SiteComp Survey
Built on Coordinate Design and Information System (CDIS) Technology

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A. Introduction

This whitepaper introduces SiteComp Survey, an extraordinary software solution for the land surveying and mapping industries. Unlike most survey software products, SiteComp Survey is not based on a CAD (Computer-Aided Design) core engine. SiteComp Survey is based on Coordinate Design and Information System (CDIS), an engine which was created specifically for design disciplines that require geospatial analysis.

B. Coordinate Design and Information System (CDIS) Technology

With CAD-based surveying software, the core technology is the base drafting package and little more. In CAD systems, the core draws lines, arcs, polylines, and text with a myriad of functions all related to general drafting. The core offers a technology universal to many design pursuits among them surveying and other similar domains. In order to perform surveying functions, modules must be added to the CAD core to adapt the linear application to the spatial discipline. Without these modules, and in many cases even with them, CAD is and always will be fundamentally a line drawing package as opposed to a spatial design product. In most cases the software complexity that has risen out of the effort to build required spatial design capabilities on top of a linear core technology has led to unstable software that is difficult to develop and use.

On the other hand, Coordinate Design and Information System (CDIS) was specifically designed for the domains that require a combination of geospatial positioning and precise design functionality, such as surveying, mapping, and land development. The single CDIS core is a stand-alone technology that performs all the functions required by these spatial disciplines. It performs complete computation and design faster and more accurately than any existing CAD package. Because the CDIS foundation was fully developed with versatility and adaptability as primary design criteria, adding further functionality and features is easily accomplished.

CDIS is a point-based, object-oriented data model that was originally designed for surveying and mapping applications. Point-based systems were created decades ago to address the specific needs of land surveying, the discipline charged with representing land with high precision. CDIS came from those early origins and was clearly identified, even then, as an ideal surveying solution because it combined a technology rooted in the methods surveyors used to perform their work. In short, point-based software worked the same way surveyors thought. The continued recent development of CDIS as a spatial technology has amplified the benefit of its point-based origins and resulted in a comprehensive approach to representing and processing spatial relationships of precise designs.

CDIS has unmatched mathematical drawing precision combined with spatial design and analysis capabilities built into its core engine which results in the perfect basis for a surveying software tool. While it is true that CAD systems are also based on coordinates, in CAD systems each object (e.g. an arc or a line) maintains its own representation of the coordinates that define the object. This creates huge redundancies in data that result in awkward geometry commands and significant probability of error. **In CDIS, points alone maintain coordinates and all objects are then located by the points. Each point exists in the data representation only once, and can be shared by multiple objects of varying types.** This significant difference reduces errors, lowers storage requirements, enables advanced productivity, and improves performance. The result is two powerful core capabilities that separate CDIS from CAD.

1. *The Fusion of Coordinate Geometry (COGO) and Drafting:* In CDIS the drawing is the geometry. Because the drawing figures (arcs, lines…) are actually the coordinate geometry, snapping to a line or arc picks up accurate coordinate points, so the lines are used dependably for COGO calculations. Commands are written with this advantage, making the drawing process and the calculation process one in the same. In CDIS, the drawing does not actually exist as a separate entity like it does in CAD. By default, the drawing changes when point location changes are made. Every screen refresh is an instantaneous drawing recalculation not just a redraw. Every plot represents the latest calculations, virtually eliminating any chance of error.

2. *The Blending of Coordinate Geometry (COGO) and GIS Functionality:* CDIS features a unique blend of coordinate geometry and GIS spatial abilities. Unlike typical GIS with its limited ability to accurately calculate geometry, CDIS provides accurate geometry and ease of precise calculation. Similar to GIS, in CDIS the user is able to easily define areas and query for information about those areas. Areas are calculated instantly from the point data and tools are provided to analyze those areas. CDIS provides all the power of COGO combined with the spatial analysis tools of GIS, providing the user with a powerful tool to compile accurate mapping and perform dynamic planning.

C. SiteComp Survey

SiteComp has introduced a CDIS-based surveying software package, SiteComp Survey, that demonstrates the advantage of using point-based, object-oriented technology for surveying and mapping. By using the superior CDIS data model, SiteComp has developed a highly stable software package with an instinctive command structure. This data model leads to a natural intuitiveness in the use of the software, thereby dramatically reducing the learning curve and training time. In CAD systems, the awkwardness of the

command structure is one way in which it is revealed that the underlying technology was not designed for the surveying domain. It almost seems as if the most important design criterion for most survey packages was that they utilize a CAD engine, as opposed to SiteComp Survey where the main criterion was making the land surveyor's job easy, accurate, and efficient.

