USING GPS TECHNOLOGY AND WEB IMAGERY IN ROOF CONSULTING

BY REMO CAPOLINO, RRC, PE

In the late 1990s, this author watched an interview of a military satellite expert on television. The man stated that the government no longer needed to send people to observe gatherings of individuals; instead, they could use satellites to watch. He went on to say that he could not divulge the extent of the technology, but that if someone had a party at his or her house, a satellite would not only be able to read the license plates of the cars parked in the driveway, but the images could probably reveal if chicken or fish was being served! This was over 10 years ago, and it did not even describe the limits of the capabilities available at that time. Just imagine what can be done now!

Technology has come a long way since the creation of the personal computer. Today, anyone can go onto any number of Web sites to view satellite imagery, aerial photography, and even street views taken from vans of almost any address in the United States. In addition to satellite/aerial/street imagery, the Global Positioning Satellite (GPS) system can provide anyone with almost any location on the globe with the precision of less than a centimeter – that is, if one is willing to pay for the equipment and software. As is the case with many advancements, scientists solve the technical hurdles, and then it is up to the engineers and other creative (and sometimes devious) people to figure out a use for the technology. The intent of this article is to provide building envelope consultants with a taste of the author's experience in using these technologies and some idea of how they already impact our industry.

GLOBAL POSITIONING SATELLITES (GPS)

In the summer of 2008, Wiss, Janney, Elstner (WJE) was asked to investigate the points of origin of leakage in a white, single-ply membrane at a 37,000-sq-ft building in the Midwest. Due to the membrane and the assembly configuration, the firm was able to utilize High Voltage Integrity Testing (HVIT) equipment that can quickly pinpoint the location(s) of the breach(es) in the membrane. WJE was told that there were dozens of leaks in the building, and the author's experience with similar previous projects indicated that there were possibly hundreds of holes that must be located.

Due to the speed of the HVIT equipment, which can test up to 40,000 sq ft a day, the slowest part of this type of project is marking the breaches that are found – both on the roof and on a roof plan. They must be marked on the roof to allow them to be found and repaired, and then they should be marked on a roof plan so they can be reported to the client. Additionally, the markings are used during verification inspections to assure that all of the leaks have been repaired properly and

Photo 1 – Handheld GPS units.

Photo 2 – Sub-meter GPS device.

that none have been overlooked. The "old-fashioned" method was to have a paper copy of the roof plan and to mark the locations of breaches, to the best of one's ability, on the plan.

The accuracy of these notes varied greatly, not to mention the difficulty of working with large pieces of plan paper on a roof that invariably is very windy. When working on a warehouse with few if any penetrations, accurately noting the location relative to perimeter edges that can be over 100 ft away can be difficult and very time consuming. One good thing is that the person holding the "dumb" end of the tape measure (or, if the consultant is more up-to-date on technology, using a laser distance meter) gets a lot of exercise.

For this project, WJE researched and tested handheld GPS equipment that is typically used by hikers or other outdoor enthusiasts (*Photo 1*). The cost of this equipment was anywhere from $200 to $400. In-house testing revealed the latitudinal and longitudinal accuracy and repeatability to be about 16 ft. While this degree of accuracy may be acceptable for hiking – if trying to find a circle of orange paint on the roof indicating the presence of a pinhole-sized breach in the membrane, or if attempting to create a roof plan with over 100 of these locations – this degree of accuracy is not sufficiently precise.

The GPS devices with the next degree of increased accuracy (typically called "sub-meter" equipment due to their ability to provide location accuracy of less than 3 ft was then tested in house. It was found that to get this degree of accuracy, "post processing" of the data was typically required. The cost of these types of "toys" was in the $4,000 to $7,000 range and varied with software interfaces and other features. Some available software packages allow users to import Google Maps or other Internet mapping data and will display color satellite images of the points of interest (*Photo 2*).

When tested on the top deck of WJE's parking garage, the accuracy of these "sub-meter" GPS devices was found to be between 3 and 5 ft prior to post processing. This is not as good as the advertisements lead one to believe, but it is precise enough for our purposes.

Upon arriving at the job site, the first thing WJE did was take readings at the corners of the building to provide an outline roof plan. Drains and other important rooftop penetrations were also located. Then, as the HVIT unit located each of the over 100 membrane breaches, the location of each breach was marked on the roof with spray paint and a reading was taken at that location on the GPS device. The GPS reading was stored in the internal memory, with data points being identified simply by typing on the LED touchscreen (Leak #1, Drain, Pipe, Building Corner, etc...). Back at the office, the specialized software was used to convert the data into a format that could be imported directly into AutoCAD. Using AutoCAD, a roof plan was created with each of the 114 breach locations and incorporated into the final report and was then provided to the client (*Photo 3*).

