

Digital Architectural Survey Technologies

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New laser scanning, digital photogrammetry, and portable computer technologies offer a wealth of efficient survey options for architects faced with recording the built environment.

Tools and techniques for recording existing building structures have been transformed by advancements in electronic technology. Whether fielding a team of architects or contracting with a professional surveyor, architects will be better prepared if they are familiar with the broad range of established and emerging digital building recording technologies.

ARCHITECTURAL SURVEY GOALS

Architects design the built environment, but more often than not we find ourselves designing within the context of an existing built environment. Whether an architect is enhancing, expanding, or restoring an existing structure, a clear understanding of preexisting conditions will facilitate implementation of design solutions, and surveying existing conditions is the best way to reach that understanding. Familiarity with building recording technologies makes it possible for architects to select survey methods that are most appropriate for a particular project. This topic briefly introduces a wide variety of survey tools and technologies to help architects select the recording method that best suits their projects.

Meeting the Needs of the Client

Meeting the needs of clients often begins by helping them understand their needs. According to AIA contract language, building survey is a predesign service. Occasionally, clients may come to you with a complete set of measured drawings of their building's existing conditions. All too often, however, the architect must inform a client of the need to survey existing conditions to ensure they are properly addressed during project delivery. Once the needs of the client have been assessed and agreed upon, the architect is prepared to evaluate survey options.

Identifying Types of Information to Gather

The term "digital building recording technologies" may infer collection of accurate and efficient dimensional data, but in actuality a building's size is often of secondary interest for a project with a preservation or conservation focus. Information that may be equally

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important in the context of preserving or conserving a significant architectural monument includes the following:

- **Cultural resource data.** Period of construction, sequence of construction, areas of previous damage or repair, evidence of architectural modification
- **Material characteristics.** Finish versus structural materials; surface treatments; cracks, defects, and irregularities; hardness; color; condition

The technologies described in this topic can provide reliable and reasonably accurate metric data for use in the building documentation process. However, none of them can supplant the eye of an experienced professional in evaluating cultural and material criteria. The most complete record of existing conditions combines accurate dimensional data with the cultural significance and material condition of a building to facilitate a full range of future activities, from monitoring or quantifying material repairs to reconstructing a building following a catastrophic event.

Achieving Acceptable Levels of Accuracy

The accuracy with which existing conditions need to be recorded depends on the project. The client may expect a certain level of accuracy, and the architect will have a professional opinion of what data is sufficient for delivery of a buildable product. For example, facility programming for a college campus will not require exact measurements, but a steeple addition to a historic chapel very well may. Other projects may require precise geospatial registration of the work so it can later be added to a larger geographic information system (GIS) database. Regardless of the accuracy required, during construction the contractor will have to verify critical dimensions on all construction documents.

NEW DIGITAL RECORDING TECHNOLOGIES FOR ARCHITECTS

The technological advancements of the decade flanking the turn of the twenty-first century have generated a worldwide barrage of solutions and equipment for recording buildings digitally. A few of the technologies are of particular interest to the architecture profession, as they can offer increased precision and true time savings in the collection of field data.

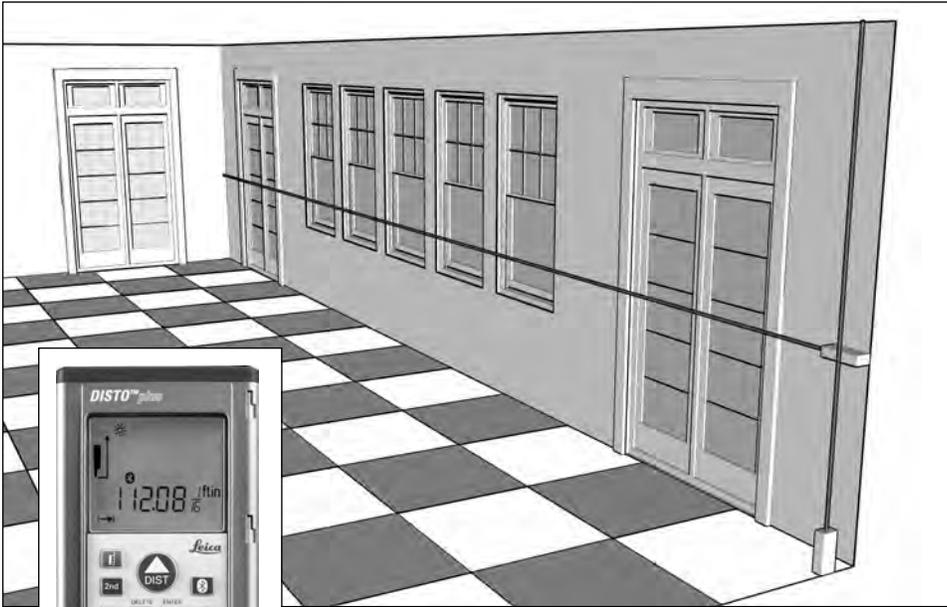
Laser Tapes and Levels

Handheld laser distancing devices, or laser tapes, are highly affordable, exceptionally accurate (typically from $\frac{1}{8}$ inch to $\frac{1}{16}$ inch), and have a range up to 650 feet under ideal conditions. With costs starting below \$400, this tool brings an exceptional level of speed and convenience to field survey.

First introduced by Leica in 1993, laser tapes employ a clearly visible red laser to enable precise selection of each point to be measured. These devices use a time-of-flight ranging method, calculating the distance to the target by sensing the amount of time required for a laser pulse to return from it. Newer models of the Leica Disto™ pro include Bluetooth technology, which makes it possible to transfer measurements wirelessly to devices such as personal digital assistants (PDAs) or tablet PCs.

Certain survey sites, such as an analytical laboratory crowded with scientific equipment, defy measurement with a 20-foot steel tape measure. Such challenging conditions are what prompted one architecture firm to invest in an early handheld model (then \$600). The scientists breathed a sigh of relief that two outsiders would not be stringing a tape through their delicate equipment, and the project manager was pleased by the increased measuring efficiency.