For many years surveyors have been forced to use CAD systems for lack of a better product. The introduction of SiteComp Survey has changed this. The land surveying industry has taken notice and an increasing number of surveyors have switched to SiteComp Survey. Also, SiteComp Survey's seamless import and export of CAD files into and out of CDIS has made the customer transition process smooth and worry-free. SiteComp Survey even has functionality to detect and repair data errors caused by using CAD systems. *The American Surveyor* recently reviewed SiteComp Survey calling it "an extraordinary program," and "one of the best surveying programs ever sampled".

SiteComp Survey is a fully integrated program that includes data reduction, COGO, boundary, contouring, design, drafting and earthwork calculations. While a complete feature-by-feature description of SiteComp Survey is beyond the scope of this whitepaper, this document discusses several important elements of SiteComp Survey that make it the clear choice for surveyors. These include:

- Accuracy and Precision
- Storage and Performance
- Spatial Intelligence
- Advanced Drafting Commands
- Spatial Queries
- Point Management and Referencing
- Advanced Surface Generation
- Point Clustering
- Ease of Use and Training

C.1 *Accuracy and Precision*

One of the most significant advantages of a point-based system from the surveyor's perspective is accuracy. In CAD-based systems users can easily create parcels that appear to close, but actually do not. Most CAD systems have now added extra functionality in an attempt to force closure, but the user must go out of their way to cause parcels to close. In contrast, SiteComp Survey users need to go out of their way to create a parcel closure error. As previously noted, the figures, their annotation, and the coordinate points are all the same data structure, thus making previous field errors immediately apparent. As a result many costly and time-consuming errors that occur during the steps from calculation to drafting are easily avoided. Another immediate benefit to this data structure is the surveyor's ability to automatically and without further recalculation or point-setting use the points associated with the linework to stake-out elements of the design in the field. Since all of SiteComp Survey's
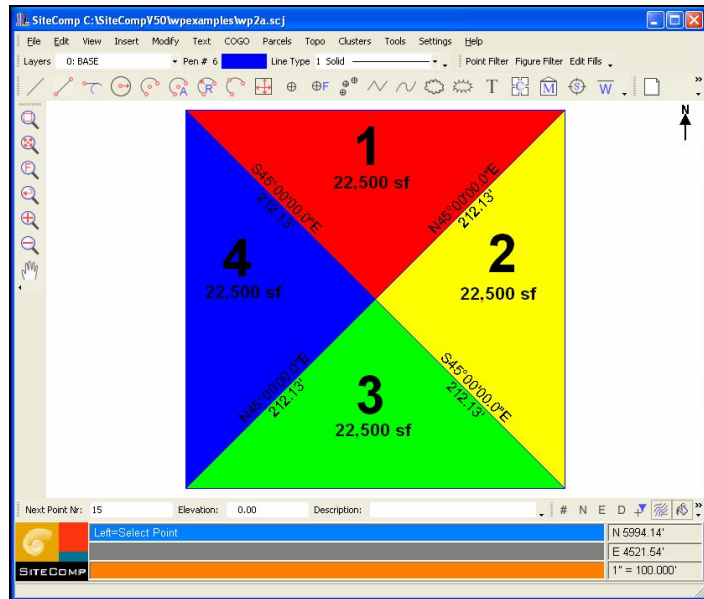