The file conversion and importing into CAD took no more than five minutes, which meant that the roof plan with all breaches marked took less than 30 minutes to create. The "old-fashioned" way would have required the drawing of dots on a plan in the field that would then have to be transposed point by point into CAD, which no doubt would have resulted in at least one error in transposition. The time savings from just one job paid almost half of the equipment cost.

Rather than doing all the research and equipment trials as WJE did, there are

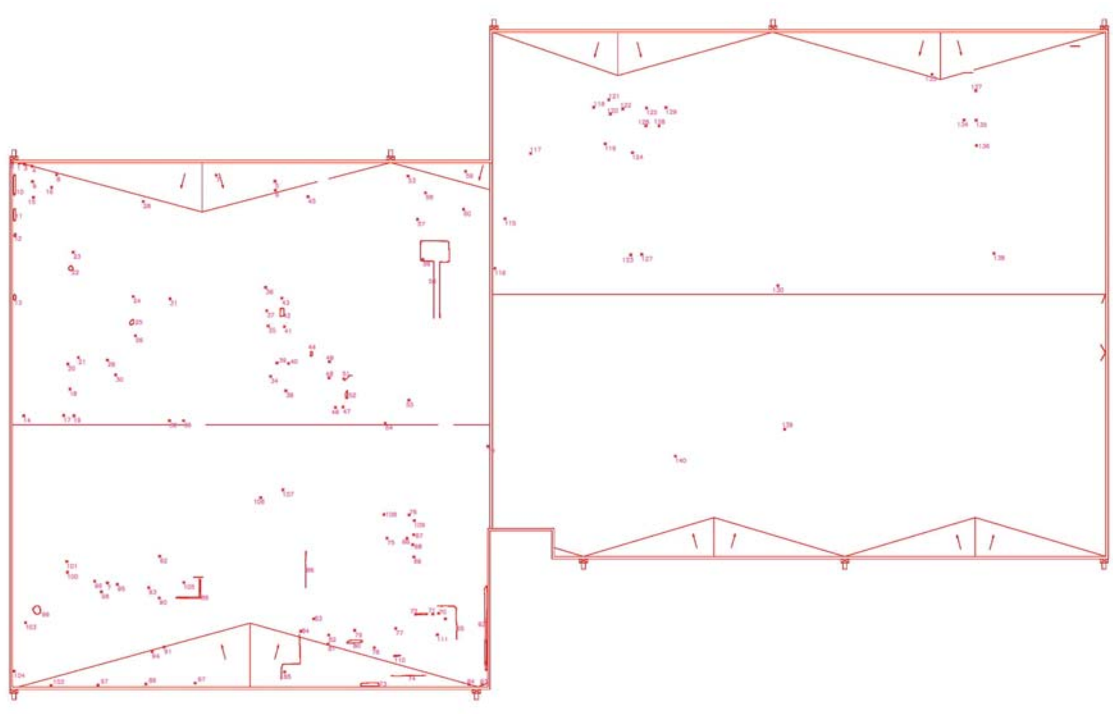


Photo 3 – Roof plan with all 114 breaches located.

