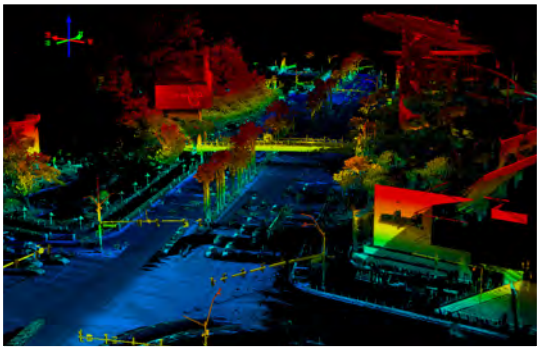
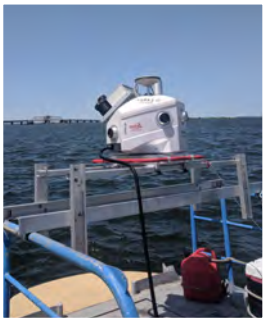
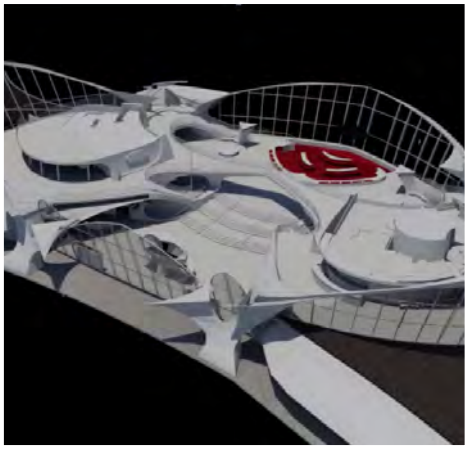
LANGAN

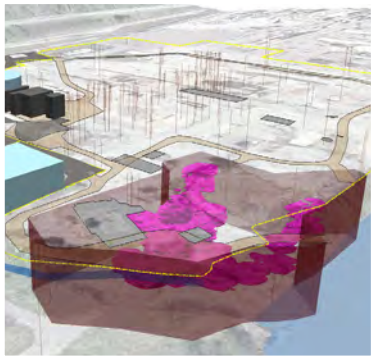
GENERAL STATEMENT OF QUALIFICATIONS

SURVEY & GEOSPATIAL





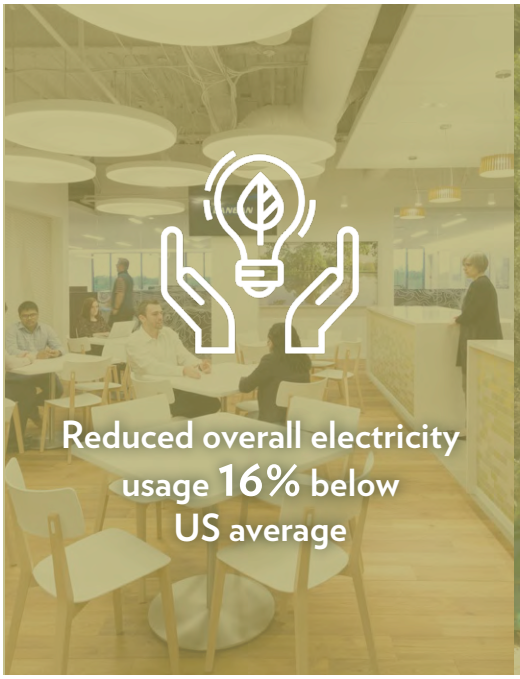


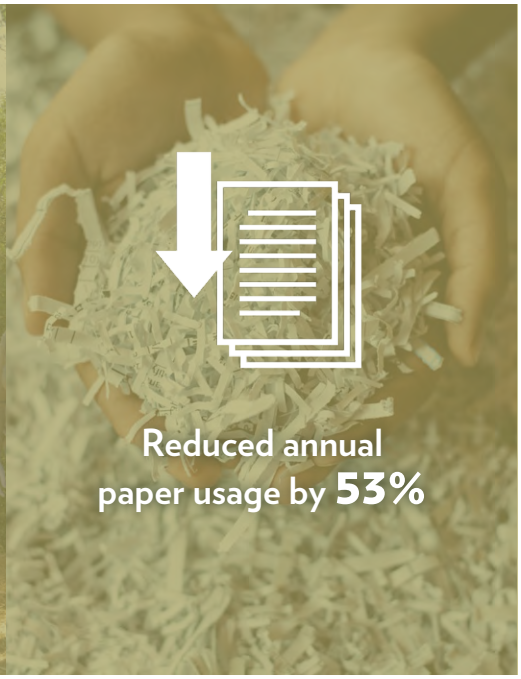
Technical Excellence | Practical Experience | Client Responsiveness

LANGAN

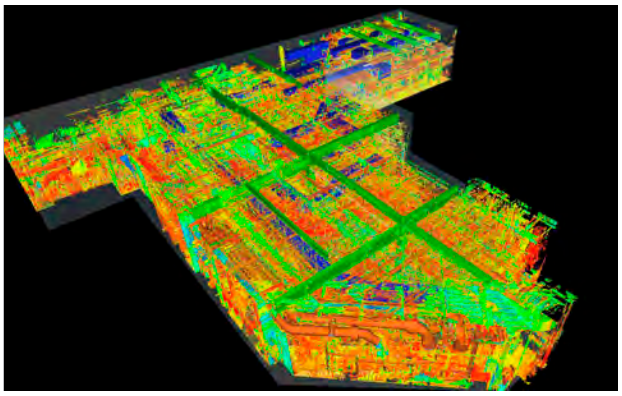
is committed to applying principles of sustainability and environmental stewardship to our internal operations.

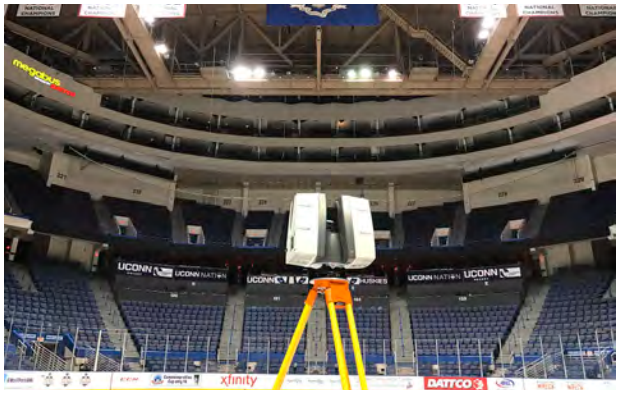
In addition to minimizing the environmental footprint of our operations, Langan partners with CarbonFund, a non-profit entity, that manages carbon reduction projects that protect the environment and reduce the threat of climate change.