Figure 1 The plots in Figure one are resized by moving the point where they intersect. All lines and parcels are immediately updated. Note line bearings and distances as well plot areas are recalculated when the screen refreshes. There is no chance that the user can "forget" to recalculate any of this information.
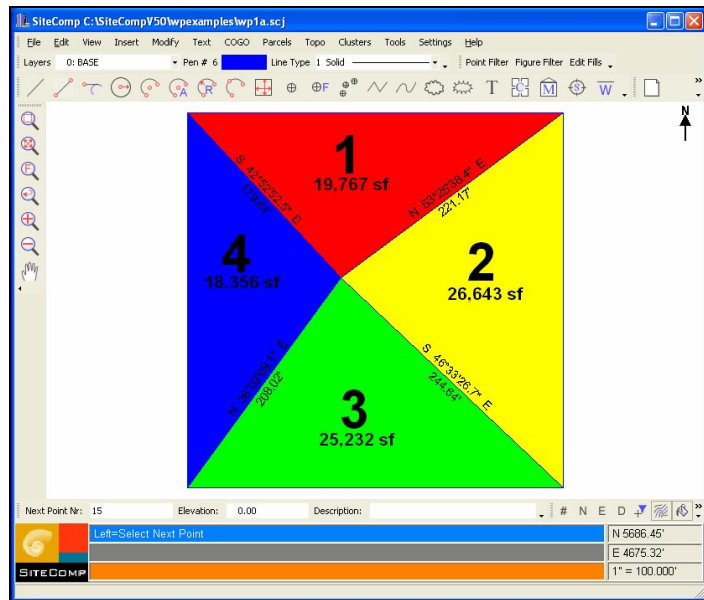

Figure 2 Depicts four parcels before moving common point. Note line bearings and distances and parcel areas designated by color fills.

linework is the product of coordinate geometry and does not exist as a separate entity, all drawings are instantly and precisely recalculated with

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every screen refresh. Every plot represents the latest calculations, virtually eliminating the chance of error.

For example, let's consider the resizing of a parcel using SiteComp Survey as compared to this function in a typical CAD-based system. In SiteComp Survey the user simply moves the appropriate points. All parcel boundaries associated with that point will move automatically. All coordinate geometry associated with the point is updated instantly. Area fills are immediately recalculated (indicating that parcels have been redefined spatially) and the annotations reflect the relocation of the point. In CAD, the user must ensure that all parcel boundaries are moved to the appropriate new locations. Even if this is done properly, the information associated with the parcels is not updated to reflect the new dimensions. Each parcel must be recalculated, involving minutes, if not hours, of work and dramatically increasing the chance of error.

C.2 *Storage and Performance*

The CDIS approach has implications on storage and performance metrics. By optimally representing points in the data structure (each point only once, as opposed to once for each time the point is used in a figure) the storage requirements are dramatically reduced. **File size is unlimited** and speed is dramatically enhanced because CDIS data is managed by objects and not by numerical point listings. **SiteComp Survey's native .SCJ files are on average a factor of five times smaller than .DWG files.** An entire project is stored in a single file simplifying data access and file management.

Performance is also improved by driving all functionality with a single core engine, instead of the patchwork of add-on modules that are found in CAD based systems. The single core engine drastically simplifies the underlying codebase, resulting in a high performance package that is not prone to inaccuracies or system crashes. In addition, when it comes to importing or exporting data from and to open standards such as LandXML, the transfer process is remarkably faster and cleaner.

The compact nature of CDIS' storage ability while maintaining fully-functioning performance make it the ideal technology to satisfy one of the fastest growing market segments in the surveying hardware industry. **That is: the need to integrate surveying software capability directly onto hand-held, small storage, data collection devices, thus enabling land surveyors to do comprehensive design work on the same device and at the same time that field work is performed.**

C.3 *Spatial Intelligence*

The CDIS spatial intelligence embedded in SiteComp Survey's coordinate geometry allows even the most complex calculations to be produced quickly and accurately, opening the way for the automation of many design tasks and enhancing productivity. For instance, SiteComp Survey generates parcels based on complex geometric parametric inputs. Figures 3 and 4 show a simple lot creation example to demonstrate the ease with which a lot can be subdivided based on area parameters using the built in coordinate geometry. The result is lots calculated exactly to desired specifications directly from the original point data.
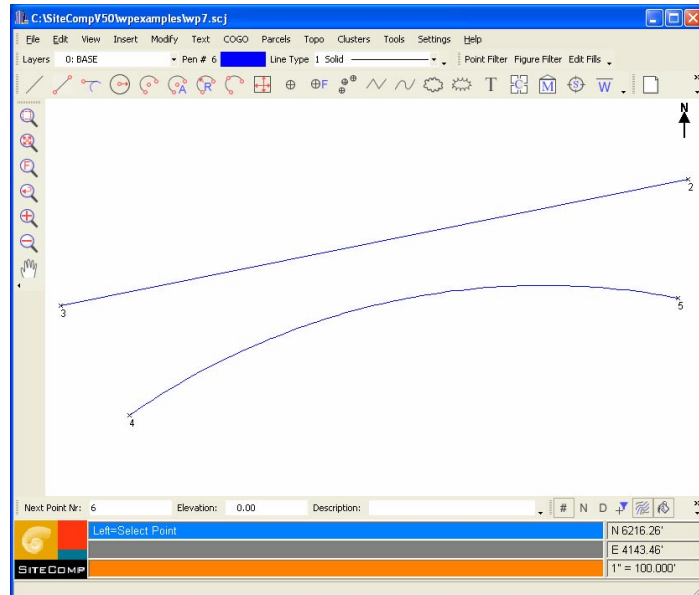