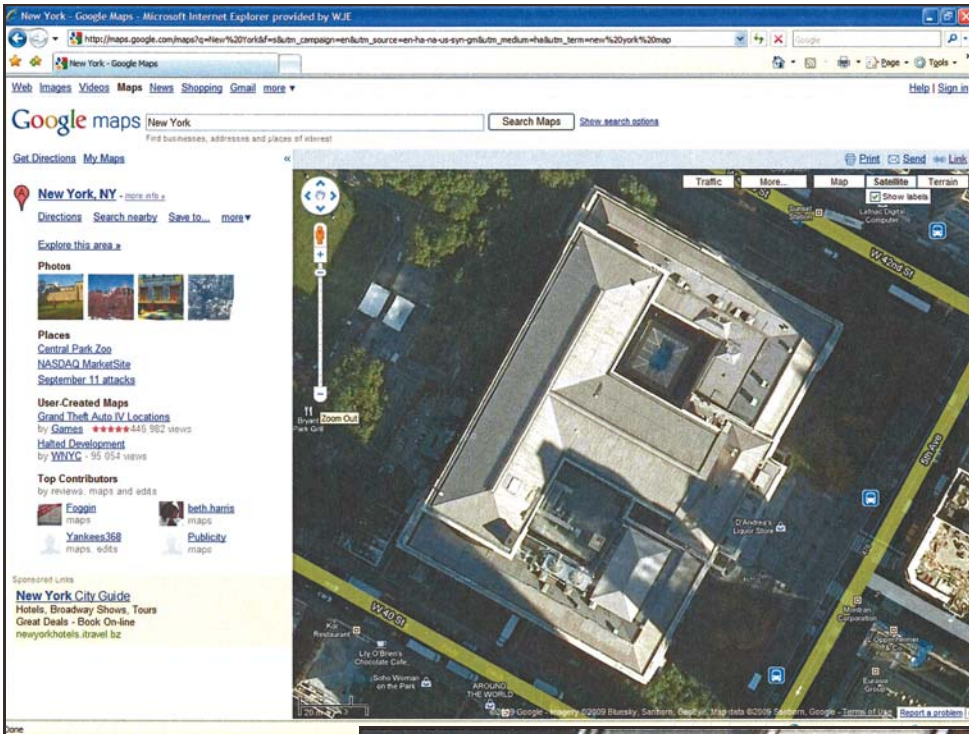
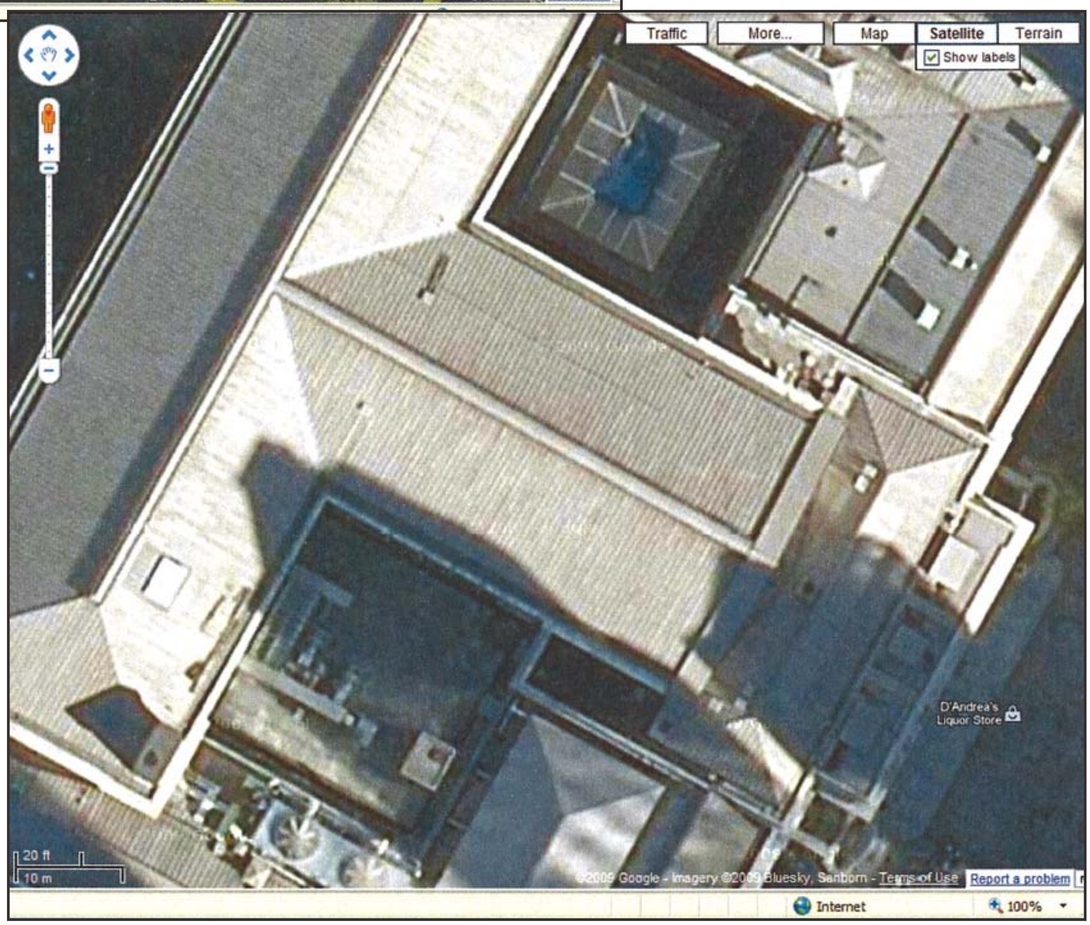


Photo 4 – Overall view of New York Public Library roof from Google Maps.