Laser levels also provide an efficient means of establishing a datum line to which floor or ceiling variations can be measured. Most laser levels are self-balancing and can rotate to provide a full 360-degree sweep of a room at a constant elevation. For this task,

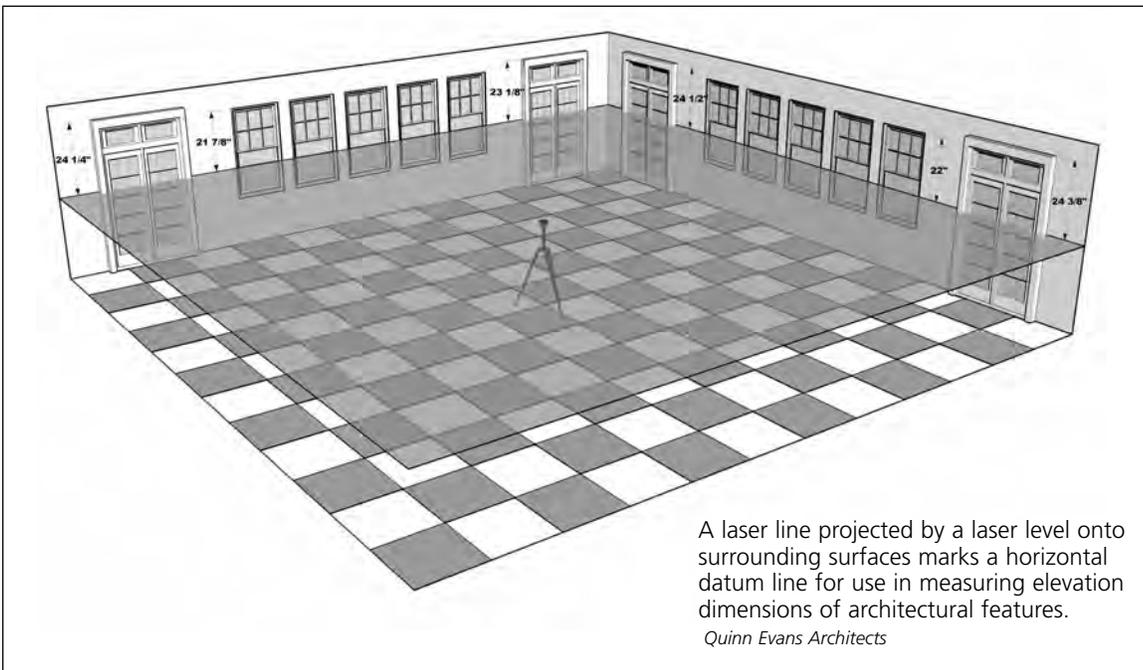


Handheld laser tapes like the Leica Disto pro (inset) speed collection of survey data for the solo architectural surveyor. Newer Bluetooth-enabled models can link wirelessly to handheld PDAs to further streamline recording of dimensions.

Quinn Evans Architects and Leica Disto

too, the equipment allows one person to complete a task that once required two, armed with string, line level, and tacks in the wall.

For a project that involves evaluation of existing conditions, adopting this laser technology alone can advance the survey process by leaps and bounds over traditional methods, both in speed and accuracy.



A laser line projected by a laser level onto surrounding surfaces marks a horizontal datum line for use in measuring elevation dimensions of architectural features.

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The HP Compaq Tablet PC tc1100 is a three-pound, pen-based computer with a keyboard that can be detached or swiveled 180° and folded behind the display.

Courtesy, Hewlett-Packard Development Company, L.P.



Tablet Computers in the Field

The tablet computer is not as new to field survey work as you might expect. The Smithsonian Institution has used pen-enabled computers to document facility conditions at its numerous facilities in Washington, D.C., since the early 1990s. The new generation of these computers, introduced with the Tablet PC by Microsoft in 2003, brought the platform in step with mainstream business software at a cost near that of comparably equipped laptop computers weighing twice as much. Averaging between three and four pounds, tablet computers come in two general categories: convertibles and slates. Slates have a separate keyboard that can be removed. The keyboard on the convertible is usually designed to fold behind the display and is not removable. Slate-style tablets are normally half a pound to a pound lighter than convertibles.

While tablet computers are capable of performing most functions that can be accomplished on a laptop, they generally do not have optical (CD or DVD) drives onboard, a concession to achieve a lighter system. However, with a full complement of data ports and external storage devices, such as USB memory keys, data transfer is convenient. Pen-enabling the tablet makes it possible to create field sketches, collect and annotate digital survey photos, and modify and annotate CAD plans.

The single biggest drawback of using tablet computers for survey work is the difficulty of viewing the screen in direct sunlight. When the bulk of survey work is done indoors, however, this is a tool worth considering. In fact, for tasks such as sketching joinery details in a darkened attic, the backlit screen serves as both an illuminated drawing surface and a flashlight.

The portability and adaptability of these small computers quickly makes them more attractive than a laptop for use in the field. Newer tablet PCs run CAD software quite well, but their 10- to 14-inch displays can make using CAD less than pleasurable for plan creation. However, for plan annotation, Volo View from Autodesk on a tablet computer may be a good solution.

Software such as Plan Surveyor from InfoQuesT Technologies is designed to make it possible to create plans in the field using a tablet computer. By measuring along each room's perimeter in a systematic process that verifies geometric closure for each room, Plan Surveyor builds floor plans one room at a time. This software is particularly useful for institutions that have multiple buildings for which they lack plans. Tolerances acceptable for facility management purposes can be adjusted in the software, but data collection can be tedious if a higher degree of accuracy is required.

Digital Photogrammetry

The ubiquity of the digital camera is undeniable, but in field survey these cameras are good for more than pretty pictures. When combined with photogrammetric software, digital photographs can provide a rapid means for useful data collection.

Historic American Buildings Survey Projects That Pushed the Envelope

Since 1933 the Historic American Buildings Survey (HABS) and Historic American Engineering Record (HAER) offices in Washington, D.C., have undertaken the daunting task of documenting national architectural and engineering treasures, both great and small, for the Prints and Photographs Division of the Library of Congress. Their mission of documentation makes HABS and HAER the ideal testing ground for the evaluation of building recording technologies. According to John A. Burns, FAIA, principal architect of HABS, "When it comes to new technologies, we're always interested . . . and we're always cautious." HABS uses projects with settings that challenge conventional hand measurement techniques as pilots to evaluate technological advances.

Independence Hall, Philadelphia, Pennsylvania (1986 to 1987)

Glass-plate stereophotogrammetry was used to document this historic structure. HABS specified that measurements on the building's façade should be accurate to the nearest $\frac{1}{8}$ inch. This level of detail is not apparent in the small-scale drawings, but large-scale drawings can be produced from archival-quality glass photos as necessary.

Loma Prieta Earthquake-Damaged Structures (1989)

Following an earthquake centered in the Santa Cruz Mountains of central California, a leased Rollei semi-metric camera was used to record buildings at risk of imminent collapse. Metric cameras have rigid production standards and record images with great precision. These images can later be interpreted using photogrammetric software. The precarious conditions in Loma Prieta, including continuing aftershocks, dictated an approach to architectural recording that provided both speed and safety.