Figure 3   A coordinate geometry command to calculate lots that have radial sidelines and contain an area set in a parametric fashion.

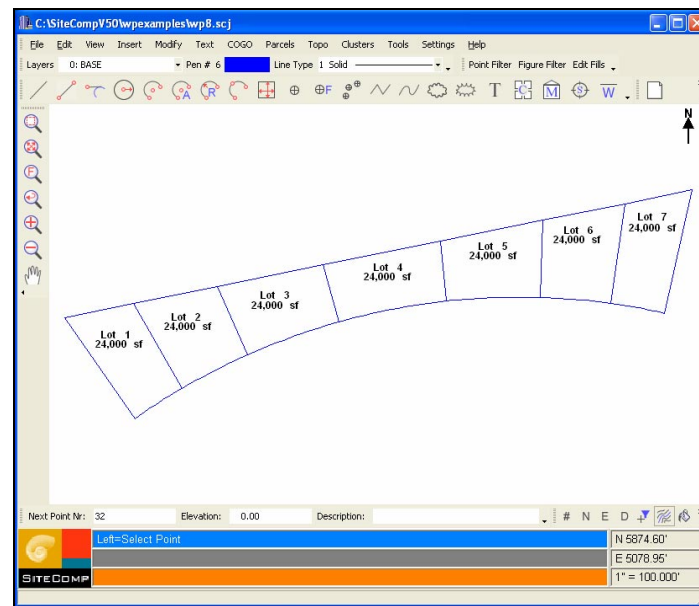Figure 4   The results are lots calculated exactly to specifications directly from the original point data.

C.4 *Advanced Drafting Commands*

Drafting is at the heart of the surveying profession– the highest quality fieldwork is useless if it cannot be translated into an accurate survey map. This is a key area where the CDIS point-based system used in SiteComp Survey demonstrates a clear advantage over CAD survey packages. In CDIS, every line and figure in a drawing is based on coordinate geometry points stored in the database. This point-based nature of SiteComp has a significant impact on the accuracy of drawings. Consider the bounding lines

of a parcel of land. In a CAD-based system each parcel boundary line is represented by a line consisting of two coordinate pairs (as opposed to coordinate points) representing each end of that line. The important thing to note is that there is no connection between the end points of the adjoining lines. In reality, the end points of adjoining lines are actually the same

point–but this relationship is not represented by the CAD data structure.

SiteComp's CDIS data model represents reality. The endpoints of the adjoining lines share a common point (as may endpoints of lines associated with adjoining parcels). In SiteComp Survey, all the drafting linework is actually the coordinate geometry itself. Snapping to a line or arc picks up accurate coordinate points, so the lines
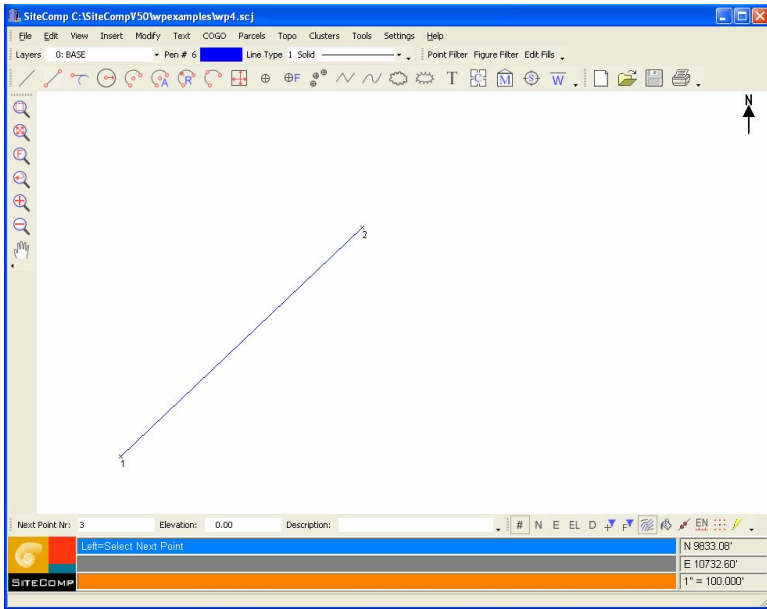

