

elements



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A Fine Pairing—This 3D laser scanner is using terrestrial Light Detection And Ranging (LiDAR) scanning to capture high-definition data on an ancient structure still standing in a Roman theatre in Volterra, Italy.

No Boundaries

CEC's professionals became engineers and scientists because of their curiosity and desire to challenge their capabilities. Performing projects that rely solely on one's experience does not consistently satisfy our professionals.

When our engineers and scientists are put to the test, and I mean *really put to the test*, in some of our planet's toughest, most challenging environments—environments others may determine to be time, cost, or otherwise prohibitive—they flourish. Getting out of our comfort zone when possible to help our clients allows us to flex our creativity, apply new technologies, and exercise in new ways those deep core principles that are the basis for truly sound technical solutions. Delivering for clients in these scenarios allows us to bring better, more ingenious solutions and unconventional approaches back to the problems we solve for CEC's entire client base every day.

The projects described in this newsletter allowed our professionals to challenge their capabilities to achieve unique objectives.

Kenneth R. Miller, P.E.

President and CEO

October 2, 2017

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Civil & Environmental Consultants, Inc.

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An Unmanned Aerial Vehicle (UAV) engaged in flight over the Tuscan countryside is capturing aerial data via thousands of high-definition photographs.

Modern History:

DigITALLY Preserving the Ancient City of Volterra

In June 2017, the mayor of an ancient village went on a virtual walk through his domain as it appeared in the first century BC. The ceremonious voyage was the capstone of a nearly nine-month endeavor that began in October 2016 with an international team of technicians, software experts, architects, engineers, and historians on a mission to help digitally preserve the city of Volterra, Italy.

This walled city has been continuously inhabited for more than 3,000 years, with historic sites dating back to the fourth century BC. Its gateway, Porta all'Arco, is the oldest (and one of the last two standing) Etruscan arches in the world. The city is also home to a spectacular example of a Roman theatre and a very recently uncovered Roman amphitheater.

In 2014, the fragility and vulnerability of this village—home not only to ancient structures of historic significance but also to 7,000 people—became palpably obvious when part of the medieval wall collapsed due to a landslide. This natural event likely was not an anomaly, as earthquakes are known to rock the relaxed Italian lifestyle, giving pause to Volterra's mayor, Marco Buselli, about the potential for future damage to his village, both architecturally and culturally.

The historic significance of Volterra is top of mind for Mayor Buselli, as he has been actively pursuing a World Heritage site classification from the United Nations Educational, Scientific and Cultural Organization (UNESCO). Gathering data on and documenting the details of this village would likely support (and hopefully nudge along) the application process.

And so an initiative to collect critical and comprehensive physical data about the city was launched—championed by the Volterra-Detroit Foundation, a previously established collaboration between the city of Volterra and the University of Detroit Mercy School of Architecture. Mark Dietrick, a board member for the Volterra-Detroit Foundation, secured sponsorship for the initiative from Case Technologies, Inc., a technology solutions provider for the A/E/C industry, where he serves as director of services. Case assembled an international team—including its partner, software developer Autodesk, Inc., and staff from CEC—to bring diverse capabilities and expertise to the effort. Matt Bainbridge of CEC Bridgeport and Rick Celender and Rob Sinclair of CEC Pittsburgh would soon travel across the ocean, and in some ways, back in time to participate in the International Reality Capture Workshop.

“The project appealed to CEC because of its historic importance and because it provided an opportunity for the firm to demonstrate its expertise with cutting-edge Unmanned Aerial Vehicle (UAV), laser scanning, and modeling technologies,” noted Sinclair, CEC's Corporate CADD Technology Manager.

After settling into the Tuscan countryside and immersing themselves in its oft-romanticized culture, the team was charged with capturing all of the necessary data to complete three tasks: create a digital, interactive 3D model of the city; create Building Information Models (BIMs) for historic buildings and architectural features; and create 3D models of ancient artworks and sculptures.

Capturing physical data for the city would enable a kind of digital historic preservation and potentially serve as a preventive measure against the effects of time and natural disasters. “If you capture data every few years or so, you can measure the shifting or deterioration that gradually occurs over time,” said Dietrick.

