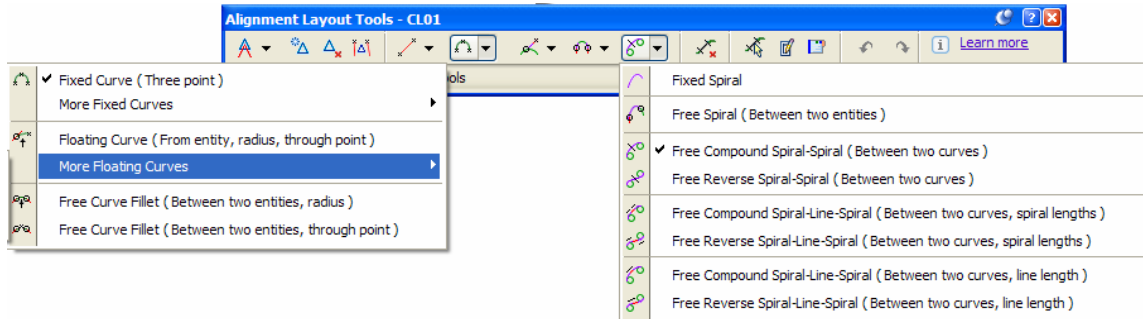
### **Surface Modeling**

Surface modeling and analysis is one of the fundamental elements of any design software. Even though MX has many surface model analysis tools, they are not dynamic and require that the user rerun a wizard if the surface changes. Civil 3D is able to display a predefined analysis method by simply applying the required surface style from the library. Any changes to the surface are automatically reflected in this display. Surface objects can be shared across the design team. A referenced surface can be displayed with any style. It does not have to use the same style as the source surface object.



## Alignments

Alignment design is another area that illustrates the differences between Bentley MX and Autodesk Civil 3D. Why? Because the functionality is similar but the experience of using them is completely different. MX users find it easy to understand the use of fixed, free, and floating element-based design options that the Civil 3D alignment layout tool provides. Once alignment has been defined, it can be edited by simply clicking a grip that represents a design constraint and dragging it around the screen. The software respects parameter value constraints, such as the radius snap. A curve can be stretched across the screen but its radius can change only by a predefined incremental value set by user.



MX has a powerful set of alignment design tools to tackle any horizontal alignment geometry job. It uses the fixed, free, and floating element design methods for flexibility. Civil 3D does that via a single set of tools used for both creating and editing alignments. The difference is that Civil 3D does it with an interface that uses dynamic labels for feedback and data grids for parametric editing, while updating the object on the screen at the same time. AutoCAD functionality, such as object snaps, is available. Alignment objects can be assigned the design speed parameter to automate the application of any preset roadway superelevation design standards and calculate the correct values based on the selected superelevation method. Earlier versions of MX supported AutoCAD objects, but it is not known how long this support will last. New MX developments focus on features supported in MicroStation only.

## Profiles and Longitudinal Sections

The preceding information about alignments also applies to profile or longitudinal sections design. There are fixed, free, and floating tangents and vertical curves with some specific constrained grip editing. But the best feature is the fact that once you learn how to use the horizontal alignment layout tool in Civil 3D, you also know how to use the profile layout tool because they are so similar. Options to control vertical curve lengths by specifying sight distances are another highlight of the profile layout tool in Civil 3D.

## Roadway Modeling

Roadway modeling and highway design features are historically the most used MX features. Designers can control any detail of the roadway components by defining a series of strings with independent or referenced alignments and profiles. The definition must follow strict naming conventions to retain productivity after design changes are made. This is where the use of batch file processing is important. The MX user can visualize sets of related strings describing multiple pavement layers, sidewalks, benches, ditches, medians, and so forth that need to be maintained and synchronized with the design changes of the master alignment and its single associated profile geometry. The relationships between them are maintained in the

batch input files, which must be rerun every time the master design string is edited. MX designers must maintain the relationships between the related strings manually.

Autodesk Civil 3D software uses a design object for roadway modeling. Because most Civil 3D objects are created as generic engineering design objects that can be used for any purpose, this object is called a corridor. Any shape that follows a baseline or alignment in general terms can be modeled with a corridor. Highways are one example.

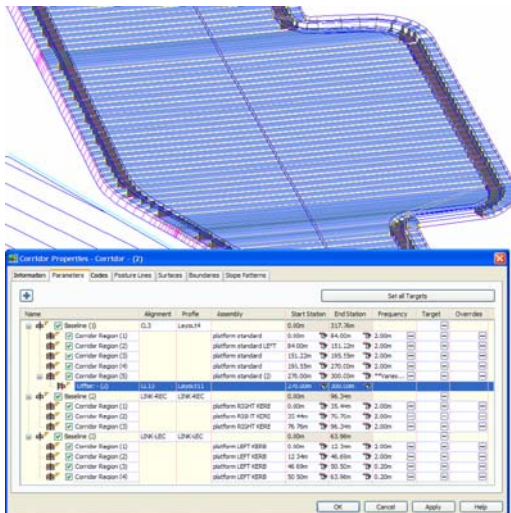
**Corridors** are 3D objects defined by horizontal alignments, profiles, and assemblies.