Figure 5 Here a tangent curve with radius 400' and length 350' is entered using the Traverse command. This shows the tangent line.
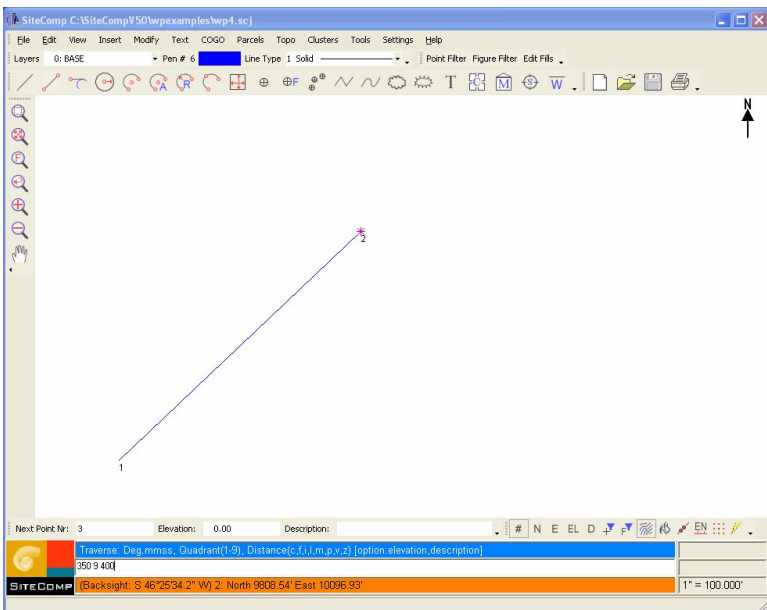

Figure 6 The data entry of the Traverse command is shown at the bottom of the screen.

can be used dependably for geometry. This intrinsic use of coordinate geometry eliminates redundant drafting procedures, dramatically reduces errors, and increases productivity.   Furthermore in CDIS, coordinate geometry is used to permit surveyors to create drafting based on the data they have collected, without requiring calculations to get the data into a CAD

format. Curves can be calculated directly from geometry (lines or arcs) using myriad COGO curve calculation routines and drawing routines. Because SiteComp Survey is based on the CDIS platform, it provides users with a broader set of drafting commands that translate directly to surveyor functions. These drafting commands include traverses, sideshots, inverses, parcel generation functions, offsets, curves and many more.
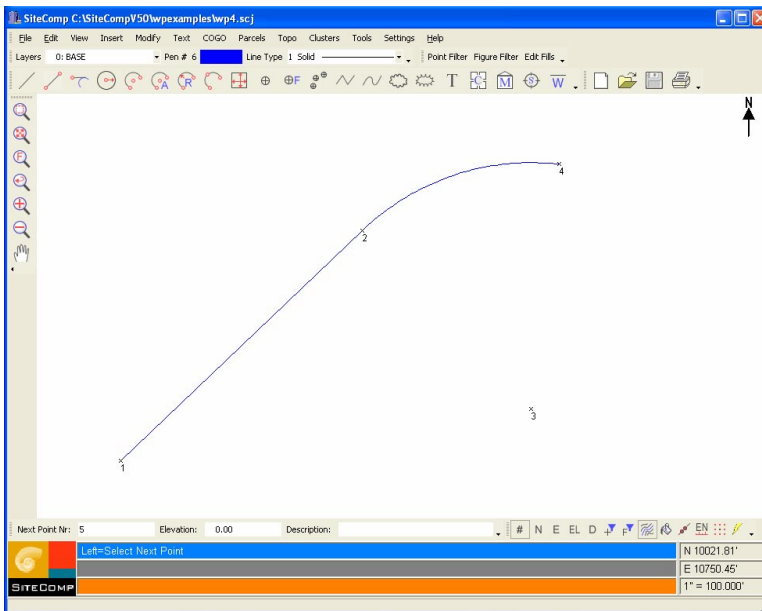

Figure 7 This shows the completed curve, notice that the radius point (3) is automatically calculated and placed in the file. Many CAD systems force users to manually calculate the radius point in order to draw an arc.