Photo 5 – Close-up view of portions of the roof at scale of 1 in = 30 ft.



some vendors who will provide customers with all the equipment and software necessary to do something very similar to what WJE achieved. Companies such as RoofExpress will sell GPS receivers and digital recording devices that allow consultants to capture GPS and photographic data as well as any notes a consultant chooses to type in on site. For an annual fee, that data can then be uploaded to the software company's Web site and formatted into one of its many templates, such as a roof take-off, repair, or replacement report, or a simple condition survey. This fee varies, based upon the number of data collection units, offices, authorized users, etc. This type of system can be a very handy "turnkey" solution to data collection, provided the report formats offered match a company's needs. EagleView Technologies is another firm that specializes in buildings with steep-slope roofing, and, for a fee, it will provide aerial views and a take-off of the roof that details the slopes, square footage of each roof area, and lineal footage of ridges, rakes, eaves, and valleys.

SATELLITE IMAGERY AND STREET VIEWS

With today's technology, a consultant can almost avoid leaving the office to do a reconnaissance site visit of a roof. Satellite imagery from Web sites such as Google Earth, Bing Maps, and many others can provide scaled images as close as 1 in = 30 ft. At this resolution, the roof perimeter, drains, curbs, and other significant conditions can clearly be seen and drawn in CAD before the consultant ever sets foot on the roof. In addition to satellite imagery, many Web sites offer aerial images taken from airplanes, and some Web sites even provide street views taken from vans traveling the streets. This type of reconnaissance information can make a world of difference when conducting an initial site visit at a project that is remote from one's office. It can also greatly improve the effectiveness and efficiency of the consultant's initial site visit, which was traditionally spent accumulating plans, sketching roofs and elevations, and doing other tasks that can now be done prior to arriving on site.

When working at the New York Public Library (NYPL) Main Branch on 5th Avenue and 42nd Street in New York City, it was no surprise that we were provided with relatively good documentation of the original construction plans and subsequent repairs and modifications. Despite this, we have used the imagery available on the Web to augment that which was provided and to facilitate our investigation and documentation of the construction.

The overall view of the roof was obtained from Google Earth (*Photo 4*) and used to check the plans the firm was provided. Once the roof investigation was under way, WJE's observations were checked and sometimes augmented by the close-up satellite imagery (*Photo 5*) that was sometimes used to count the number of batten seams at a particular section of the metal roof and compare them to the original plans and our site notes.

The resolution of the imagery available for cities such as New York City is astounding. The roof above the 5th Avenue main entrance is shown in a screen capture of an aerial photo from Bing Maps in *Photo 6*. Photos taken from the roof, as well as one obtained from Bing Maps, are provided in *Photos 7* and *8*, respectively. The detail pro-

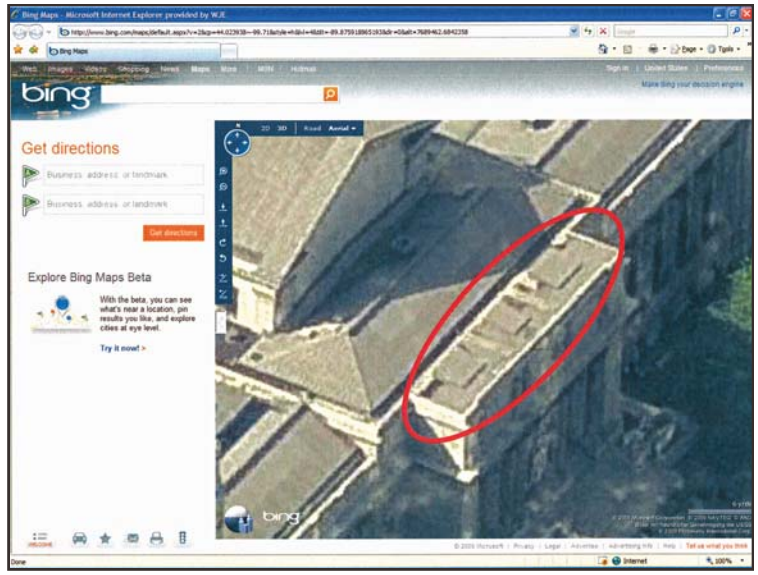


Photo 6 – Aerial photo from Bing Maps of the roof above the 5th Avenue entrance to the New York Public Library.