**Assemblies** play the role of a typical cross section on a project. Assemblies are collections of roadway components called subassemblies. **Subassemblies** are dynamic, intelligent objects designed to support the specific role that the roadway component modeled by the subassembly needs to play in a roadway model. For example, a bench needs to show up on the earthworks slope every time the height of that slope increases by 2m. So a subassembly has that logic built into its definition. Each subassembly can contain defined logic that responds to changes in the design model.

The logic that any subassembly brings to the corridor model is defined by its VBA (Visual Basic Applications) macro. All Civil 3D standard subassemblies are open source. There is the ability, through the API, to build your own subassembly to support any design requirement. This means that, although Civil 3D comes with a comprehensive library of subassemblies, users can build a design environment that has the potential to grow into a rule-based highway design system over time. The possibilities and potential are limitless.

After the correct set of subassemblies has been applied to a corridor, control of the model's details depends on the logic built into those subassemblies and the value of the user-defined parameters.

This technology can fully automate most roadway modeling functions. Subassemblies that define basic generic links can be combined with ones that have built-in logic to achieve virtually anything in a corridor model. Complex corridor models can be put together by combining multiple controlling strings and independently defined offset alignments, such as bus bays or parking bays, as in the following example:



## Intersection Design

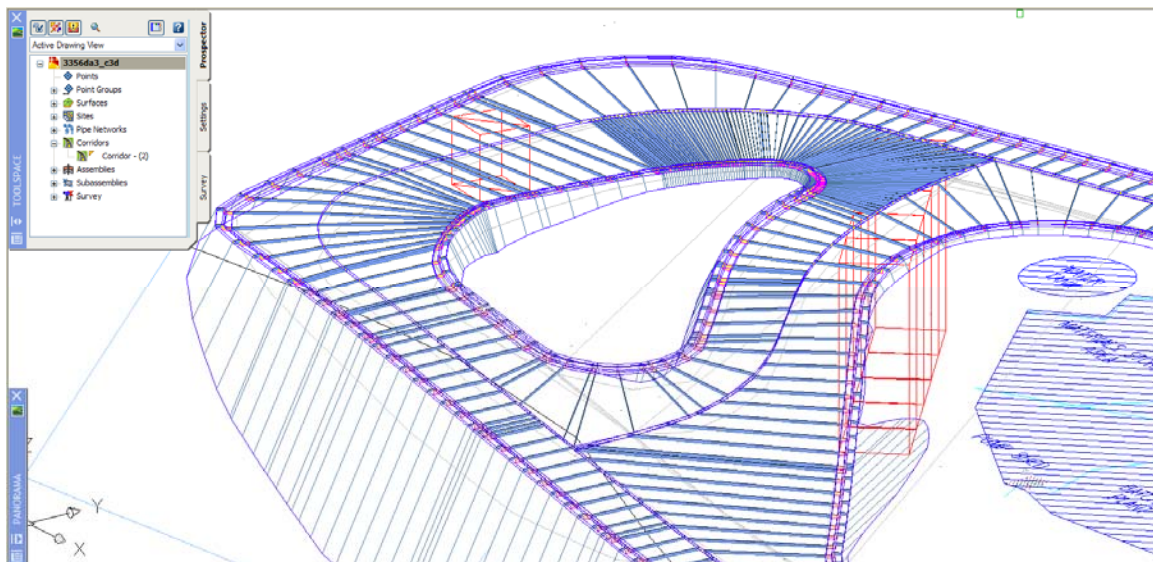
Intersection design is one of the major components of roadway modeling. Here, Civil 3D software's most complex features and sophisticated methods are shown to best advantage.

MX includes some design tools that can be applied for intersection design. However, the complexity of maintaining naming conventions and relationships between strings is the downside for Bentley MX.