Terrestrial Light Detecting and Ranging (LiDAR) scanners were used inside historic buildings, such as the town hall, where the team captured millions of intelligent data points about everything from the intricate



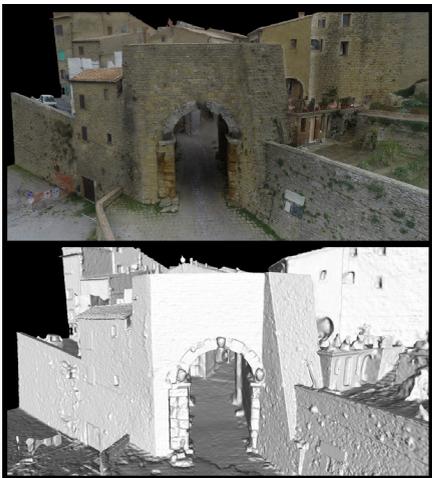
Rick Celender, head of CEC's UAV services, maps out a plan for the day's aerial data capture needs. These UAVs carried cameras, but LiDAR scanners can be mounted to collect survey-grade data at 750,000 points per second.

artwork on the ceilings to the tiniest of cracks in a pillar. The points were used to create detailed 3D models of the structures and their features, as well as a BIM, which becomes a useful tool for architects and planners should there ever be maintenance, restoration, or retrofitting needed as time decays the architecture. LiDAR scanners were also used outside, as was the case in the Roman theatre, which alone required 120 individual scan locations to capture all of the data for a complete model.

Aerial data on the archaeological sites and ancient historical structures inside the city wall were captured using UAVs (aka drones) with mounted cameras. The data were then processed into point clouds and 3D models using photogrammetry (stitching together photos into a continuous image). These models may eventually be combined with geographic information system (GIS) visuals such as land surface, roads, and rivers to create more complete georeferenced 3D digital models.

Finally, objects in Volterra's museums and architectural details from around the city were captured with high-resolution digital cameras (and, frankly, even iPhones) and converted to 3D models. The models of the artifacts will be used in virtual exhibitions, for research, and for conservation efforts. They can also be replicated using 3D printers for educational purposes or should the need arise for a tangible version.

Every evening, the team processed data captured during the day. "We took the point clouds and created a mesh, which turns the point cloud into a 3D model. From there, we can take the mesh data and incorporate it into AutoCAD® Civil 3D® or Revit® to create an as-built model," noted Sinclair. "We can truly recreate the space—put details in, tag



These textured mesh models of Volterra's iconic Etruscan gate, the Porta all'Arco, were created from a UAV point cloud. The top model is showing the RGB color of each point to bring it to life.

it with data, etc. All the measurements of the BIM were based off the point cloud or mesh we created." The processing of data continued in the months that followed the workshop.

When representatives from Case, Autodesk, and the Volterra-Detroit Foundation returned in June, they took with them a few interactive models and 3D-printed physical replicas for a presentation in the town hall. Mayor Buselli, his staff, city residents, and representatives from UNESCO were treated to a virtual reality (VR) demo that mimicked walking through Volterra's historical sites, including a chance to experience a fully recreated Roman theatre in its original glory. The public also was invited to experience the models throughout the month of July.

The team plans to launch an interactive website and online virtual gallery in the coming weeks so that all products created from the captured data can be viewed by anyone, anywhere. And though the mayor has not yet received word on his World Heritage site classification from UNESCO, it is evident that there is a great deal of interest in opening Volterra to the world and in making sure its heritage is preserved for generations to come. ■

*Visit our microsite for stunning photography, short videos, and interactive models:
www.cecinc.com/italy*



No, we didn't accidentally add two photographs of the same ceiling! The top image is an incredibly detailed point cloud created from data captured by a LiDAR scanner. The bottom image is a photograph.



What's Mined Is Now Yours: Restoring Disturbed Lands for Future Use

Before restoration, the public used this stream as a road, which degraded aquatic habitat in the watershed. A geomorphic survey and natural channel design were completed to provide an ecological improvement to the watershed. Public access was maintained, and an improved riparian corridor now runs parallel to the newly designed road.

