A New Dimension to Land Development and Subdivision Design: Application of AutoCAD Civil 3D®

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INTRODUCTION

Land development is the process of converting land from one use to another, and is typically applied to residential, commercial, agricultural, and industrial lands. Land development process involves many entities including, but not limited to the land use planner, landscape architect, civil engineer, land surveyor, developer, realtor, and land owner. From an engineering and design perspective, the land surveyor and the civil engineer are essential parts of this process, as they are usually the first to arrive at the site and the last to leave the site after the completion of the development. Some of the major components of land development and subdivision design include street design, sidewalk and trail design, storm-water drainage design, water distribution systems design, sewage collection design, on-site and off-site sewage treatment design, utility systems and easements, erosion and sediment control design, lot and open space grading, and installation of survey monuments and markers (Dewberry and Davis, 1996). With rapid environmental concerns and issues in modern societies, robust and efficient land development practices and management are increasingly more vital in community development.

The subdivision of land is the first step in the process of community development. Once land has been divided into streets, blocks, lots, and then publicly recorded, the correction of defects is costly and difficult. Subdivision of land is a public responsibility involving the extension of infrastructure and the provision of various public services customary to urban areas. The standard subdivision is the division of a tract or parcel of land which creates more than two new lots, sites, or other divisions or involves new street, utility, or drainage construction. Developed at the county level, land development and subdivision standards are designed for the harmonious development of the area, to secure a coordinated layout and adequate provision for vehicular and non-vehicular traffic, to secure adequate provision for light, water, transportation, drainage, sewer, recreation, air, and other sanitary facilities. Essentially, it is to provide for an improved living environment. It is customary that the final plat of a new subdivision shall be drawn to a

scale of 1"=100' (or larger) and the plat must conform to the following engineering and design requirements presented here as an example:

- Determine the lines of all streets and alleys, lot lines, lots numbered in numerical order, reservations, easements, and any areas to be dedicated to public use or sites for other than residential use with notes stating their purpose and any limitations.
- Specify the bearing and length of every street line, lot line, easement, boundary line, block line, and building line (whether curved or straight), and including true north point. This shall include the radius, central angle, and tangent distance for the center line of curved streets and curved property lines that are not the boundary of curved streets.
- The unadjusted linear error of closure of the boundary survey shall not exceed one foot per 5,000 feet of perimeter. The angular error of closure shall not exceed 30 seconds times the square root of the number of angles turned.
- All dimensions shall round up to the nearest 100th of a foot and angles to a 20 seconds accuracy.
- Location and description of monuments shall be specified.
- The names and locations of adjoining subdivisions and streets and the location and ownership of adjoining un-subdivided property shall be specified.
- The date, title, name, and location of subdivision, graphic scale, and north arrow must be determined.
- Show location sketch map showing site in relation to area.
- Certification issued by an engineer or surveyor of accuracy of the survey and plat and placement of monuments.

These engineering requirements which are part of land development and subdivision design have traditionally been completed using command-based AutoCAD®, then with AutoCAD® Land Desktop, and now AutoCAD® Civil 3D® is becoming the software of choice for the land development community. The two major characteristics of Civil 3D® are the dynamic engineering model and the conformity to the emerging 3D data modeling systems such as Geographic Information Systems, Modern Cadastral Information Systems, and Google® Earth (GE). For example, in Civil 3D®, a digital representation of topography in an area, also called digital surface, can be imported from (or exported) to GE. The dynamic engineering model links design and production drafting, so a change or update to one part of the design propagates throughout the entire project (Autodesk, 2007b)

This article presents some of the main functionalities that make AutoCAD® Civil 3D® 2008 a unique software for land development and subdivision design. This review is intended to be brief and for educational purposes only. It only highlights some of the key features of the software. This article is based solely on the authors' professional experience with using this software. Any findings and opinions reported here are those of the authors and do not necessarily reflect those of the software's manufacturer(s), their subsidiaries, and their distributor(s).

LAND DEVELOPMENT USING AUTOCAD CIVIL 3D® 2008

AutoCAD Civil 3D® 2008 is an improved version of AutoCAD® Land Desktop with advanced civil engineering design tools to support a wide range of design tasks. The 3-Dimensional (3D) environment of Civil 3D®, which is different from any other land development software systems, adds support for 3D shapes, surface modeling and real-time perspective viewing to land development process. This section presents the functionality available in AutoCAD® Civil 3D® 2008, related to some of land development and subdivision design tasks including survey data preparation, parcel creation, alignments, and profiles (Autodesk, 2007a).