Photo 7 – Photo taken from the roof above the 5th Avenue entrance to the library.

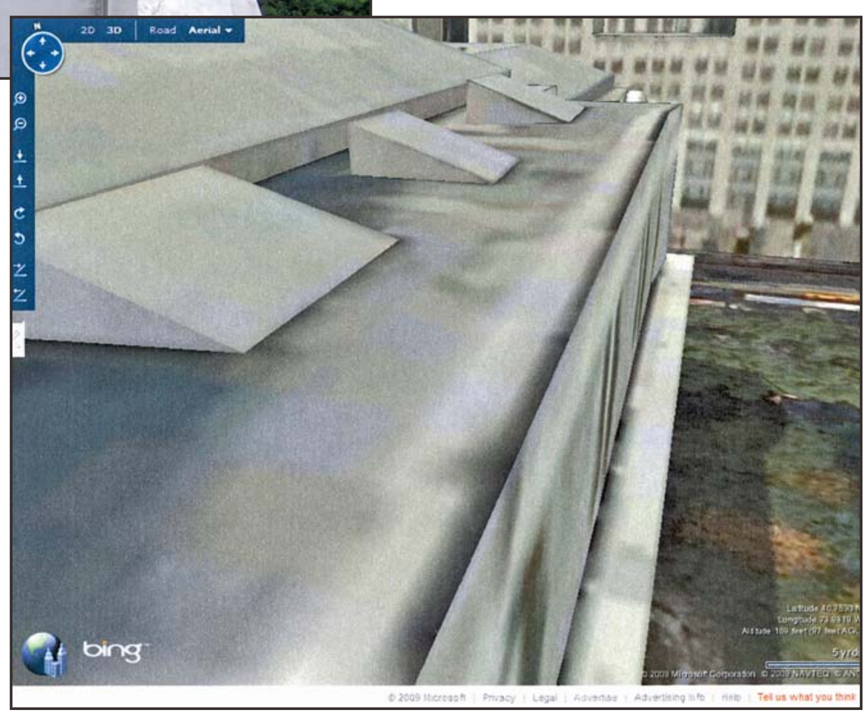


Photo 8 – Image from Bing Maps of the same location shown in Photo 7. Only the flagpole is missing!

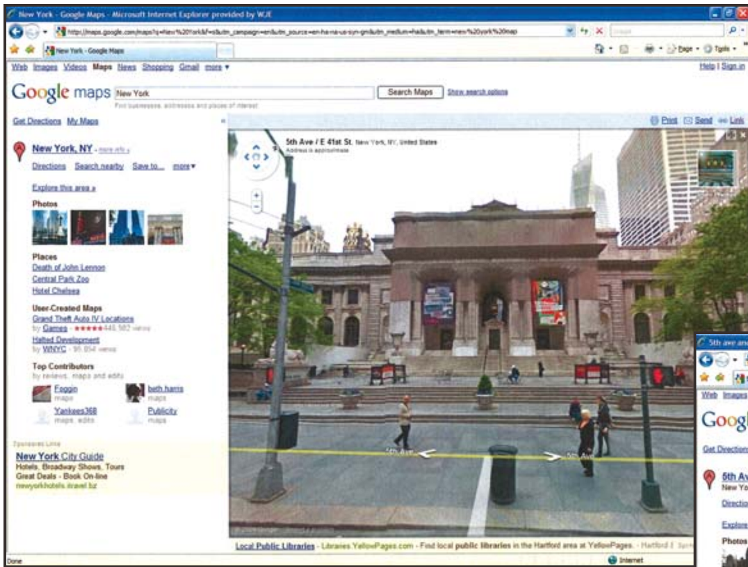


Photo 9 – Street-view photo from Google Maps.

Photo 10 – Zoom-in on center doorway from Google Maps Street View.