National Capital Region Memorials (1991 to 1993)

Two Linhof Metrika photogrammetric 4 by 5 cameras were used to record the Lincoln and Jefferson memorials and Washington Monument (at 555 feet, the tallest structure documented by HABS) for the National Park Service. CAD files were generated from the survey data using PhotoCAD convergent photogrammetry software and AutoCAD 12.

Statue of Liberty (2001)

In a cooperative agreement with Texas Tech University, the exterior surface of the Statue of Liberty was recorded with a Cyrax 2500 laser scanner. In four days, forty-three individual scans from the thirteen points of the statue's star-shaped base generated more than 200 million data points. The resulting data will be used to monitor and manage the condition of Lady Liberty's copper skin.

Chicago Auditorium Building Documentation (2003)

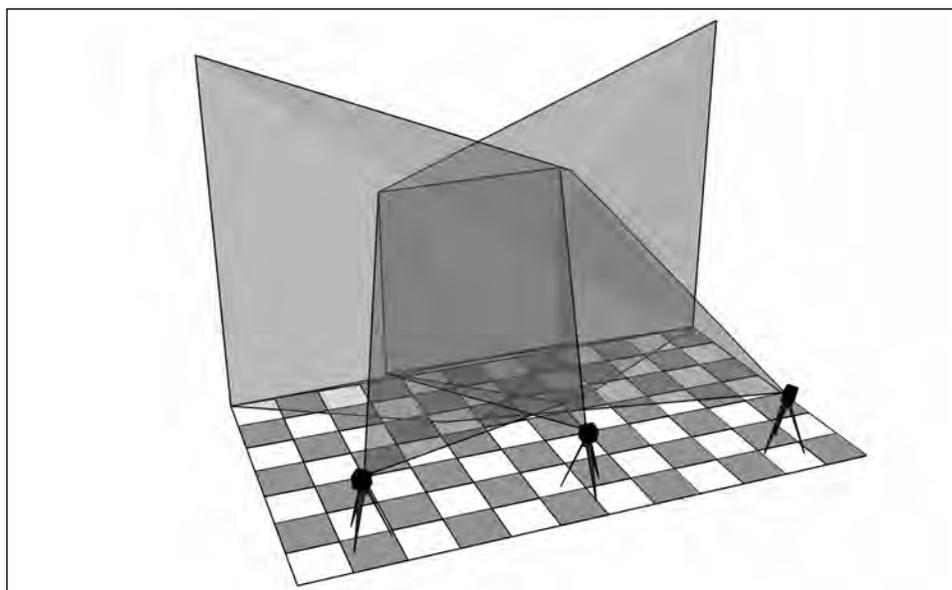
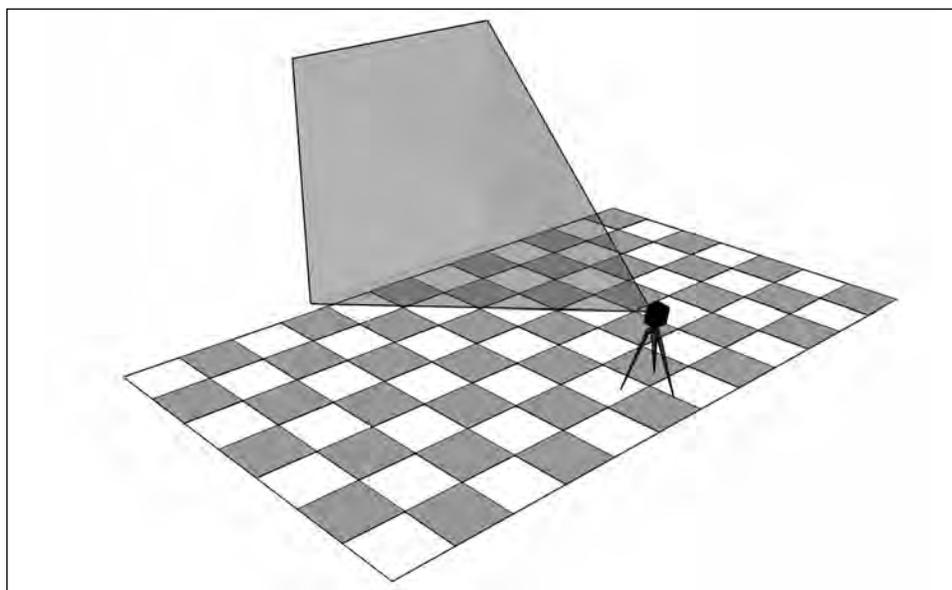
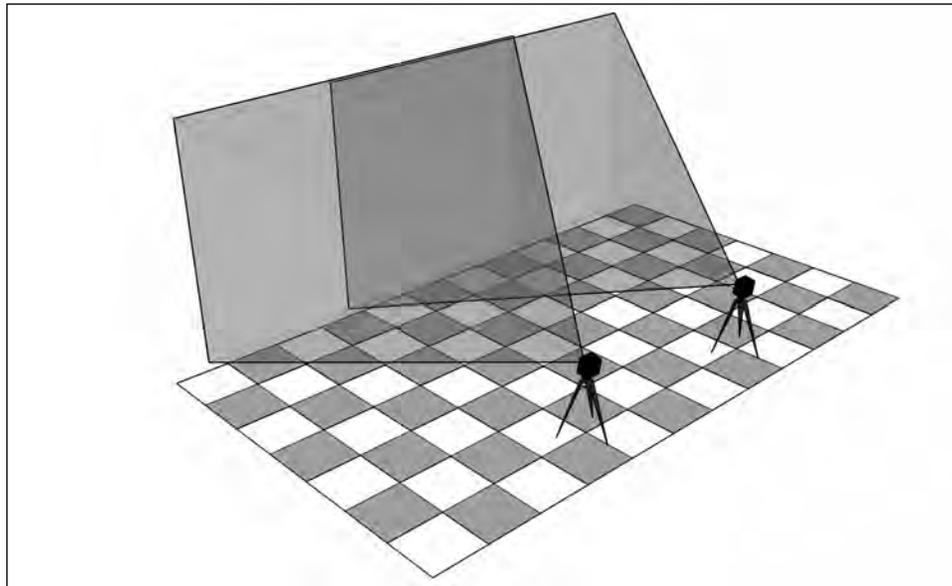
The documentation package for the survey of the Auditorium Building became the first architectural documentation set accepted into the Library of Congress that includes drawings derived from laser scanning.