Survey data preparation: In Civil 3D®, field survey book can be reviewed in a text editor, survey data can be edited in the Survey Toolspace, the correct (or corrected) field book file can be imported to the graphic environment where survey network can be created to accommodate survey data, and later points, figures, and surfaces can be created from the field data. After the field file is being edited and points are created, a digital surface can be created from the survey points. This is done by selecting "Surfaces" from Civil 3D® main menu, selecting "Create surface" and assigning a name, and then specifying whether "all of" the points "or subset of it" are to be used to create the surface (Figure 1). The resulted surface properties can be modified by direct editing, by assigning a contour style, and/or by applying surface labels. The surface can then be exported to GE, or an image can be imported from GE and draped onto the surface (Asnani, 2007).

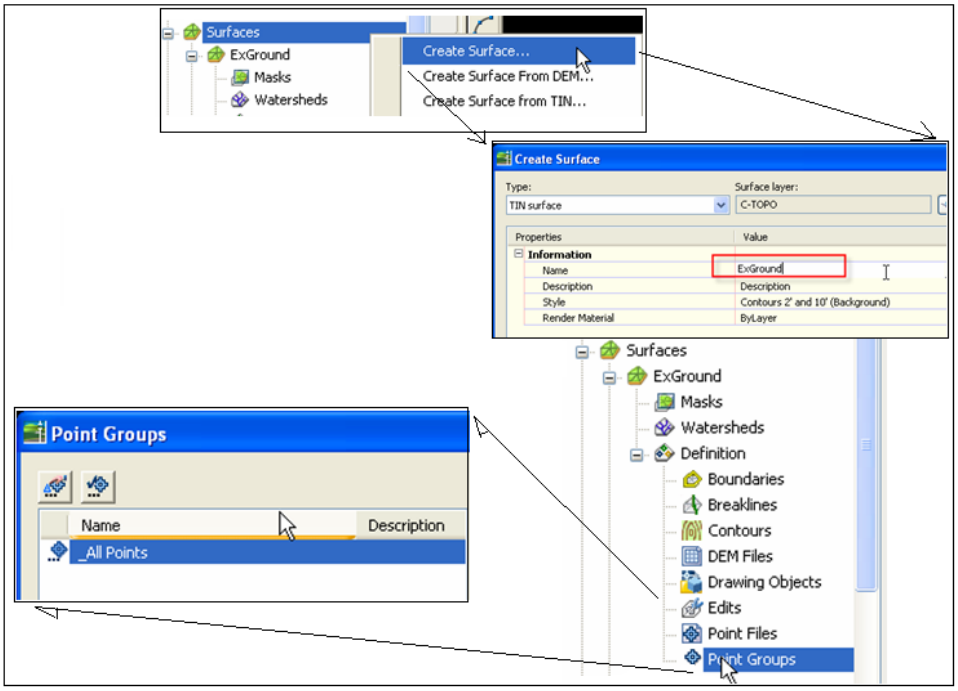

Figure 1: Creation of Surface from Points Example

Surfaces can be created from GE by launching the free version of GE and selecting the area of interest specified by address or zip code, and then the appropriate coverage can be

obtained using the GE navigation tools. Then, in Civil 3D®, select "File" and "Import" to import the GE surface (and image) selected above. One may then select the coordinate system option or "Identify" for manual placement of the surface (Fig. 2).

Parcel creation: Parcel creation is performed in Civil 3D® using "Layout Tools" or from "Objects," also called "Intelligent Objects." These can be point, surface, alignment, grading, section, profile, or corridor with well-defined interdependencies with other objects in Civil 3D® model. The unique characteristic of this dynamic model is that if any object is updated, all related objects will be updated too. This applies to editing and renumbering of parcels, labeling, and parcel attribute table. This dynamic modeling environment provides an excellent project-based environment, which enables for collaborative land development and subdivision design process in which all project team members can participate.