Since the drawing for all these functions is the geometry itself, these calculations are precise and accurate each time because they are based on actual surveying data and not arbitrary CAD inputs. To develop functions similar to those in SiteComp Survey, CAD-based systems require another separate data structure that completely removes the geometry from the drawing.

C.5 *Spatial Queries*

Not only does SiteComp Survey quickly and automatically compile lot areas, the underlying CDIS engine allows information queries based on complex coordinate geometry that can be displayed in a text report or in graphical format. For instance, it is easy to generate a graphical query that displays which parcels fall in a given lot size range. Because the CDIS core calculates the results on-the-fly based on the actual coordinate geometry as opposed to querying a stored list of parcel sizes, the query reflects accurate plot areas.

This advance querying is not limited to simple plot size calculations. For example, surveyors can define areas on a site from the information on a basic lot survey. The surveyor is then able to create value-added survey information for the client that not only shows the total extent of that ownership, but accurately shows and calculates measurements for all areas, including paving, walks, homes, and green space. During land development design, the drawing therefore becomes a conduit of information that gives

the client valuable data, information that cannot efficiently be rendered using a CAD-based system.

The reliance on the CDIS object-oriented approach has made it easy to create parcel objects in SiteComp Survey that reflect point locations. This also combines with the spatial querying abilities to offer comprehensive information that SiteComp Survey provides as integrated functions. Area definitions that can be used for geometry listings, calculations, color fills, error checking, queries, and more.
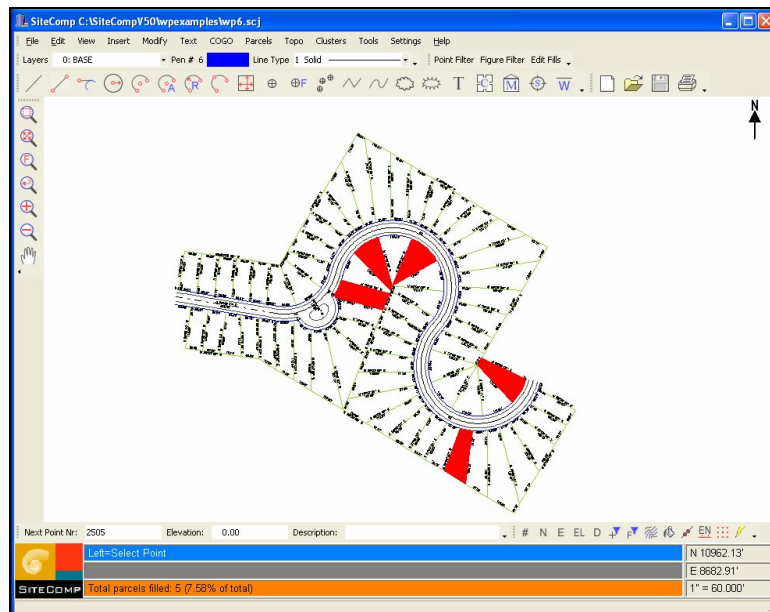

Figure 8 In this subdivision all the lots of area 10,000 to 10,500 sq. ft. are easily highlighted. The areas are calculated off the point data when the query is placed. No list of areas is stored It is unnecessary to store a list of areas.

C.6 *Point Management and Referencing*

Another important aspect of the CDIS core is that it uses point descriptions in addition to point numbers, giving the user the ability to work with what the point actually represents rather than a number assigned to a point. Even though point number geometry is a major internal component of the program, SiteComp Survey emphasizes the use of point description over that of the point number thus resulting in significant point management efficiency.

Point numbers came into surveying existence and coordinate geometry decades ago. In early digital systems only 50 to 100 points could be stored. Today most modular CAD systems can process hundreds of thousands of points (**CDIS processes millions and millions**), and a good field person can collect upwards of 1,000 points in a day. In CDIS, because the linework is actually defined by the physical coordinate, and lines are separated by layers (the only similarity to CAD), points can be described by layer, allowing the use of actual point descriptions to manage the points.