Corporate Summary





Integrated Solutions. Measurable Value.

Langan provides an integrated mix of engineering and environmental consulting services in support of land development projects, corporate real estate portfolios, and the oil and gas industry. Our clients include developers, property owners, public agencies, corporations, institutions, and energy companies around the world.

Founded in 1970, Langan employs over 1,600 professionals in its Parsippany, NJ headquarters and among regional offices in:

- Princeton, NJ
- New York City, NY
- White Plains, NY
- New Haven, CT
- Boston, MA
- Philadelphia, PA
- Bethlehem, PA
- Doylestown, PA
- Pittsburgh, PA
- Cleveland, OH
- Chicago, IL
- Arlington, VA
- Nashville, TN
- Charlotte, NC
- Miami, FL
- Fort Lauderdale, FL
- Tampa, FL
- West Palm Beach, FL
- Orlando, FL
- Houston, TX
- Austin, TX
- Tyler, TX
- Dallas, TX
- Denver, CO
- Phoenix, AZ
- San Francisco, CA
- Oakland, CA
- Riverside, CA
- Sacramento, CA
- San Jose, CA
- Los Angeles, CA
- Santa Barbara, CA
- Irvine, CA
- Salt Lake City, UT
- Seattle, WA

Langan International, the firm's wholly owned subsidiary headquartered in New York City, provides all firm services for projects in the Middle East, Eastern Europe, Latin America, and the Caribbean. Langan International regional locations are in:

- Athens
- Calgary
- Cranbrook
- Dubai
- London
- Panama

SUSTAINABLE DESIGN:
As the recognized industry leader, Langan's team of over 125 LEED Accredited Professional provides sustainable solutions for every aspect of your project.

LANGAN

Contacts

- New Jersey
- New York
- Pennsylvania/Ohio
- Connecticut
- Mid-Atlantic Region
- Gulf States
- California
- Nationwide
- New England

JOSEPH ROMANO

PLS, Principal | SURVEYING

jromano@langan.com/973.560.4618

PAUL FISHER

PLS, Principal | SURVEYING

e: pfisher@langan.com p: 212.479.5580

SHAUN HIGGINS

PLS, Associate Principal | SURVEYING

shiggins@langan.com/215.845.8917

ANDY IVES

PLS, Associate Principal | SURVEYING

aives@langan.com/203.784.3041

LANGAN

Surveying/Mapping

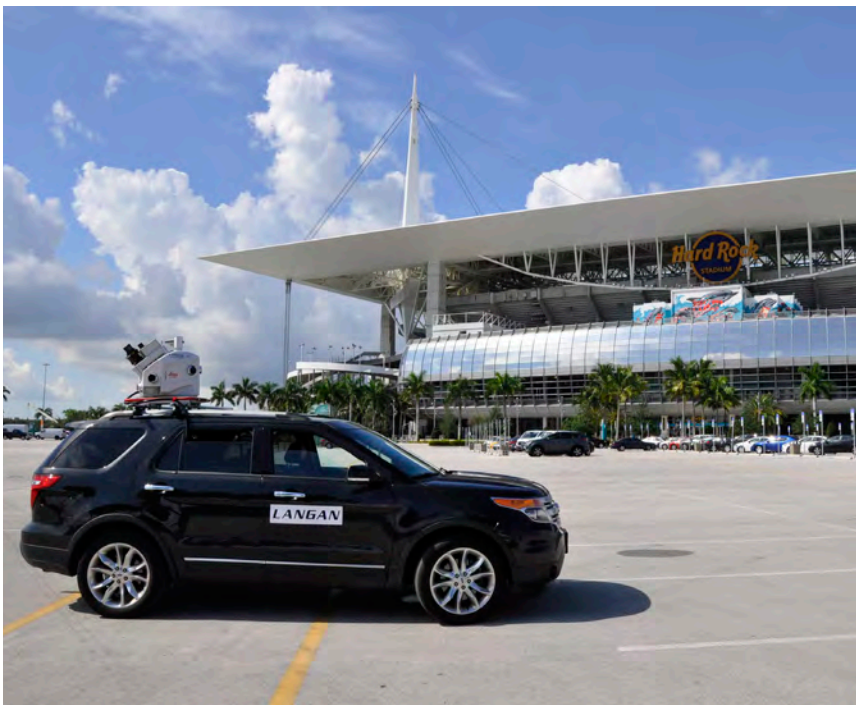
Accuracy and Efficiency

Langan's survey group combines experience, technology, and responsiveness to meet our clients' needs and maintain project schedules and budgets. The group is versed in traditional survey methods, as well as cutting-edge technologies including 3D Laser Scanning, UAV/Drones and BIM support. The group's efforts are overseen by Professional Land Surveyors who bring experience and a solid knowledge of traditional methods to new innovative technologies. Seamlessly coupled with Langan's integrated technical disciplines, the group is positioned to meet every survey challenge.

Langan approaches surveying problems with a combination of knowledge, experience and innovation that we believe renders the most efficient solutions while maintaining cost effectiveness. Our staff of professionals and specialists combines their knowledge and experience to provide comprehensive services to our clients. They are supported by field personnel who possess an understanding of both the technical aspects of survey and the practical potentials of design/construction. Either completing a standalone mapping task or when seamlessly coupled with Langan's integrated technical disciplines, the group is positioned to meet every survey challenge. We apply the same degree of professionalism and interest to both large scale and small project assignments.