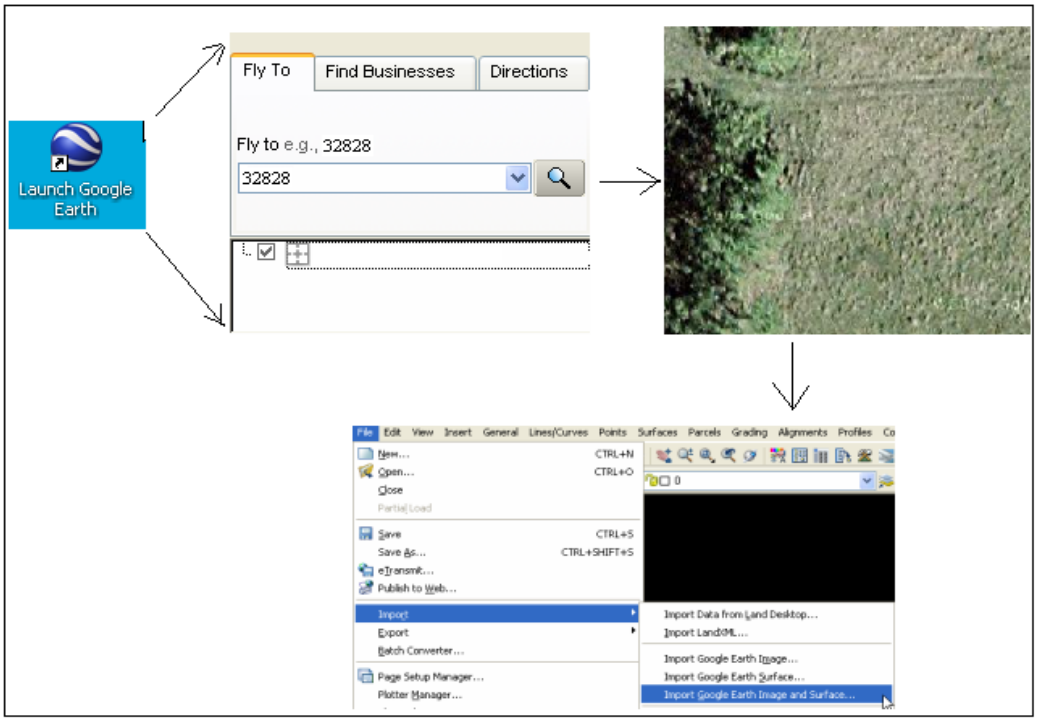

Figure 2: Creation of Surface from Google Earth® (GE) Example

Creation of alignments: Here there are three options for creating an alignment including (a) alignment with polylines, (b) alignment with LandXML, and (c) alignment with Layout Tools. After creating the initial alignment, they can be edited and labeled. The user has the option to save the alignment attributes in an alignment table as well as creating alignment reports. For example, to create alignments using "Layout Tools," select "Alignments" and then "Create Alignment by Layout." Then a "Name" needs to be provided and other settings (Styles, Station, etc.) must be selected. From "Layout Tools," curve and spiral settings can be selected. Then, a start point needs to be specified, followed by other clicks on screen to define other point of intersection. To finish the alignment session, "Enter" or "ESC" keys may be used (Fig. 3).

Creation of profiles: Profiles are created from existing surfaces using "Layout Tools," then the profile geometry can be edited, the profile view styles can be modified, and the profile reports can be viewed and exported. Design profiles can be created by selecting "Draw Tangents with Curves" option, and then a start point must be specified followed by clicks on screen to define other points of vertical intersection (PVI).

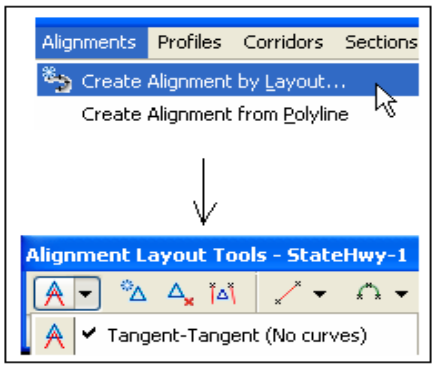

Figure 3: Creation of a Horizontal Alignment Example

CONCLUSION

This article presents some of the functionalities that make AutoCAD® Civil 3D® 2008. AutoCAD® Civil 3D® has advanced civil engineering design tools which support a wide range of land development and subdivision design tasks. The authors believe that the dynamic model of Civil 3D® makes this software very unique, robust, an efficient. It helps to provide and maintain a connection between the different objects in the same projects, so an update in one part updates the entire project. The 3-dimensional (3D) environment of Civil 3D® has enhanced powerful visualization and design tools, which adds another dimension to the land development and subdivision design.

PRODUCT INFORMATION

AutoCAD® Civil 3D® is a powerful and robust software supporting a wide range of land development and subdivision design tasks. More information is available in the literature and at the company's website at http://usa.autodesk.com via the internet.

REFERENCES

Dewberry and Davis (1996). Land Development Handbook, McGraw Hill.

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Autodesk (2007b). Autodesk ® Civil3D Website located at www.autodesk.com/civil3d