These and other examples have been published in the second edition of *Recording Historic Structures* (2003), edited by John A. Burns. HABS and HAER materials, as well as those from the much newer Historic American Landscapes Survey (HALS), can also be accessed through the Library of Congress Web site.

While HABS continues to track the development of new laser scanning technologies with interest and caution, the single biggest concern is the lack of any guidelines or standards for laser scanning services. It can be challenging to specify precisely what the desired deliverable should be. Standardized guidelines deemed acceptable by the architecture community will be key to the ultimate success of this technology in the design and construction industry.

Photogrammetry is the process of utilizing photographic images to create reliable quantitative and, to a lesser extent, qualitative data. This approach is particularly applicable when a structure is not stable or access to the property is limited. Affordable photogrammetric software can be used to produce rectified photographs from which reasonably accurate dimensions may be taken.

Stereophotogrammetry (top) utilizes overlapping side-by-side images to create record drawings. Monophotogrammetry (center) utilizes a metric, factory-calibrated camera to create rectified scalable record images. Convergent photogrammetry (bottom) compares multiple images from various oblique viewpoints to create accurate record drawings.
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Unlike laser scanning, photogrammetry has an extensive history of architectural application, beginning in the mid-nineteenth century in France and Germany. While film and glass plates are often the photographic media used to record photogrammetric images, these images are scanned for data extraction through photogrammetric software systems. There are some unique benefits to this approach:

- **Established standards.** Because of the history of its architectural application, numerous recording standards enjoy long-standing acceptance among professional organizations such as the International Society for Photogrammetry and Remote Sensing (ISPRS), the American Society for Photogrammetry and Remote Sensing (ASPRS), Comité International de Photogrammétrie Architecturale (CIPA), and the International Council on Monuments and Sites (ICOMOS).
- **Media stability.** Medium- and large-format photographic plates or negatives are the products of surveys carried out with analog photogrammetric camera equipment. These materials are considered more stable than digital media on which raw field survey data may be stored. The stability of the recording media is important when the building being recorded is a significant cultural resource, long-term monitoring of structural movement is planned, or an easement is being documented.
- **Image quality.** In addition to the dimensional data they can provide, photogrammetric images may be used to assess the condition of building materials. The Historic American Buildings Survey (HABS) documentation guidelines recommend using large-format photography to document structures. Photogrammetric images are as valuable as any other large-format photograph in their ability to represent the physical appearance and context of a structure.

Stereophotogrammetry utilizes pairs of images taken from station points that are a known distance from one another, normally along a horizontal bar with an overlap of approximately 60 percent. These images are then processed using an expensive analytical photogrammetric plotter to derive 3-D measurements. Although noted for its high degree of accuracy, stereophotogrammetry is complex enough that it should be left to photogrammetric professionals.

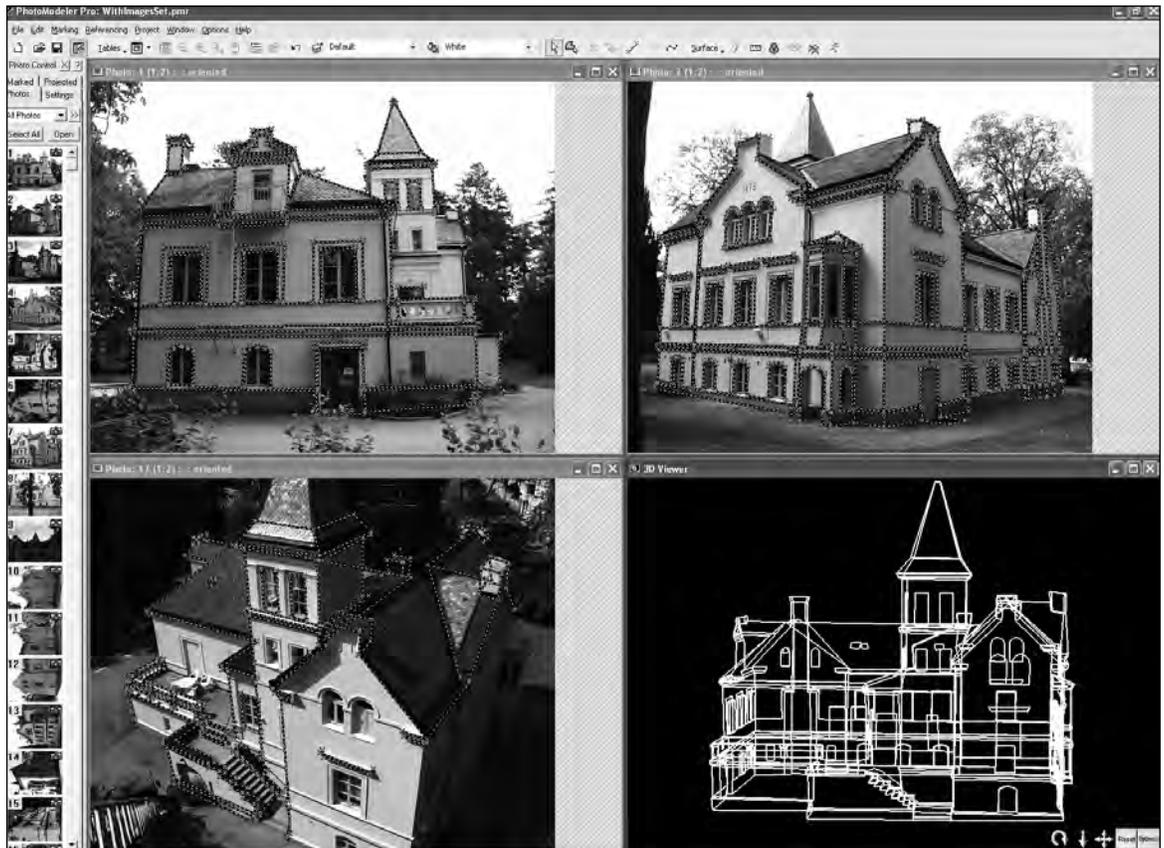
Monophotogrammetry involves the use of a metric camera to create rectified (orthographic) scalable line drawings of elevations. Metric cameras are factory-calibrated for precise photogrammetric applications. Because they are exceptionally expensive and bulky, they are not recommended for those who only infrequently require this type of equipment.