With CAD-based systems, items are often grouped into point number ranges. For example, fieldwork may be points 1 through 1,000; curbs may be 1,001 to 1,499; and lot corners may be 1,500 to 1,999. Obviously, given that categories are limited to a finite number range, a risk exists that future work

will result in exhausting the appropriate number range and thus further complicate point management. This scenario illustrates the inadequacy of point management by numbers alone. CDIS does not require grouped point numbers, but rather allows points to be grouped in many ways including grouping based on what the point actually represents. The result is increased efficiency, accuracy, and clarity.

C.7 *Advanced Surface Generation*

One of the more innovative CDIS representations is the proprietary surface generation algorithm. In SiteComp Survey, the surface is intrinsic to the site, so contour generation, slope shading, and flow patterns are generated instantly. The CDIS core includes the digital terrain information for the parcel, creating instant access to any contour interval or topographical data. Because the terrain is internal to the core itself, no extra files are needed.
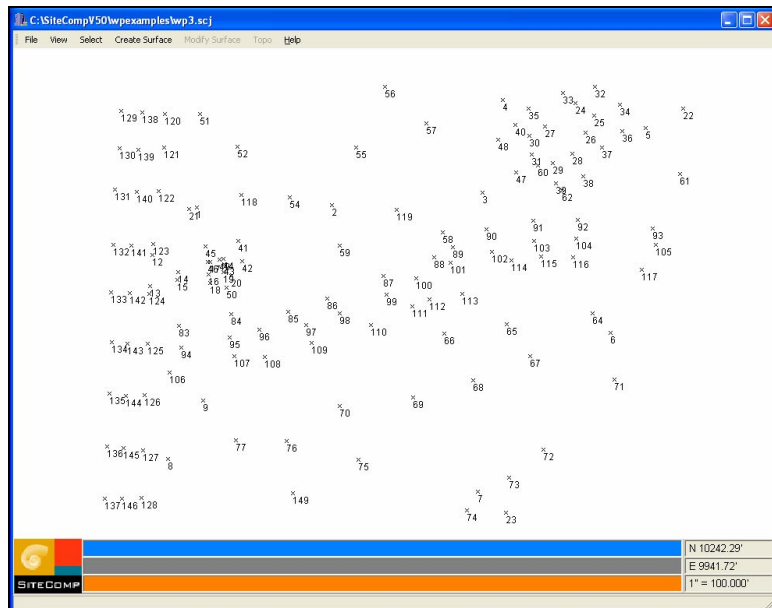

Figure 9 Using only point data (northing, easting, elevation) SiteComp Survey can create easily creates a DTM (digital terrain model) or TIN (triangulated irregular network).
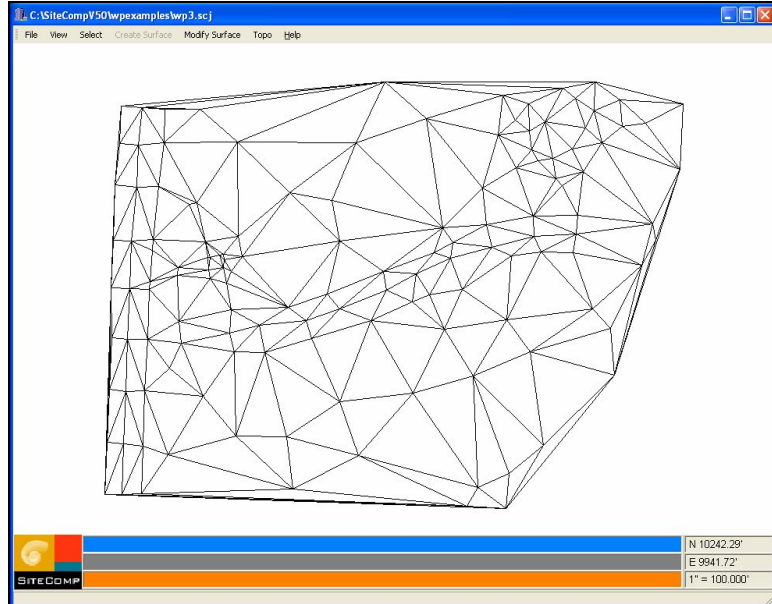

Figure 10 Using SiteComp's proprietary algorithm, a TIN is created from only the points, no breaklines work is required.