Coal mining operations in a state with terrain as complex as West Virginia's

involve creative extraction methods, including doing so atop mountains with unusually steep slopes. As difficult as they may be to mine, these sites can prove even more difficult to reclaim when operations are complete

Further, to obtain a new environmental permit to begin extracting resources in the first place, mining companies need proof they will offset their unavoidable impacts to the landscape, and will do so in the same watershed as their intended operations.

To that end, many companies now look to mitigation banks for said proof, which comes in the form of credits. Why mitigation banks? Because organizations like the U.S. Army Corps of Engineers have stated that obtaining credits from a reputable mitigation bank is the most preferred method of mitigation, not the company's own permittee-responsible mitigation. And because they free the mining company to focus on what it does best: mine coal.

When mitigation banking sponsor Ecosystem Investment Partners, LLC, (EIP) opted to provide a thoughtful and balanced option to reclaim previously surface-mined and deep-mined coal sites in West Virginia and then offer those restored sites as options for offsetting future impacts to sites, a kind of benefit loop ensued: mine reclamation as an enabler of future mining operations.

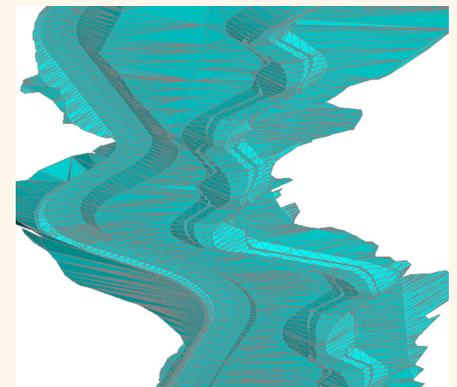
In 2014, EIP purchased three properties totaling roughly 10,000 acres, including 85 miles of streams, for a new mitigation bank in the Guyandotte and Tug Fork River watersheds in West Virginia. The bank would be developed in partnership with the Canaan Valley Institute, an organization dedicated to improving water quality in the central Appalachian region.

Where others might have opted to restore an easily accessible river, EIP specifically targeted these three properties. "We thought, 'Let's mitigate the impact on the same stream types likely to be affected as a way to restore equal balance,'" said Katherine Birnie, Managing Director of EIP. The project would be the largest stream mitigation bank ever created in West Virginia.

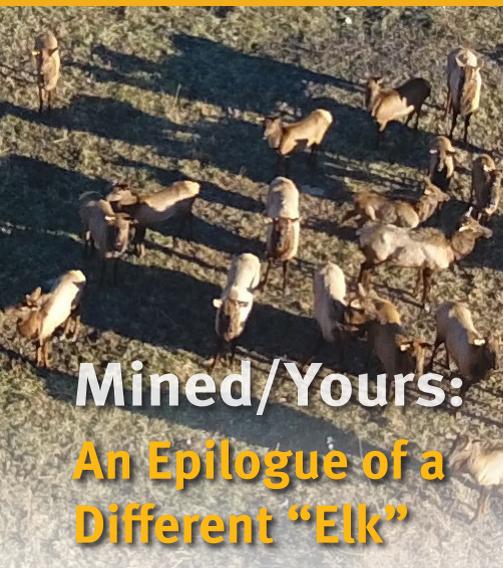
Geomorphologist Nate Ober, an ecosystem restoration expert in CEC's Bridgeport, W.Va., office, led the project design. "All of the EIP properties required not only mine reclamation but also stream restoration to reconnect, reestablish, and enhance ephemeral, intermittent, and perennial streams disturbed and disconnected by industry," noted Ober. "The project posed unique challenges compared with other mitigation banks. First, reforestation had somewhat masked the underlying land and stream disturbance. Second, we were looking at slopes pushing 70% with headwaters streams cascading down the hillsides. No one else is doing stream restoration at those kinds of slopes."

"We continue to seek out CEC for these demanding sites," Birnie explained. "The volume Nate has designed is unmatched, and his work has been groundbreaking in terms of the way it's been done."