Langan Survey/Mapping Services:

- Boundary Surveys
- ALTA/NSPS Land Title Surveys
- Topographic Surveys
- GPS
- GIS/LIS Data Acquisition/ Systems
- Riparian Surveys
- 3D Laser Scanning
- Construction Stakeout
- Hydrographic/Bathymetric Surveys
- Environmental Surveys
- As-Built Surveys
- Photogrammetric Control
- Deformation/Monitoring Surveys
- Wetlands Location Surveys
- Utility Surveys
- Subdivisions
- Highway/Route Surveys
- UAV/Drones



High Definition 3D Laser Scanning

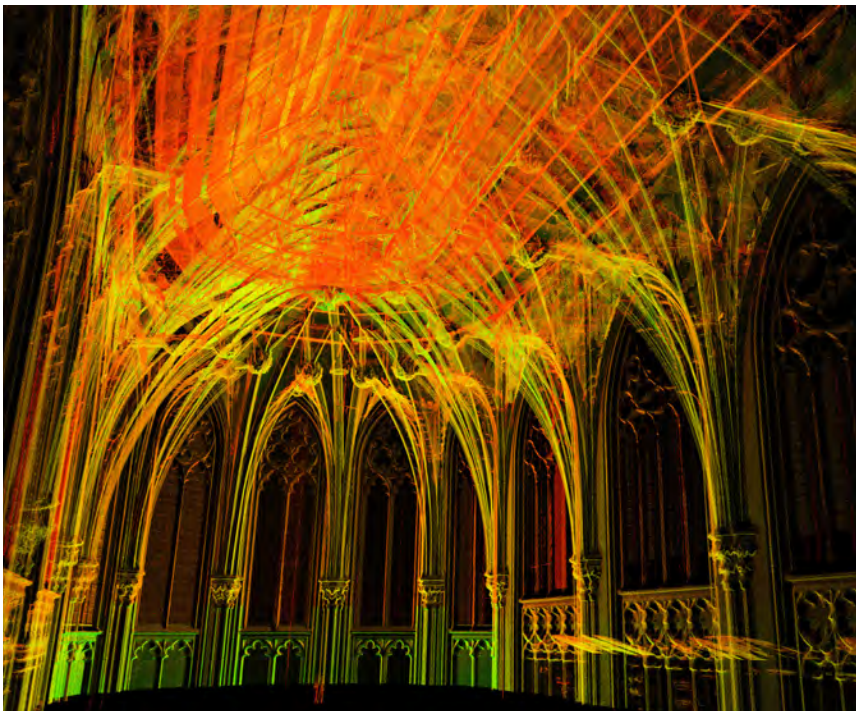
Work in the Data, Not on the Data

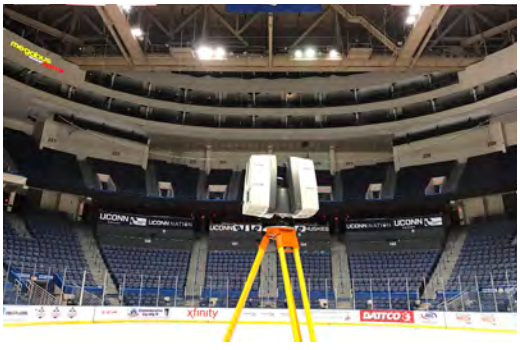
3D Laser Scanning is changing the surveying/mapping industry and Langan is leading the revolution. Since the addition of High Definition Laser Scanning services in 2003, Langan has offered the most accurate and highly detailed existing conditions surveys possible. This advanced technology allows for the collection of millions of data points in less time and with lower overall cost than traditional techniques. 3D Laser Scanning equipment allows end users to accomplish project objectives more efficiently and accurately at all stages, in turn minimizing overall project costs and reducing turn around time, while achieving a higher level of detail.

Our ability to offer a combination of High Definition Laser Scanning and conventional surveying methods allow Langan to deliver a complete product. As with all of our surveying services, the scanning effort is overseen by Professional Land Surveyors who bring experience and knowledge of traditional methods to this cutting-edge technology.

In scanning, the data collected is known as a “point cloud” which contains a 3D database of the entire project area and allows the measurement of any surface information that is visible in the cloud to be used during the entire project lifecycle. After processing, the data from the “point cloud” can be utilized to produce dimensionally correct 3D models and/or 2D dimensional plans, with outputs to Microstation, AutoCAD or a host of other platforms. The registered data can also be used as a base to create highly detailed site visualizations or mass models. The end data can be used for the generation of existing condition BIM models, forensics studies, to determine possible construction conflicts, to validate construction/fabrication dimensions, or even to model major motion picture sets.

With prior technologies the end user had to work on the data. High Definition Laser Scanning allows the end user the ability to work in the data and be “on site virtually” with the push of a button.





LANGAN

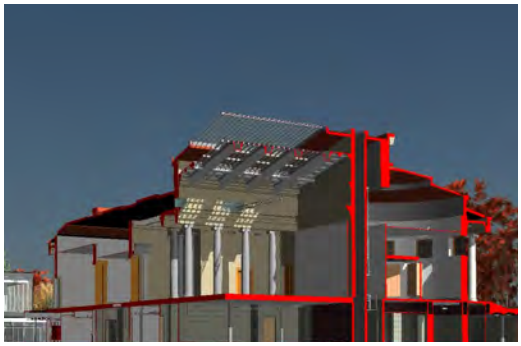
BIM/Building Information Modeling Support

Leading the E-BIM Revolution

Construction depends on sharing accurate data. E-BIM or BIM (Existing Conditions Building Information Modeling), as it is known to the AEC industry, is changing the way we use data. As in many other design industries such as automotive, aerospace, aviation and others where computer modeling is the norm, the construction industry now recognizes the benefits of this modeling revolution. Modeling allows the entire design team to use data in a new fashion, pre-assembly of the project in a virtual 3D world, not on flat 2D paper. By assigning attribute data to each component of a building, structure or site, the design team can assemble, analyze, coordinate, review, prepare cost estimates, and make informed decisions early in the design process. This new way of using data bridges a wide gap in the design process, greatly reducing cost and schedules while allowing the final product to be consistent with the original design intent. For the first time in our industry, IM allows a team member to truly visualize the data, and Langan is leading this 3D revolution.

Langan saw the benefits of E-BIM early on as our Survey Group was spearheading their way through the Nationwide 3D Laser Scanning Market. As with many design challenges, the need for accurate and precise existing conditions data is critical to the outcome of a project's design. This need is greatly magnified with building reuse and interior construction projects. The solution was obvious, offer our 3D Laser Scanning services and provide the same level of "survey grade data" to the IM world (construction industry). Who better than licensed surveyors could understand the accuracy requirements and adjustments in scanning control needed to produce accurate existing conditions base mapping?

To date, Langan has successfully provided existing conditions data for a wide range of IM projects. From standard 2D CADD elevation and floor plans to fully intelligent 3D, 4D, and 5D models, Langan continues to lead the industry with unmatched solutions to complex challenges.