Additionally, modifications to the surface are reflected immediately as surface points are added, elevations changed, and edges redefined. In addition to automatic recalculation, SiteComp generates surfaces instantly via a

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proprietary algorithm that, in most cases, eliminates the need for time-consuming breakline work.

C.8 *Point Clustering*

For large-area surveying calculations, planning design, and compiling of accurate mapping, a SiteComp Survey feature called "point clustering" is used. In situations where a large boundary is comprised of many individual conflicting tracts,
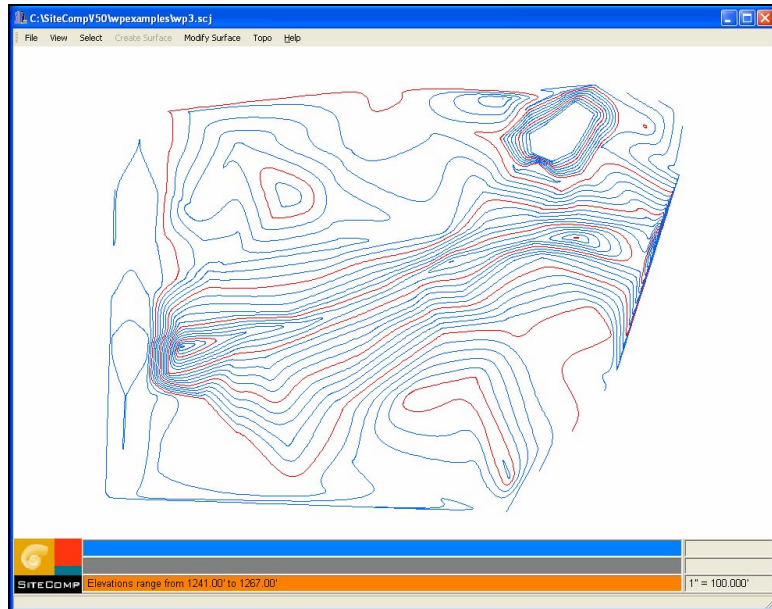

Figure 11 Features like the road and ditch are picked up. Normally this would require extensive breakline work.

clustering enables the determination of the correct boundary by allowing individual tracts to be moved and rotated until the most accurate representation of the map, based on the actual fieldwork, is provided. In contrast, CAD systems rely on "blocks" of inaccurate remote data not tied to mathematical intelligence to attempt to perform the same function.

Entire cities and counties can also be clustered by entering each deed and subdivision into individual files and registering them to accurate section coordinates. This technique produces maps with survey plat accuracy, as opposed to the alternative of rubber sheeting, which creates entire city maps that do not represent accurate parcels. And regrettably, today's city and county maps produced with CAD are often expensive, digital representations that cannot be used for accurate site data. Because external files need not be referenced (as they are in a CAD system), large-area planning using CDIS is much easier, faster, and more accurate. Detailed plans can be created in the same time, or less, than it takes to do simple linework.

C.9 *Ease of Use and Training*

Because CDIS technology is a natural extension of the way surveyors perform their field work (i.e. by shooting points, not lines), the software is extremely easy to use. Its stand-alone nature is organized and intuitive. Functions are clearly laid out menu-by-menu, command-by-command. Full training for SiteComp Survey is between eight and twelve hours, depending on the user's initial familiarity with design software. Also, since the core CDIS technology never changes, upgrades are the addition of features that

utilize previously learned operating skills, so no retraining or relearning is necessary.

D. Summary

In 1978 SiteComp software was one of the first computer aided design programs ever developed. Formatted originally in Basic, it was ported to UNIX in the mid eighties in exclusive partnership with Hewlett Packard hardware, and ported to Windows in 1998.

From its inception, the software has been based upon an advanced foundational technology call CDIS–Coordinate Design and Information System. Supported by the premise that certain design disciplines are spatial in nature, CDIS is fully point-based and is thus the obvious technology choice for the surveying, mapping, and land development industries.

Coupling years of point-based software development with new geospatially integrated advancements, CDIS has emerged as the replacement representation for inferior linear applications and the likely successor technology for many geospatial disciplines.