Convergent photogrammetry uses multiple images of the same building elevation taken from oblique angles. Using digital photogrammetry software, key points that appear in multiple images are selected from the image on the computer monitor. The software then uses algorithms to create a reasonably accurate computer model from which dimensions can be taken. The degree of precision that can be achieved using this method depends on the quality and resolution of the camera, the number of images containing common reference points, and the angle between images (more oblique is preferred).

Photogrammetric Software

PhotoModeler Pro software from Eos Systems, Inc., and Elcovision software from PMS AG are two popular photogrammetric systems that analyze survey images for a wide array of applications, from accident reconstruction to cultural heritage object records and architectural record drawings.

PhotoModeler Pro has gained a following among professionals and academics alike. Numerous scholarly papers presented to the International Society for Photogrammetry and Remote Sensing (ISPRS) use this software to calibrate cameras, create rectified photographs, and prepare visualizations by applying images to the surfaces of 3-D models generated by the software. The work can be tedious, but the results are reasonably accurate. Camera calibration software that accompanies PhotoModeler helps the user map the optical characteristics of the camera to improve the accuracy of dimensions.



This PhotoModeler screenshot shows three of many survey photographs containing common architectural features that were used to create the 3-D model seen in the lower right corner.

EOS Systems, Inc. and GISCOM AB

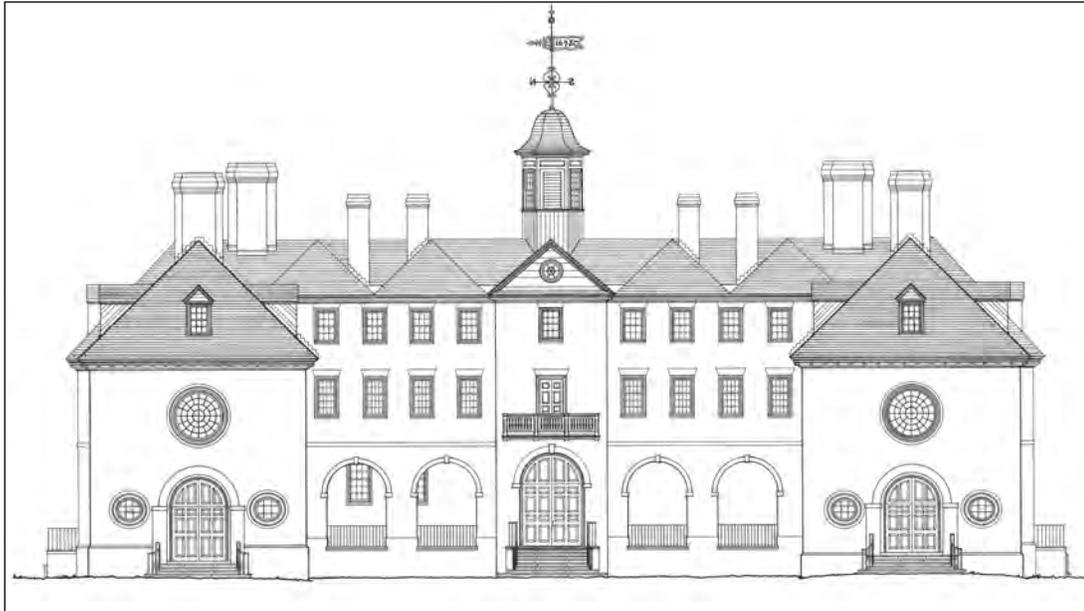
Frazier Associates, of Staunton, Virginia, uses Swiss-made Elcovision digital photogrammetry software and a Fujifilm FinePix S2 Pro, which produces 12-megapixel images, for field documentation. They produce measured line drawings, rectified scalable images, and hybrid drawings that blend line drawings and rectified images. Hybrid drawings make possible efficient representation of irregular materials, such as rubble stone masonry, and delineation of more regularly coursed ashlar masonry.

Camera Equipment

Most consumer-grade digital cameras have zoom lenses, a necessary convenience for the family photographer. When a digital camera is used for photogrammetric survey, however, great care must be taken not to change the focal length of the lens between shots, as this will impede the software's ability to resolve the geometry of the survey images. Certain known factors (such as the focal length and optical characteristics of the camera lens) must remain constant in order for the photogrammetric software to resolve the unknown geometric points. Elcovision, like most digital photogrammetric software, can accommodate input from different lenses and different cameras. However, working with a fixed set of constant factors throughout the survey process leads to greater accuracy.

German camera maker Rollei has developed a point-and-shoot digital camera, the Rollei D7, which has a fixed focal length lens and high precision, factory-calibrated optics intended for photogrammetric survey. The D7 is so specialized it must be ordered directly from its German manufacturer's Web site for around \$6,000. Other photogrammetric systems use medium-format metric cameras with digital sensor backs for direct digital image capture.

The level of precision achievable depends on the project budget. If highly accurate measurements are required, though, contracting with a service provider who has a calibrated metric camera is advisable.



The images on this page illustrate the process of creating hybrid drawings, a blend of measured drawings and high-resolution photographs taken from multiple points of view. Shown are five survey photos and a HABS drawing of the Sir Christopher Wren Building on the campus of the College of William & Mary in Williamsburg, Virginia. Frazier Associates of Staunton, Virginia, rectified and scaled these photographs for integration with the measured drawing to create the hybrid elevation drawing shown.

Frazier Associates Architects



This portion of another hybrid elevation drawing of the Sir Christopher Wren Building illustrates how a measured drawing can be combined with survey photographs to add a record of material condition data to the dimensional data recorded in the drawing.