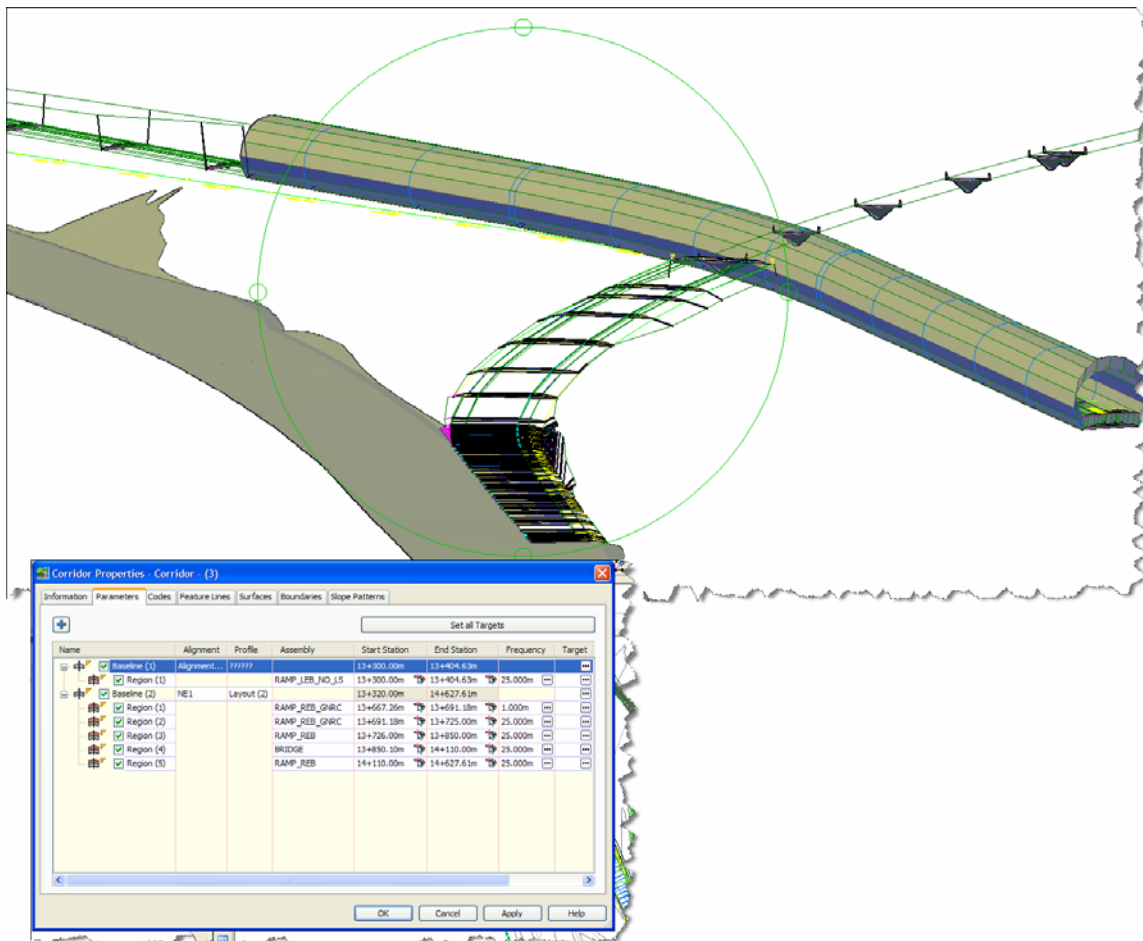
Civil 3D software has a similar level of sophistication and offers these advantages:

- It provides a rich graphical user interface where parameters are selected from the screen for stations, connection points, controlling alignments, and profiles. The Corridor Properties user form provides access to most parameters required for model definition.
- The output or the objects created are interactive graphical objects that can be edited by a simple mouse-click.
- Any derived labels, tables, or drawings referencing model components are updated automatically. Examples are cross section sheets, finished surface models, and rendered visualization displays.
- A surface model of the corridor can be built automatically and updated every time a corridor component is redesigned.
- Areas of the corridor model can be assigned a rendering material so the visualization is updated every time the corridor changes.
- The level of detail and the presentation style for the corridor features and derived points are defined as part of the corridor to automate the design updates.

The following graphic shows modeling of complex objects by combining multiple baselines and regions to include adjacent intersections and curbing:



Combining many of Civil 3D software's best features can produce models and drawings that include the on/off ramps and even the whole interchange models:



It would be a misconception for MX users to believe that Civil 3D does not provide enough features to support some of the most complex modeling requirements, particularly where independent design strings require complex editing to produce the finished ground model. By setting up temporary design objects, you can use Civil 3D as a generic design tool and simply export portions of that object to 3D strings to be included in the finished ground model. In Civil 3D, these 3D strings are called feature lines and breaklines.

## Conclusion

This white paper compares two generations of software technologies. Bentley MX, developed some 30 years ago and based on a core written in the FORTRAN programming language used for mainframe computers at the time. The other one, Autodesk Civil 3D, is designed to take advantage of all contemporary and future computing technologies such as a graphically rich user interface, .NET development platform, 64-bit systems, and more.

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development. That translates to \$300 million a year, which is almost as much as the annual revenue of their closest competitor. The commitment to delivering the best possible design solution is huge.

More than 6 million design professionals worldwide use Autodesk software. More than 30,000 of those users have Civil 3D on their desktops, making it the fastest growing Autodesk product.

Users of Bentley MX and users of Autodesk Civil 3D can each develop and maintain complex design models. The dynamic model-based architecture and generic design objects in Civil 3D combined with the features of the underlying CAD platform provide a complete environment that can adapt to any design and modeling method.

For more information about Autodesk Civil 3D, visit [www.autodesk.com/civil3d](http://www.autodesk.com/civil3d).

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