LANGAN

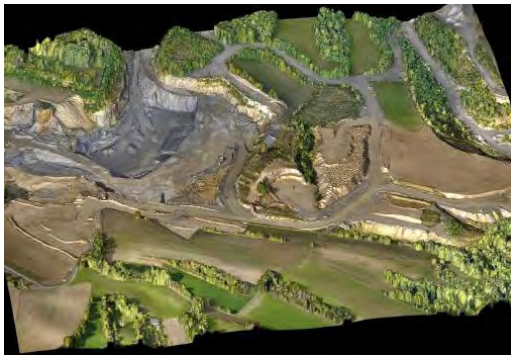
Unmanned Aerial System (UAS) Data Collection and Mapping

Raising the *Data* Bar

Langan has been actively positioned to provide Unmanned Aerial System (UAS) acquisition and data processing services to support and supplement our clients needs. Utilizing DJI Unmanned Aerial Systems, Langan can provide aerial imagery products and services that are in compliance with Federal Aviation Administration (FAA) rules and regulation governing the commercial operation of unmanned aerial systems. Langan's UAS Data Collection and Mapping program has been designed to provide aerial video and imagery, orthophotography, digital point clouds, planimetric and topographic mapping products in various levels of accuracy on projects where the geographic size, location, budget or schedule of the project limits the effectiveness of a manned aircraft acquisition. Our UAS acquisition and processing team has the ability to mobilize quickly and efficiently, taking advantage of the nimbleness of the collection platforms. Processing of project deliverables as well as any required field control surveys are performed in-house, while being controlled, registered and projected to the level that satisfies most project requirements and specifications.

Langan UAS Services:

- Construction Monitoring
- Site Reconnaissance
- Site Design
- Aerial Photography/Videography
- Orthophotography
- Planimetric/Topographic Surveys
- Colorized Point Clouds
- GIS/LIS Data Supplementation
- Wetlands Surveys
- Subdivision Surveys
- Campus Mapping
- Environmental Surveys
- As-Built Surveys
- BIM Modeling



LANGAN

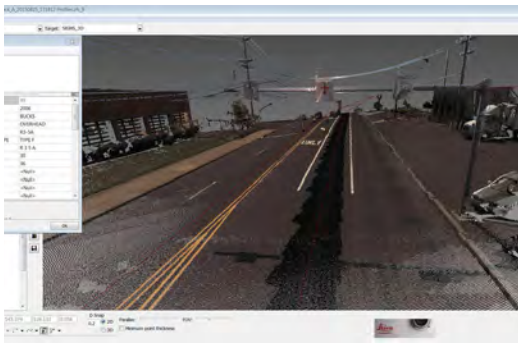
Mobile LiDAR Data Collection and Mapping

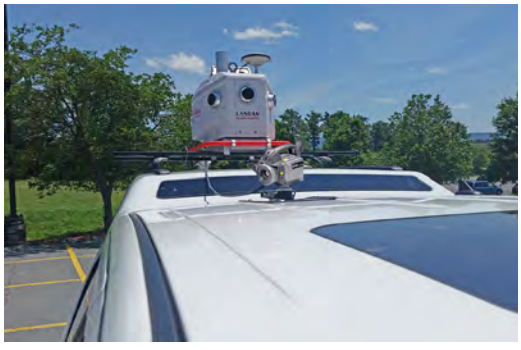
Taking Scanning on the Road

As one of the emerging technologies in the Surveying/Scanning/Mapping/GIS profession, Mobile Mapping has been added to Langan's capabilities. Langan has acquired a Leica Pegasus 2 mobile mapping system and has built a team of professionals to provide our clients with these new services. Langan's mobile mapping combines the usability and familiarity of videos and photographic images with the accuracy and precision of LiDAR point clouds to deliver a total asset management solution. The Pegasus 2 is fully transportable and can be shipped anywhere in the world to provide cost effective mobility while maintaining the accuracy and precision required by our clients. The Pegasus 2 can be placed on a vehicle for roadway based collection, on a boat for shoreline or bridge projects, on a rail car for railway and transit applications, or even on an ATV/UTV for off road uses in the Utility, Oil and Gas, and Electrical energy industries. Langan's survey and mapping group has been a leader in the 3D scanning and BIM markets for years by providing survey grade existing information in innovative formats. The new mobile mapping department is the next part of that innovation.

Langan Survey/Mapping Services:

- Boundary Surveys
- ALTA/NSPS Land Title Surveys
- Topographic Surveys
- GPS
- GIS/LIS Data Acquisition
- Deformation/Monitoring Surveys
- Wetlands Location Surveys
- Utility Surveys
- Subdivisions
- 3D Laser Scanning
- Campus Mapping
- Mobile Scanning/Mapping
- Construction Stakeout
- Hydrographic/Bathymetric Surveys
- Environmental Surveys
- As-Built Surveys
- Photogrammetric Control
- Riparian Surveys
- Highway/Route Surveys
- BIM Modeling
- Geographical Information Systems