Frazier Associates Architects

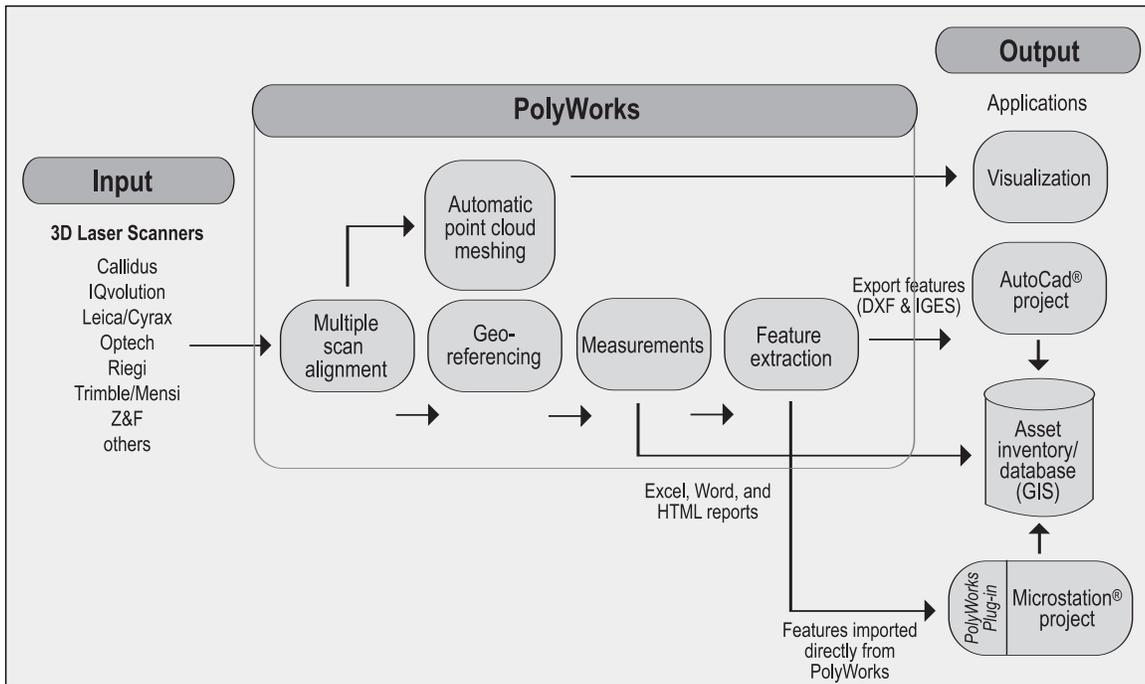
Laser Scanners

Laser scanners collect survey data by sending a stream of laser pulses toward a target, such as a building façade, in a sequential array of rows and columns. The scanner has a sensor that detects the laser pulse's reflection from the façade and calculates the exact distance to that point using the time-of-flight method in much the same way as the laser tape discussed earlier. Scanners also record with a high degree of accuracy the horizontal and vertical angles at which a pulse is sent to the façade.

With the three measurements—distance and horizontal and vertical angles—the location of each point in relation to the scanner can be recorded in three dimensions. The strength of the returning pulse is also recorded, and serves as a measure of the reflectivity of the material. Laser scanners can accurately record 3-D points in an orderly sweep over a façade, collecting data at a rate of thousands of points per second. However, since the scanner is aimed from a fixed position, its pattern of acquisition will miss areas behind projecting features in the same way a point source light would cast shadows behind such features. Thus, additional scans from other viewpoints are carefully selected to fill the voids and supplement information from the initial scans.

A completed scan—called a point cloud—comprises millions of individual points representing the surface of the façade. This product is then interpreted using point cloud post-processing software, such as PolyWorks by InnovMetric, 3Dipsos by Mensi, or Cyclone CloudWorx by Leica Geosystems. The steps involved in using the software are these:

1. View the point cloud.
2. Register multiple scans into a single composite point cloud. (This is achieved either by utilizing known control points in each scan or through 3-D geometric matching of overlapping scans.)
3. Cut slices through the point cloud, vertical slices for building sections and elevations, and horizontal slices for floor plans.



This diagram illustrates the role of point cloud post-processing software, in this case PolyWorks, in documentation projects for which laser scanning is used.

InnovMetric Software Inc., <http://www.innovmetric.com>

4. Create a mesh surface between points that shows the façade as a surface rather than a collection of points. The program can then be used to illuminate this virtual surface with a directional light source that permits a study of surface features.
5. Extract accurate dimensions of features of the façade. Because of the 3-D character of the point cloud, volumes may also be determined.
6. Align the point cloud with known geospatial control points for GIS-related projects.
7. Detect and insert common features such as corners, edges, cylinders, planes, and so on.
8. Export point clouds or resulting geometry to any of myriad common graphic file and CAD drawing exchange formats.

Laser scanning equipment was developed in stages, and three principal types are currently available for use.

