Developments in electronics push surveying into a faster and a more accurate mode

By BOB ALLEN AND PAUL DUNKELBARGER

Survey maps have been shaping our world for centuries. Since George Washington began surveying northern Virginia as a 16-year-old, the fundamental requirements of surveying to measure distances and angles precisely have not changed.

In recent history, survey field crews painstakingly measured distances and angles using a transit (an optical instrument for measuring angles), rod, and measurement chains—equipment that today would cost perhaps a few hundred dollars. One crew member would set up the transit carefully while the other crew member would hold a calibrated rod at the point to be located. The angle and distance between the transit and the rod then would be measured. Then the process would be repeated for each of the points that followed.

Field measurements were entered into a notebook, along with descriptions of the points, to include the locations of vegetation, distances to the corners of structures, and so forth. When surveying in many areas, the limiting factor was often the speed with which results could be written down. Working efficiently, a survey crew typically could measure about 250 points a day.

Once the field measurements were completed, the crew would return to the office and subject the data to a series of calculations that would produce the information needed to draw a map.

Twenty years ago, maps were plotted by hand. Ten years ago, mathematics was computed on scientific calculators and then fed by hand into computers that automatically would locate key points. A surveyor then traced over the map by hand. But it was still a time-consuming and always laborious process.

But recent developments in instruments, data collection and computer software have kicked surveying into high gear. Now it is commonplace for a survey team to gather data automatically using an electronic instrument, to transfer the information directly into a computer, to map the results swiftly through software automation, and to deliver both a paper map and a computer disk directly readable by an architect's or engineer's computer-aided design (CAD) system the following day.

Today's crew goes into the field with an electronic instrument called a "total station," which may cost tens of thousands of dollars. A crew member sets up the total station, and another crew member holds a prismatic target at the point to be located. With the push of a button, the total station not only determines the angle of the target, but uses infrared rangefinding to measure automatically the distance to the target within 3 millimeters. Luke Skywalker would be proud.

With the push of another button, both the angle and the distance are recorded automatically in an electronic data pack that attaches to the total station. In addition, when the distance and angle of a special object are measured—a tree, for example—a code indicating "tree" is punched into the total station.

There is a whole series of codes to indicate objects that surveyors frequently deal with, such as "iron pipe found" or "corner of building." The entire process is so fast that an efficient crew can make nearly three times as many measurements a day as the surveyors of old who used transit and rod.

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the information in the data pack is downloaded through a cable into a computer. If the crew happens to be working out of town, the information can be transferred via modem. The data is converted by the computer from raw field data into a software-compatible input file. Special software then processes the results of the day's work and uploads it into a CAD system.

Here is where real "magic" begins to happen. When the CAD software encounters the special code for an object that is

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defined by a single point, it automatically inserts the object—a tree, an iron pipe or whatever—into the draft map that it is preparing. The CAD technician then manipulates the software, and it draws the lines for consecutively located points that define buildings, roads and boundaries. While the software requires some help from the CAD technician, the speed at which it can go from raw field data to final map is truly astounding.

Surprisingly, the prime beneficiary of all this new technology is not the surveyor. The surveyor can do more work faster, but the boost in efficiency is offset by the $40,000 to $50,000 investment needed to achieve that boost. The survey client, instead, gains the most from the new technology.

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easier to record additional information. Despite the greater detail and a high degree of accuracy produced by the new equipment, the cost of surveys actually has dropped slightly in the past 10 years.

Architects and engineers now can choose to receive survey maps on both paper and computer disks readable by their own CAD systems.

Brought up on the screen, the CAD survey map easily can be enlarged or shrunken to increase or decrease the scale. And by making software selections, details such as overhead power lines can be included or excluded from the map. It is easy to isolate items such as road surfaces, boundaries and sewer lines to meet special needs such as facilities maintenance. The freshly altered maps can be

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plotted on paper for construction crews or site inspectors whenever needed.

Because of its mathematical processing capabilities, CAD software can do things with survey information that would be virtually impossible by hand. For example, suppose an architect is planning a building for a sloping piece of land. The surveyor is commissioned to measure its contour. Using the CAD software, the architect can determine quickly, and with a high degree of accuracy, how many cubic yards of dirt will be excavated from the foundation and how many additional yards will be needed to fill in a low spot further on down the slope.

Capabilities such as this are used routinely in the field of toxic waste disposal. Contractors often are paid per cubic yard; and surveys, combined with the volume-measuring capabilities of CAD, can be used to determine exactly how much toxic waste was removed.

CAD-generated survey results even can be fed into a geographic information system that can show in detail the location of roads, sewers, waterlines, utilities, houses and commercial buildings, as well as property ownership and tax map parcels, throughout an entire town. Armed with such information, town governments can do a better job of managing existing resources and planning for the future.

For all their high-tech wizardry, total stations and CAD software still cannot perform the historical deed-sleuthing that supports so much of modern surveying. But despite this, the electronic revolution promises faster, more detailed field work; extraordinarily fast conversion of field data to a useful product; and far more versatile survey results for use by architects and engineers.

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