LANGAN

GIS/Data Management

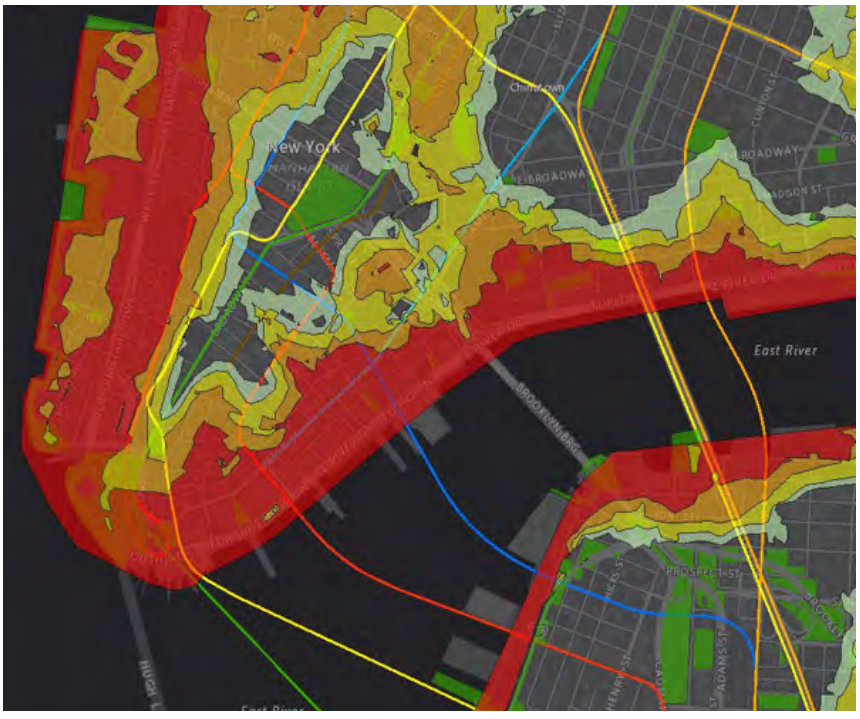
Cutting-Edge Data Visualization

Langan utilizes the latest CADD, GIS, and Data Management software applications to analyze and design cost-effective solutions to our clients' problems. Our CADD-GIS group provides custom training, programming, and technical support to both our staff and to our clients in Autodesk's Map, Land Desktop and Civil 3D, as well as ESRI's ArcGIS suite of applications including ArcMap, ArcEditor, and ArcInfo and their assorted extensions. Langan utilizes SITEOPS software for value engineering and to provide design optimization of land development projects. We use Earthsoft's EQuIS Chemistry and Geology products to manage large datasets for our environmental and geotechnical clients, and use GIS, Rockworks, GMS and EVS to visualize the data. Langan also uses 3D Studio and various post production products to generate computer generated animations of our clients' projects, allowing them to see the virtual design before construction.

Langan provides our clients with easy access to their project data by developing Extranets and Sharepoint data portals that allow for easy data exchanges between all of the project team members. Our Web designers can develop custom Web-based applications using ESRI's ArcIMS and ArcGIS Server to further leverage our clients' data.

Langan GIS/Data Management Services:

- Software Integration and Technical Support
- Custom Programming
- Software Training
- Web Design
- CADD Conversions
- GIS Mapping
- 3D Animations
- SITEOPS®
- Data Entry



Key Personnel

LANGAN

Key Personnel

Joseph E. Romano, PLS, Principal, Senior Associate/VP | Parsippany, NJ

Mr. Romano has a broad range of experience in surveying, construction and design-related fields for over 42 years. Starting his career as a title searcher, he developed his expertise while working as a draftsmen, construction inspector, rodman and survey party chief, and department lead. His experience in land surveying ranges from traditional survey tasks, including highly detailed geodetic networks, to advanced mapping technologies and expert witness services. As Director of Surveying and Manager of the Langan Survey Department, Mr. Romano is very active in promoting land surveying and has been a guest speaker at numerous national and international conferences. In addition to his areas of special interest, which include boundary law and GPS/GIS/Laser Scanning technologies, his passion to give back to the surveying profession, as well as other aligned professions, has inspired him to be active at the Board level of numerous educational institutions and professional organizations. Of special note is his cofounding of the USIBD (United States Institute of Building Documentation), the only non-profit organization dedicated to the profession of building documentation.

Education

New Jersey Institute of Technology

Professional Registration

Registered Professional Land Surveyor (PLS) in NJ, NY, CT, DC, FL

Paul Fisher, PLS, Principal, Survey Manager/VP | New York, NY

Mr. Fisher's 32 years of experience have exposed him to all phases of land surveying, including topographic, boundary, subdivision, construction stake-out, and photo control. He has extensive experience in G.P.S. surveying, and has also spearheaded Langan's foray into laser scan based surveying. His principal focus is on laser scanning and modeling, and providing solutions for difficult surveying tasks such as tunnel surveying, subsurface surveys, and detailed mapping of historic structures. Mr. Fisher has also developed educational programs on laser scanning and general surveying which he has presented to a wide array of architects, engineers, construction managers and attorneys. His responsibilities include management of the New York survey office, which services Langan's New Jersey, Connecticut, and New York clientele.

Education

M.Sc., Civil Engineering
Ramapo College of NJ

Professional Registration

Registered Professional Land Surveyor (PLS) in CT, NY

Key Personnel

Shaun Higgins, PLS, Associate Principal, Survey Manager/VP | Philadelphia, PA

Mr. Higgins has over 30 years of experience in all aspects of land surveying. He is well-versed with all types of modern surveying field equipment and various software systems for computer aided drafting. The majority of Shaun's experience has come as a survey project manager, in charge of field and office personnel involved with gathering and manipulating existing conditions information for residential, retail, institutional and commercial properties and preparing and managing construction layout projects for various types of development. Shaun also has extensive experience with 3D laser scanning and modeling services.

Education

Dublin Institute of Technology, Ireland

Galway Regional Technical College, Ireland

Professional Registration

Professional Land Surveyor (PA, VA, WV, NC)

Andrew G. Ives, PLS, Associate Principal | New Haven, CT

Mr. Ives has over 22 years of experience on projects throughout the northeast including Massachusetts, Connecticut, and New York. He provides land surveying and mapping services in both the public and private sectors, and is responsible for project coordination, research, field location, mapping, boundary determination, and construction stake out services. He currently oversees surveying services for the Northeast with staff in White Plains, NY, New Haven, CT, and Boston, MA and holds licenses in New York, Connecticut, and Massachusetts.

Education

A.S. Engineering Naugatuck Valley Community College

Professional Registration

Land Surveyor (MA, CT, NY)

Affiliations

Connecticut Association of Land Surveyors

New York Association of Professional Land Surveyors

Key Personnel

Brett Milburn, GISP, Associate Principal | Bethlehem, PA

Mr. Milburn has over 20 years of experience in Geographic Information System (GIS) mapping and analysis activities along with enterprise database design and management to support compliance, municipal, utility, renewable energy, environmental, survey, litigation, natural resource, geotechnical and site/civil projects. In his current role as the leader of Langan's GIS and Data Solutions group, he oversees various GIS, enterprise data management and web/mobile technology related projects, and is responsible for the development of this technology within the firm. This includes managing a diverse staff of analysts, programmers and engineers on a wide variety of projects, researching new technologies, beta testing, development of corporate-wide standards and best management practices along with training of staff on these technologies. Over his career, he has amassed extensive experience in the use of Esri products including ArcGIS Desktop and associated extensions, ArcGIS Server and ArcSDE along with Earthsoft's EQuIS data management software based on Microsoft's SQL platform. This includes using the aforementioned software to support mobile LiDAR scanning, Unmanned Aerial Vehicle (UAV) and field GPS survey data collection and reduction, due diligence mapping, renewable energy and contaminant concentration modeling, 3-D model and animation development along with web and mobile-based application development a myriad of application programming languages.