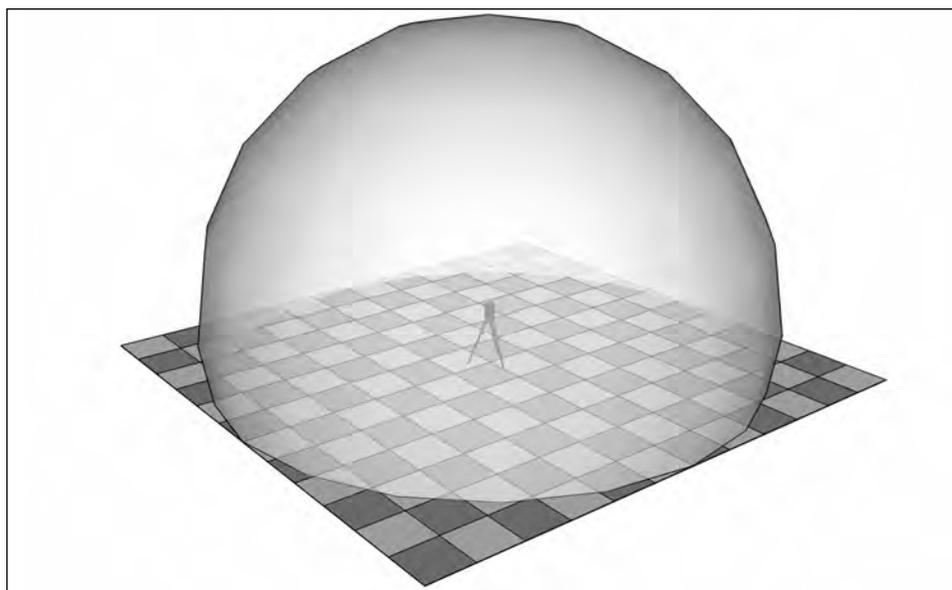
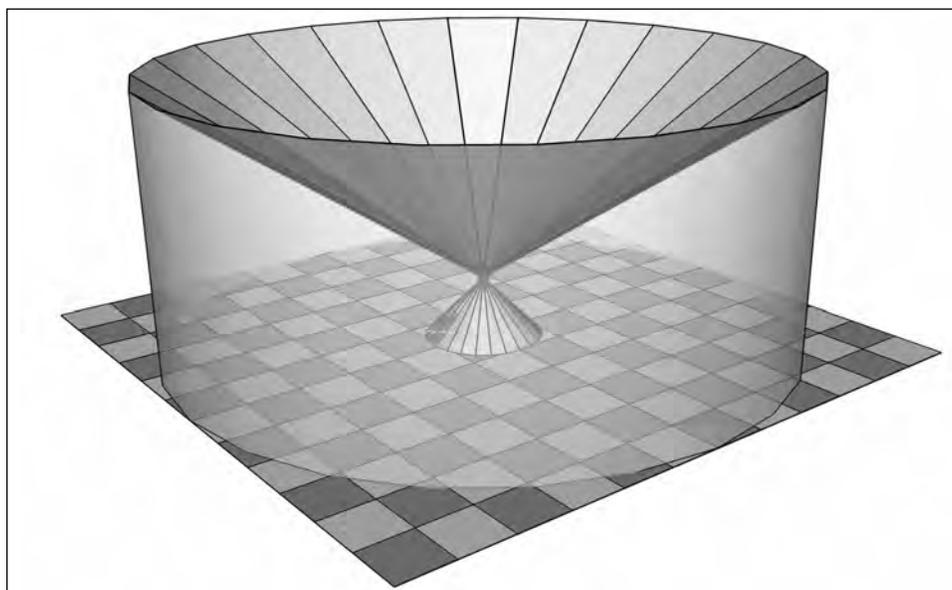
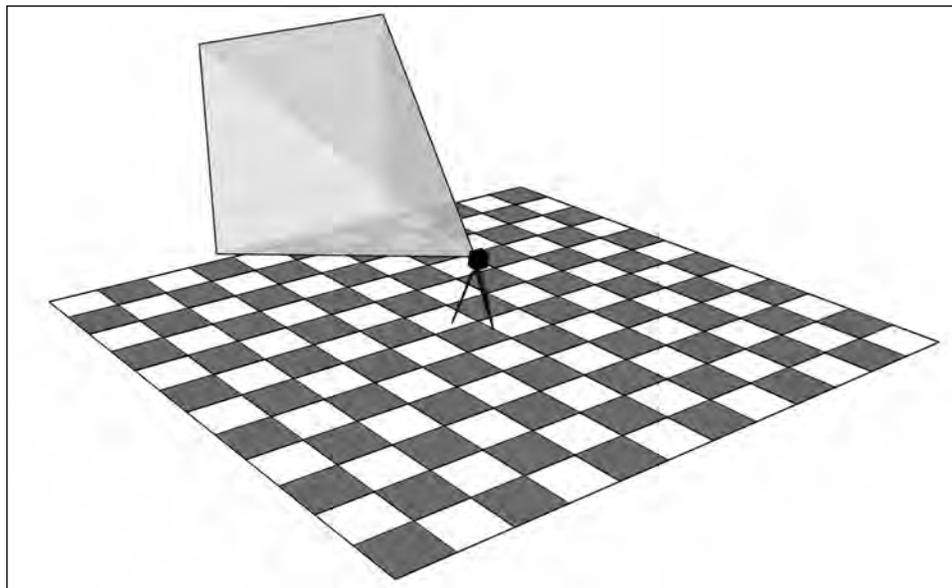
First-generation scanners work within a fixed housing that is aimed at the target, much like a camera. They have a field of view that is roughly 40 to 60 degrees vertically and horizontally with a maximum range of about 330 feet. Examples of this type include the Leica Geosystems HDS2500 and Optech ILRIS-3D.

Second-generation laser scanners have housings that rotate during the survey process so they can provide a 360-degree horizontal sweep of information. Vertical coverage varies from 60 to 90 degrees. The maximum range of this type of scanner is 100 to 200 feet. Examples of this approach include the Riegl LMS-Z360i, Mensi GS100, and Callidus CP 3200.

Third-generation laser scanners can achieve continuous vertical coverage, with the exception of the portion blocked by the scanner's base and tripod. This creates a full dome of survey data, ideally suited for interiors and greatly reducing the need to manage the multitude of individual scans once required to achieve this level of coverage. The maximum range of these devices varies from 175 to 330 feet. Examples of this type are the HDS 3000 and HDS 4500 by Leica Geosystems and the iQsun 880 by IQvolution.

First-generation laser scanners scan a fixed field of view, with a cone of vision of up to 60 degrees horizontally and vertically. Second-generation scanners rotate about a vertical axis to provide 360 degrees of horizontal coverage and up to 90 degrees of vertical coverage. Third-generation scanners can record 360 degrees horizontally and 300 degrees vertically, omitting only the area blocked by the scanner's tripod base.

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First-generation fixed scanners are capable of providing a degree of accuracy similar to that of more recent rotating models. The primary advantage of the rotating laser scanners is the speed at which they can collect data in the field. This can be a tremendous advantage for collecting interior data because a single scan per room may suffice, while a fixed scanner may require five scans to collect the same information.

Laser scanning technology offers some unique benefits for architectural survey work:

- **Speed of collection.** Less time and fewer personnel are required in the field to collect raw data.
- **Lighting optional.** Scanners are line-of-sight devices that provide their own light source, allowing them to “see” through areas in shadow that photogrammetric survey technology could not. Laser scanners work very well in the dark, facilitating after-hours survey in areas that may be heavily used during the day.
- **Direct to digital.** Creating the survey record directly in digital media reduces the possibility of introducing errors in translation, such as may occur in digitizing analog media (film or prints).
- **Desktop analysis.** Point cloud post-production software can be run on computers adept at running CAD software.
- **Geospatial data.** Inclusion of global control points (GCPs) in the scan makes it possible to orient the point cloud to known geospatial reference points.

Hybrid Laser Survey Technologies

Recent technological advances have combined the collection of digital images with laser scanning devices, making possible a result that has the accuracy of a laser scan and the legibility of a digital photo. In this hybrid approach, photographic data is correlated with the laser survey point to provide full-color data for each survey point, which is used to create a photographic “model” of the setting. This photographic effect fragments as you zoom in on the survey points, but if creating an overall visualization of the building benefits a project, hybrid scanning is a tool to consider.

Hybrid scanning techniques have been used to record objects with significant cultural heritage. Automated systems for scanning such objects typically employ a turntable on which the object is placed. As the system rotates the object, it is scanned to create both a point cloud and a digital photographic image. Software is then used to connect the dots of the point cloud with triangular surfaces. The triangulated surface of the object is then combined with its texture-mapped image. The result is a somewhat photo-realistic model that can be presented using a Web viewer plug-in, which allows a viewer to rotate and zoom in on the model.