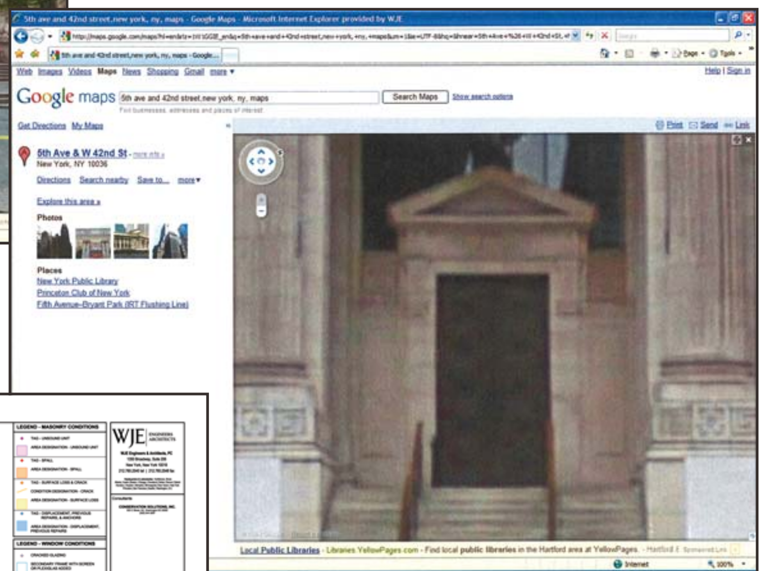
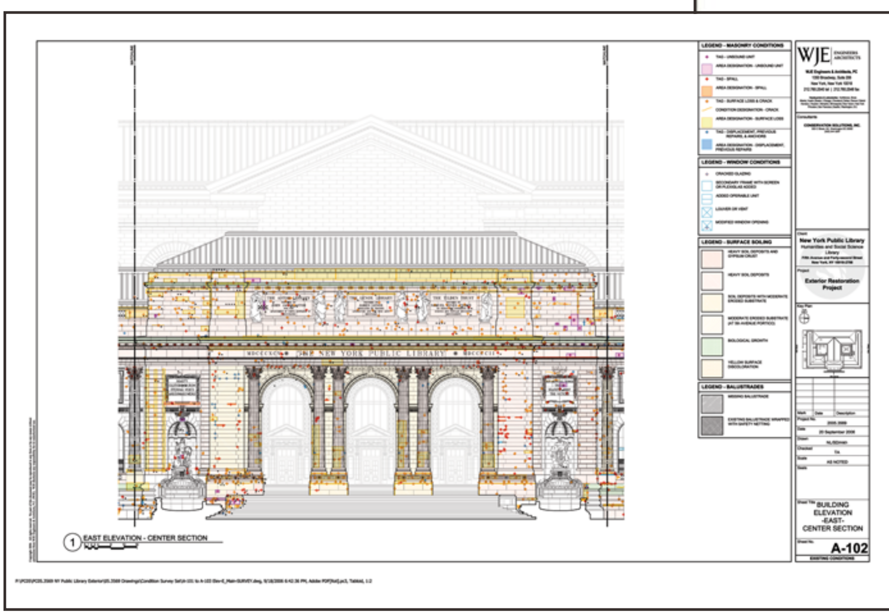


Photo 11 – Building elevation.



vided from the available Internet imagery is astonishing and can provide relatively accurate elevation information that can be used to determine the pitch of the sloped-roof areas shown in the photos. The resolution does vary, depending upon the location. As one might expect, metropolitan areas such as New York City and Boston have better resolution than rural locations; however, consultants may be surprised with the resolution of areas such as central Kansas and find the information very useful prior to a site visit.

The available technology does not stop with views from above. Many companies now drive the streets of the U.S. in vans, taking images in all directions. Elevations of buildings can now be obtained from the Web from sites such as Google Street View. For the NYPL building, Google Street View provides pretty good images of the main entrance elevation (*Photo 9*) and a zoomed-in photo of the center entry door (*Photo 10*), when compared to the very detailed drawings available of the building (*Photo 11*).

The abilities of satellite and aerial imagery, when combined with GPS devices, can be valuable resources in the tool kit of the building envelope professional, saving time and money and decreasing the possibility of human error. These technologies will only get faster, cheaper, and more accurate as time passes. As a result, the consultant of tomorrow will need to not only have knowledge of the technology, but embrace its use in day-to-day practice.

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Remo R. Capolino, RRC, PE, grew up in a family-owned specialty roofing and sheet-metal contracting business and graduated from the University of Connecticut with a bachelor's degree in civil engineering. After more than 15 years in contracting and leadership roles with the Association of General Contractors (AGC), Northeast Roofing Contractors Association (NERCA), and the National Roofing Contractors Association (NRCA), he turned to consulting, desiring to have an impact on a greater number of projects. Remo has lent his expertise in copper, zinc, slate, and other specialty roofing assemblies on a number of internationally recognized projects.