Education

B.S., Geo-Environmental Science
Shippensburg University

Certifications and Training

Certified GIS Professional (GISP)

ArcGIS Server Administration

Kevin Benitez, PLS | Arlington, VA

Kevin has over seven years of experience in Land Surveying in the DMV area. He has a Bachelor's degree from University of Puerto Rico at Mayaguez and a Master's degree from the University of Maine in Surveying Engineering & Business. Kevin is responsible for serving the Arlington Surveying department.

Education

M.S. Engineering and Business
University of Maine

B.S. Land Surveying & Topography
University of Puerto Rico

Professional Registration

Professional Land Surveyor (PR)

Ian Wisuri, PLS | Boston, MA

Mr. Wisuri is a licensed professional land surveyor in the states of MA, NH, ME, and VT. He has over 25 years experience performing boundary, topographic, and construction surveys for public and private sector clients. Ian is an active member of each state society he is licensed in as well as the National Society of Professional Surveyors. He is the Survey lead in the Boston office responsible for lead generation, discipline specific proposals, scheduling, project management and QA/QC.

Education

A.S., Civil Engineering
University of Massachusetts

Professional Registration

Professional Licensed Surveyor
(MA, ME, NH, VT)

Key Personnel

Education

A.A.S., Civil Engineering Technology, Monroe Community College

Professional Registration

Professional Surveyor and Mapper (FL, NY)

Bryan A. Merrit, PSM | Fort Lauderdale, Flordia

Mr. Merritt is a licensed land surveyor in the States of Florida and New York with extensive background that includes terrestrial and mobile LiDAR (laser scanning), GPS surveys, GIS Development, horizontal/vertical control, right-of-way survey and mapping projects, preliminary design surveys for engineering projects, and ALTA boundary surveys.

His experience in land surveying ranges from traditional survey tasks to advanced mapping technologies. As Manager of Surveying for the State of Florida, Mr. Merritt is very active in promoting land surveying and has been a guest speaker at numerous conferences. He is part of curriculum advisory board at Florida Atlantic University Geomatics Engineering program.

He is one of the founding members and board of directors of the USIBD (United States Institute of Building Documentation), the only non-profit organization dedicated to the profession of building documentation.

Steven Waldemer, PLS | New Haven, CT

Mr. Waldemer is an experienced survey analyst with extensive knowledge in project management and a variety of surveying techniques. His practice spans a wide range of scenarios including projects for transportation, airports/aviation, and railway. Areas of Mr. Waldermer's expertise include geodetic, topographic, and boundary surveys; GIS and GPS data analysis, 3D laser scanning, and tunnel surveys. He also has significant experience in the areas of right-of-way, as-built, and construction surveys. Mr. Waldemer has a comprehensive knowledge of field and office logistics and has been instrumental in the completion of large projects for private, state and federal agencies nationwide.

Professional Registration

Professional Land Surveyor (NY)

Education

B.S., Architectural Engineering Technology
Ward College of Technology at the University of Hartford

Lance Berliner | New York, NY

Mr. Berliner is a project manager with over 17 years experience in survey, computer drafting, mapping, and boundary analysis for commercial, residential, and industrial properties throughout New York. His expertise includes utilizing various CAD platforms, boundary analysis, and extensive field experience.

Key Personnel

Timothy O'Connor, PLS | New York, NY

Mr. O'Connor an experienced surveyor in all phases of boundary, topographic, and utility surveys. He also has extensive experience in performing various surveys for the oil and gas industry, conducting hydrographic studies, 3D laser scanning, and 3D modeling. Mr. O'Connor experience has allowed him to be responsible for large scale infrastructure projects requiring multiple aspects of survey services and technology primarily in the New York City area. Mr. O'Connor has worked on numerous projects throughout the United States and internationally. He is responsible for the management of Langan's 3D laser scanning and modeling group.

Education

New Jersey Institue of Technology

Professional Registration

Professional Land Surveyor (NJ)

Ronnie Figueroa, PSM, GISP | Orlando, FL

Mr. Figueroa has over 20 years of experience in land surveying and mapping and over 10 years of experience with the Geographic Infromation System (GIS). He has experience in all aspects of surveying to include Plat Reviews, Boundary Surveys, Topographic Surveys, Hydrographic Surveys, PD&E Surveys, Right of Way Surveys, Control Surveys, LiDAR, Utility Surveys and Tree Surveys.

Education

M.B.A.
Stetson Univeristy

Professional Registration

Professional Surveyor and Mapper (FL)

Certified GIS Professional (GISP)

David Avery, PLS | Parsippany, NJ

Mr. Avery has over 31 years of land surveying experience. Mr. Avery oversees the survey operations in Langan's headquarters, Parsippany, New Jersey. Prior to Langan, Mr. Avery served as a Boundary Analyst, focusing on small and large-scale land development projects, including, but not limited to, commercial, big box, power centers, and residential properties. In addition, he has also served as boundary analyst and project manager for a large engineering/ surveying firm and an analyst and supervisor of office and field operations for a land surveying firm.

Education

B.S., Surveying
Oregon Institute of Technology

Professional Registration

Professional Land Surveyor (NJ, PA)

Key Personnel

John Hsu | Parsippany, NJ

Mr. Hsu has over 21 years of experience in the architecture and engineering fields. His main responsibility includes creating 3D existing condition models based on point cloud data. Prior to joining Langan, Mr. Hsu had practice in the architectural profession, gaining extensive experience in all facets including planning, design, and construction over a wide range of corporate, retail, institutional, hospitality, and residential projects. With a concentration on multi-family residential work, Mr. Hsu has been involved in the design and planning of thousands of residential units. In addition, Mr. Hsu has also been involved in the development and implementation of the overall Building Information Modeling process as it relates to software application and project support. He has worked closely with a variety of architectural firms to provide Revit/BIM management, leadership, model management, Revit standards and support.

Education

M.S., Industrial Management
New Jersey Institute of Technology

B.S., Architecture
New Jersey Institute of Technology

Thomas Reeves, PLS | Parsippany, NJ

Mr. Reeves has over 17 years of experience in land surveying. He will be responsible for resolving surveying, mapping, and geospatial challenges and assisting with leading the Survey team in the Parsippany office. His primary skills include boundary plotting, deed research, contouring, utility & ROW map research, boundary / evidence recovery, and utility location.