USING SPECIALIZED SERVICE PROVIDERS

The first cost to bring laser scanning or photogrammetric survey abilities in-house can be staggering. Hardware, software, and training costs can easily surpass \$100,000 to \$200,000. Compounding the cost of buying into a particular technology is the difficulty of staying current, as continuing rapid development could quickly overshadow the survey technology in which a firm has invested. Buying equipment is more than simple acquisition; a purchase commits a firm to a particular technology. Only architecture firms that work exclusively in the existing built environment and strategically feature documentation as a service could possibly justify the cost. Consequently, specialized service providers have filled the niche market of making efficient survey technologies accessible to other architecture firms.

Contracting with service providers to collect field data for architectural recording can bring the very latest survey technologies to bear with tremendous potential benefit. The client firm gains the expertise of a professional surveyor and the benefit of up-to-date equipment and avoids the high cost of purchasing the necessary equipment. Fielding a team of contracted surveyors may cost \$2,000 to \$3,000 per day, but the potential accuracy of the data that results from such an investment can easily surpass that collected using less-advanced survey technologies.

Firms that provide specialized survey services begin the survey process by outlining

the levels of accuracy and conventions to be used for the project. Some issues considered are outlined here:

- Should the resulting documents reflect the true geometry of the building being surveyed or an orthographic representation of the data? This may seem an unusual point, but in the built environment two surfaces in a room are rarely parallel. It must be determined whether the project requirements call for the representation of that condition, or if a roughly square condition will meet the project goals.
- What are the deliverables? Most service providers supply CAD vector drawings based on the survey data, but some will agree to provide point clouds or “survey worlds.” The client firm’s CAD operators can then use this data to create plans and sections in-house, using specialized software such as Cyclone or PolyWorks. Presentation visuals can also be created using the meshing capabilities of this software. The process of interpreting raw survey data can be quite complicated and will require an investment in both software and training to be done by the architecture firm.

Firms that decide to rely on the expertise of a service provider for a project should request a list of references for projects similar in scale and accuracy. If the product of a survey is to be CAD drawings, make certain references given are for projects performed by the same CAD operator that will work on your project. This is important because proper interpretation of survey data is critical to the accuracy of drawings developed from it. For this reason, some service providers will not deliver point clouds to their clients, perhaps rightly so. In-house interpretation of point cloud data can be challenging, and should not be attempted without a business decision to support the process with proper training.

Before contracting with a prospective service provider, take the time to familiarize yourself with the company’s work process. A more automated data extraction process should reduce the involvement of technicians and thus reduce the cost of the survey.

The Archival Challenge for Digital Data

The Historic American Buildings Survey submits documentation to the Library of Congress in the following forms:

- Measured and interpretive drawings in ink on Mylar
- Large-format black-and-white and color photography
- Written historical and descriptive data
- Original surveyors’ field notes

These materials constitute the documentary record for more than 37,000 structures and sites.

Why weren’t CAD files mentioned in the list? They do not meet the criteria that “documentation shall be prepared on materials that are readily reproducible, durable, and in standard sizes.” One could argue that a CD-ROM is durable, and even of a standard size, but how many architects can open and “readily reproduce” a CAD drawing that’s even ten years old? What about x-ref paths, pen weights, and was that version 12 or 13? You may also recall that in the early days of personal computing, file extensions were not standardized to indicate the software used in their generation.

According to Howard Besser of New York University, a noted authority on digital imaging and archiving, the ubiquity of the personal computer and reliance of businesses on outdated software and aging backup tapes may very well create a decade-long dark age for future historians unable to interpret our digital flailing in the early days of the personal computer. For now, the prudent professional continues to rely on boxing hard-copy records during the project closeout process. Should electronic files be excluded from the process? Certainly not, but no product of a project that affects project cost, scope, quality, deliverable, or potential liability should be archived *solely* in digital form.

ANTICIPATING FUTURE TECHNOLOGIES

Hybrid scanning technologies are now becoming more widely available. The next logical stage in the evolution of the architectural survey process is real-time, geospatially referenced building modeling. Experiments in the use of mobile multiple-sensor arrays mounted on a moving vehicle show promise for incorporating Global Positioning System (GPS), metric video, and laser scanning technologies to provide true real-time survey. The popularization of high-definition video will further enhance the capabilities of such an approach. It is not difficult to imagine a surveyor walking through an architectural space carrying a handheld video camera with onboard GPS, inertial sensors, and laser range-finding capabilities that could “paint” photographic texture onto a meshed point cloud to fill voids in the image in real time.

Other automated systems in development use robotic devices to collect spatial data while they move through a space. Key location data results from precise monitoring of the robot’s location in relation to its starting point, as well as rapid feature detection with laser scanners.

Even incremental improvements to current scanners will enhance their architectural applications. One criticism of point clouds in architectural survey is that the precise location of individual survey points on architectural features cannot be controlled. To compensate for this, post-processing software is used to detect geometry and recommend solutions in the form of corners, edges, or cylinders, although never with absolute certainty. Enhancing point cloud post-processing by making it possible to add specific profile slices that could be recorded with continuous survey data rather than points could address this criticism. With this change, architectural surveyors who are particularly unhappy with this limitation would be more likely to adopt the technology.

Continued advances in information technology will bring additional enhancements to building recording technologies. As CAD stations move to 64-bit platforms, effectively bringing the dual-processor workstation into the mainstream, fewer compromises will need to be made in the handling of increasingly larger data sets. With the so-called prosumer digital cameras—those creating images with resolution greater than 10 megapixels—the potential of digital photogrammetry approaches that of medium-format, semi-metric film cameras, which have become more difficult to find.

Architects are responsible for evaluating the degree to which any new technology, such as those used for digital recording techniques, is appropriate to meet the needs of their clients. As a group of professionals, architects are also responsible for employing our collective knowledge to establish appropriate specifications and applications for these new technologies.

“Digital Architectural Survey Technologies” was originally published in *The Architect’s Handbook of Professional Practice, Update 2005*, ©2005 by the American Institute of Architects, published by John Wiley & Sons, Inc.

The AIA provides a contract document designed especially for alternative architectural services.

B102–2007, Standard Form of Agreement Between Owner and Architect without a Predefined Scope of Architect’s Services.

AIA Document B102–2007 is a standard form of agreement between owner and architect that contains terms and conditions and compensation details. B102–2007 does not include a scope of architect’s services, which must be inserted in Article 1 or attached as an exhibit. Special terms and conditions that modify the agreement may be included in Article 8.

The separation of the scope of services from the owner/architect agreement allows users the freedom to append alternative scopes of services.

AIA Document B102–2007 replaces and serves the same purpose as AIA Document B141–1997 Part 1.

For more information about AIA Contract Documents, visit www.aia.org/contractdocs/about

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