Because the properties consisted largely of steep terrain, special restoration techniques were devised to restore stream reaches. "We had bulldozers safely but delicately navigating the steep hillsides. The contractors used a cable system and were, in a sense, 'yo-yoing' in a stair-step pattern down the mountainside," Ober recalled. "We truly pushed the limits on what you can do from a stream restoration standpoint." The project team ultimately developed innovative mitigation credit options for reforested, steeply sloped sites—options now being considered as models for similar mitigation projects. ■



This detailed 3D stream design helps provide accurate earthwork quantities and precision during construction.



Mined/Yours: An Epilogue of a Different “Elk”

The story continues ...

EIP typically opens its restored habitats to the public for recreational activities, such as hiking, hunting, and fishing. For the three reclaimed mine sites in the Guyandotte and Tug Fork River watersheds, EIP is currently leasing the acreage to the West Virginia Division of Natural Resources (WVDNR), which may eventually purchase the land to ensure long-term public access. But the WVDNR had been looking for large areas of land for something more: an elk reintroduction plan. Last fall, dozens of elk, which have not been seen in the state since 1875, were brought from Kentucky and released on one of the properties, now named the Tomblin Wildlife Management Area. It was the first-ever elk release in West Virginia. The WVDNR hopes to establish a population large enough to allow for hunting, but expects the release to benefit both hunters and non-hunters alike, as the elk are a draw for wildlife enthusiasts, too. In June of 2017, an elk calf was born, the first since the reintroduction, according to the WVDNR.

The environment that makes mining, mine reclamation, and ecosystem restoration a challenging endeavor is the very same environment that makes recreation and outdoor activity appealing, and creates prime habitat for a variety of wildlife species—even those that had once vanished. ■

Spotlight:

A Civil Exchange with Principal Adele Beaves

In July of 2017, Adele Beaves, P.E., CPESC, became the new corporate civil practice lead for CEC. She takes over for Steve Donaldson, P.E., P.L.S., who led the civil group for more than 20 years.

Q What will be your focus areas now that you are leading CEC’s Civil Engineering practice?

A First, Steve Donaldson has been a consistent, steadfast ambassador for the civil group and a mentor to me for the 17 years I’ve been with CEC. It will be difficult to fill his shoes. People have placed a tremendous amount of trust in him and have felt like they could turn to him for guidance. It will be my charge to become that person for others. I also want to focus on education and development so our staff can continue to achieve the highest level of technical competency. What I will also do, hopefully, is lead the effort to incorporate emerging technologies and tools into our daily practice, such as new AutoCAD 3D tools and InfraWorks®, augmented/virtual reality (AR/VR), BIM, LiDAR scanning, and drone applications. I’m excited to use these tools, but I’m still wary of those who use technology simply to say they’re using it and don’t truly understand the fundamentals of it. We must carefully consider how new technologies will help us do our jobs more efficiently and effectively to save our clients time and resources.

Q Is there a way to evolve what is arguably the oldest engineering discipline?

A One of my favorite things about working in this discipline is driving around town after so many years and being able to say ‘I designed that.’

I’m using the things that I designed in my daily life. Civil engineering doesn’t need any bells and whistles; it is the foundation from which our world was built. I don’t want to forget our purpose or get too flashy, but I also want to be sure we’re staying on the leading edge. That said, we do have to continuously improve, and we can do that by incorporating elements of new technology and design with well-established science-based methodologies. Always at the heart of it are good engineering principles, but we can set ourselves apart by being principled engineers who are technologically savvy and have an understanding of design.

Q How would you go about changing people’s perceptions of civil engineering firms?

A I’d like to continue opening people’s minds to the concept that, in addition to being engineers, we are design professionals. We know what it means to design and what good design means. Because we work closely with architects, we need to speak that language and have that same mentality. There’s a design process—it’s iterative, it’s collaborative, it’s testing things out, it’s thinking about more than just ‘Point A to Point B’ in solving a problem. It’s asking ourselves, ‘Is our solution elegant, efficient, artistic, and environmentally friendly? Does the design do the most good for the most people? Does the design speak to people?’ It’s about evoking an experience for the user.