Education

B.S. Land Surveying
University of Maine

Professional Registration

Professional Land Surveyor (NJ, NY)

Matthew Sipple, PLS | Parsippany, NJ

Mr. Sipple has over 21 years of experience in land surveying and has utilized a broad range of technology to obtain field data and produce deliverables based on specific client needs. His responsibilities include maintaining complex project schedules and coordinating with employees, consultant teams and the client. Mr. Sipple specializes in field data reduction and preparation of detailed drawings based upon 3D point clouds and conventional ground based survey information. He has an intimate knowledge of a variety of software platforms, including AutoCAD, Cyclone, Terrmodel, Cloudworx, Rhinoceros, and Revit. Over the years he has worked on projects ranging from large scale public/private redevelopments to highly detailed models for part replications. Mr. Sipple has also been developing solutions to incorporate highly accurate existing condition models into Information Models and Facility Management systems for long term asset and facility operations. His expertise helps the Langan team remain on the cutting edge of technology.

Education

New Jersey Institue of Technology

Professional Registration

Professional Land Surveyor (NJ)

Key Personnel

Anthony L. Maione, PLS | Pittsburgh, PA & Cleveland, OH

Mr. Maione is a professional surveyor with extensive leadership experience and knowledge of the principles, practices and procedures of ALTA, topographic, boundary, utility and construction layout surveys. He has delivered successful results in the land development and oil and gas industry and efficiently managed numerous projects and many field and office personnel. Mr. Maione has created strategies under changing conditions and has demonstrated excellent communication skills with other disciplines, outside agencies and clients. His technical experience includes use of 3D laser Scanners, Hydrographic Echo Sounders, GPR (ground penetrating radar) and other utility locating devices; AutoCAD (Civil 3D) and Carlson drafting software. He is also familiar with Spectra, TDS and Trimble/GPS software platforms.

Education

B.S., Surveying and
Mapping Technology
University of Akron

Professional Registration

Professional Land
Surveyor (OH)

Ronald King, PLS | Princeton, NJ

Mr. King has extensive experience in a wide variety of survey functions including ALTA/ACSM Land Title Surveys, boundary, topographic and utility surveys for site development and roadway design, GPS control surveys, right of way surveys, preparation of parcel maps and descriptions for right–of-way takings, 3D laser scanning, construction layout and bathymetric surveys. Mr. King manages Langan's unmanned aerial system/drone program. He has over 200 flights for projects involving photo and video documentation, site reconnaissance, traffic studies, and topographic mapping using photogrammetry and LIDAR systems.

Professional Registration

Professional Licensed Surveyor
(PA, CT)

NSPS Certified Survey Technician
Level III (NJ)

FAA Part 107 sUAS Certification

Russell Hall | Tampa, FL

Mr. Hall has over 18 years of professional surveying and mobile mapping experience that includes projects for the state government, municipalities and private projects that include residential, commercial and transportation efforts. Mr. Hall's computer expertise includes: Microstation, Geopak, Inroads, TopoDOT, Leica Cyclone, Terrascan, Civil 3d, Carlson Software, Revit, ArcGIS, and 3DS Max.

Education

Eastern Tennessee University

Professional Registration

Professional Land
Surveyor (CT)

Key Personnel

Daniel Gaul, PLS | White Plains, NY

Mr. Gaul is a licensed land surveyor and project manager with over 20 years of extensive experience in all types of surveying and project management. Daniel was born and raised in Canada and moved to NY in 2001 and has spent the last 20 years working on various land surveying projects including 3D Laser Scanning, Photogrammetry and traditional boundary surveys. Working out of the White Plains office, he is responsible for preparing project data for field work and review and process the field data. He is also responsible for planning, scheduling project budgets as well as preparing progress reports and project billing.

Education

Technician Certification,
Geomatics Engineering
Centre of Geographic Sciences

Professional Registration

Professional Land Surveyor (NY)

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Real-Time Surveying to Support NASA's Artemis I Launch

PREPARING FOR MISSION RAISES UNIQUE SURVEYING CHALLENGE—A MOVING OBJECT

Figure 1: CT fully loaded with concrete blocks. Total weight for this pass was 25 million pounds.
Photo credit Gary McDaniel.

NASA plans to launch the Orion spacecraft on a 26-day mission around the moon via the Space Launch System, its new heavy-lift rocket, in late 2021. The unmanned Artemis I flight is the first in a line of complex missions aimed at enabling exploration of the Moon and Mars.

But before the Orion spacecraft can be launched into space, it must first be moved from the Vehicle Assembly Building to the launchpad at the Kennedy Space Center.

Enter the Crawler-Transporter (CT; **Figure 1**), four connected building-sized vehicles on rolling tracks, which, when loaded with the Orion and its mobile

BY BRYAN **MERRITT** AND GARY **MCDANIEL**

Figure 3: Crawlerway road after the CT has passed over. This shows the effect on the crawlerway, but it was determined before the survey began that the movement of the CT could affect elevation anywhere in the zone of influence.
Photo credit Bryan Merritt.

launcher, will carry over 25 million pounds. That's the equivalent of 1020 school buses, one of the heaviest overland loads ever recorded.

The challenge of moving 25 million pounds

As the CT moves along the crawlerway (**Figure 2**), it has the potential to sink into the ground, tip and allow its payload to fall off (**Figure 3**). The resulting damage could put the entire Artemis I mission in jeopardy, not to mention the more than $20 billion NASA has invested in the Orion.

To address this risk, the agency partnered with engineering firms Langan and Jones-Edmunds to monitor ground deformation under the CT in real time. The solution Langan developed was a surveying process for taking measurements

Figure 2: Map of all control points used, instrument and backsight setup locations, special monitoring areas, and CT zones of influence. The Vehicle Assembly Building (VAB) is at lower left and the launchpad, upper right. The total zone of influence is delineated by the dark blue line. The yellow arrow points North. The scale bar is in feet.
Map credit Gary McDaniel.

on both sides of the CT simultaneously, collecting data every 10 feet along the 4.1-mile crawlerway.

The hardest part: they needed to survey the CT in motion, making the project exponentially more complex.

The process required establishing hundreds of control points as part of the baseline setup. Real-time surveying of the CT involves a team of 14 professionals working together, their movements carefully timed as the CT creeps along at roughly 26 feet per minute. Designing the solution took a full two years—and had to account for many moving parts.

Deconstructing the surveying project

The first step of the project involved mounting surveying prisms on the CT without altering the CT itself, which the Langan team achieved using high-strength brackets (**Figure 4**). The second step was conducting trials to develop observation procedures and timing for surveying teams.