ON THE LIST

2017 ENR RANKINGS

● #95 TOP 200 ENVIRONMENTAL FIRMS

● #125 TOP 500 DESIGN FIRMS

Ranked on 8 of ENR’s Top Market Sector lists:

● #7 SOLID WASTE

● #9 MINING

● #9 CLEAN AIR COMPLIANCE 

● #23 PIPELINES

● #25 REFINERIES & PETROCHEMICAL PLANTS 

● #30 SEWER & WASTE

● #45 PETROLEUM

● #47 HAZARDOUS WASTE

 = 1st Appearance!



Community Revitalization:



You can hire architects from anywhere in the world for their expertise, but there's a general misconception that, when it comes to civil engineering firms, it's only beneficial to hire the local guy down the street from the regulator's office who knows the local process. Sure it's important to have those relationships locally and to have people who know the terrain performing the work—but there's more to it than that. Civil engineers are quite integral to the design team. Choose a firm that knows your product and process and that will bring an extra level of service. My goal is for clients to always say, 'We need XYZ International Architecture Firm on the team and we also need CEC because they understand us.'

Q *There are several new regional leaders in the civil practice. What was the impetus?*

A *We've always wanted to grow the practice nationally. The timing was right recently as several market sectors within the real estate development industry are in growth mode right now after having been stagnant for several years. This growth has allowed us to bring on great people in Greenville, Chicago, Austin, Boston, Bridgeport, and Phoenix with lots of experience who were looking for change. We often find people who were not previously in an environment that enabled their growth or their ability to build client relationships. Our business model is appealing to people who want to be engaged in business development*

and who have the motivation to build a robust practice in their region. I want to make sure our local leads have the resources and support they need—a network of people working together with the strength of a big company behind them.

Q *What is a current development trend and how can CEC help clients meet their objectives?*

A *Urban infill and redevelopment. In most of the markets where there is a CEC office, there's a lot of existing underutilized property and aging infrastructure that could be repurposed and revitalized. We can tackle complex urban projects by combining the expertise of our civil engineers with that of our GIS and survey teams; our geotechnical, transportation, and structural engineers; and our experts in site infrastructure maintenance, property condition assessments, and green infrastructure design. I'm also excited to collaborate with our burgeoning economic master planning group to experience how projects come to life, how funding is created, and how the public and private sectors can work together to encourage development. We can pull all of these disciplines into the fold to deliver integrated, seamless projects. It's just one of the many things that differentiates CEC from other firms. ■*



The City of Ethridge in Lawrence County, Tennessee, has been working hard to apply for grants that will help revitalize the community. The city opted to begin its revitalization with a community park that would create a central and safe environment for residents and children. CEC designed a conceptual master plan for the park, divided into phases based on each park element—making it easy to target specific grants. In July, a ribbon-cutting ceremony was held for the completion of the first phase. CEC Nashville Project Manager Kelsey Kanspedos was invited to participate in the ceremony. ■

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Civil & Environmental Consultants, Inc.
333 Baldwin Road
Pittsburgh, PA 15205
www.cecinc.com

EMILY CHIODO | Editor/Writer

TARA KIRKMAN | Art Director/Design

PHOTO CREDITS

Rick Celender
Kelsey Kanspedos
Emily McElroy
Nate Ober
Rob Sinclair

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For information, address changes, corrections, or additions to the mail or email list, contact 1.800.365.2324 or email elements@cecinc.com.

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Back Cover:
PHOTO CONTEST WINNER
BRYCE RANDALL / BRIDGEPORT

CEC sponsors a Photo-of-the-Month contest encouraging employees to submit photos from their work sites. The winning photo is published on CEC's internal website and social media pages.





Civil & Environmental Consultants, Inc.

Corporate Office
333 Baldwin Road
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Amber Waves—Two of CEC’s surveyors head back to their truck after a long day of conducting a seven-mile limit of disturbances (LOD) stakeout in West Virginia. Photo by Bryce Randall.