Next, the team established the survey control networks, setting up control

Figure 4: Finished bracket mounted to the CT truck (left)— 2" square tubing 11 feet long, 4 feet high, supported with 3/4" steel tubing, all attached without damaging or altering the surface of the CT. Measuring the height of prism relative to the crawlerway road underneath the CT trucks (center). Testing prism bracket and potential monitoring procedures during a planned move of the CT (right).

Photo credits Bryan Merritt (left), Ryan Wolf (center) and Lee Stirling (right).

points every 600 feet to measure location and elevation to one one-hundredth of a foot (**Figure 5**).

The primary control network with over 100 control points was established prior to the monitoring surveys. GNSS was used to determine the horizontal positions of these points and a closed differential level loop run to determine their elevations.

Trees and brush in the area mean that surveying stations must sit within the CT's zone of influence (**Figure 6**), defined as the theoretical distance from the CT within which, according to mission engineers' estimates, the soils could potentially be disturbed by the movement of the CT.

There was only one problem

Inside the CT's zone of influence, the weight of the CT could move the ground under the surveying equipment itself, impacting the accuracy of the data. To account for this risk, Langan set up a secondary survey control network outside the zone of influence, effectively doubling the number of measurements taken.

Figure 5: Vertical control survey: a closed digital level loop was used to establish elevations for all control points set (left). Control level run started from an NGS monument near the VAB (center and right).

Photo credits Ryan Wolf.

Figure 6: Vegetation close to the crawlerway road sometimes meant that to get outside the CT zone of influence levels had to be set up 40 or 50 feet into the trees.
Photo credit Gary McDaniel.

Ideally we would have been able to put all our control points outside the zone of influence. Owing to years of vegetation growth, however, for some locations it would have been necessary to clear large amounts of vegetation to be able to see the CT (**Figure 6**), which was not allowed by NASA—or we could put the control points closer to the CT, and within the zone of influence, but monitor the ground for any "influence" by the weight of the CT from the secondary survey control network. To monitor the ground underneath the total stations we would set up a differential level that was outside the zone of influence and take readings using a custom-made self-supporting level rod (**Figure 7**). The idea was to take an initial reading of the level rod before the CT moved too close to the total station and make readings of the level rod, which was regarded as stable, continuously until the CT was past the total station and no longer influencing the ground at the total station location. We did not record any ground movement during any of the monitoring passes, but we were prepared to detect any ground movement had it been an issue.

During the monitoring survey (**Figure 8**) each total station was set on its assigned primary control point(s) and used to observe a 360° prism set at a fixed height on another primary control point. The 360° prisms on fixed height rods were used to allow multiple total stations to simultaneously use each "backsight prism" to orient the survey and could be also be used as quality control checks by other total stations.

Once the CT was within range the instrument operators would look through the total station to fix the crosshairs upon the 360° prism mounted to the CT. This was needed to allow the robotic total station to automatically and continually track the prism and

Figure 7: Monitoring the elevations. 12" square aluminum plate fixed to the bottom of a survey rod to allow for a measurement of the top of the crawlerway road surface, ensuring the rod tip did not fall between individual rocks (left). Bespoke mount for level rod to monitor ground at an instrument setup within the CT zone of influence (center). Monitoring the ground at an instrument location outside the CT zone of influence (right).
Photo credits Brian Merritt (left), Gary McDaniel (center and right).

Figure 8: The monitoring process. Top-left: Langan survey crew in position ahead of the CT, prepared to monitor once the CT moves within range. Top-right: CT being monitored from a control point setup within the zone of influence. Lower-left: One member walking with CT calling out station marks, one at total station taking measurements to the prism mounted to the CT, one at the instrument recording data in shared spreadsheet on a field tablet, one using a level placed outside the CT zone of influence to monitor the ground underneath the total station. Lower-right: Station markers were set every 50 feet along the entire length of the crawlerway.

Photo credits Ryan Wolf (top-left), Gary McDaniel (top-right, lower-left, lower-right).

make constant calculations about how far the prism was from its last recorded position. Once a distance of 10 feet from the previously recorded position was achieved, the data collector would store the prism coordinates (X,Y,Z) and use the newly stored position as the updated reference position to prepare for the next upcoming measurement. This procedure allowed us automatically to take measurements of the CT every 10 feet utilizing the technology of the robotic instruments. Team members would then enter the elevation of the recorded measurement into a spreadsheet that was used to aggregate the measurements from all four total stations being used.

Dry run

The last step—a dry run of the surveying process—is where the team's preparation was put to the test. Four robotic total stations are used, with two crews on each side of the CT leapfrogging each other as the CT moves down the path. While one crew measures the location and elevation of the surveying prism on the CT, the other moves into position for the next measurement.

Langan sends the measured data to a shared spreadsheet within seven seconds, using a formula to determine whether any ground deformation detected is within normal limits. At that point, the Jones-Edmunds team is responsible for deciding whether it's safe to keep rolling or whether the CT must stop.

The final test, however, will come when the CT finally carries the Orion to the launchpad. That day will represent years of preparation in support of a groundbreaking mission decades in the making, one that will help humans reach new frontiers in space.

Social posts

Learn how Langan is helping prepare for the upcoming @NASAArtemis #space mission #surveying #engineering #NASA; or how Langan is using real-time #surveying of a moving object to support the @NASAArtemis #space mission #engineering #NASA

Bryan Merritt, PLS/PSM is a Professional Land Surveyor licensed in New York and Florida. He serves as a Senior Survey Manager in charge of Florida and the Caribbean for Langan Engineering and Environmental Services Inc. He has been surveying since 1982 and has an extensive background in all facets of surveying methodologies.

Gary McDaniel, PSM started surveying in 2012 after teaching high school physics and chemistry for seven years. He earned his Professional Survey and Mapper License in Florida in 2019 and has been a licensed sUAS pilot since 2017.

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How to Make Your TECHNOLOGY INVESTMENT PAY OFF

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How to Make Technology Pay Off

By Christine L. Grahl

Technology advances are making it faster and easier for surveying and mapping professionals to collect data and provide increasingly sophisticated deliverables that solve complex problems for clients. But the situation also presents a challenge. With technology changing so rapidly, any new investment typically must pay for itself within five years, if not less. How can a firm make a solid business case to invest in the latest state-of-the-art system?

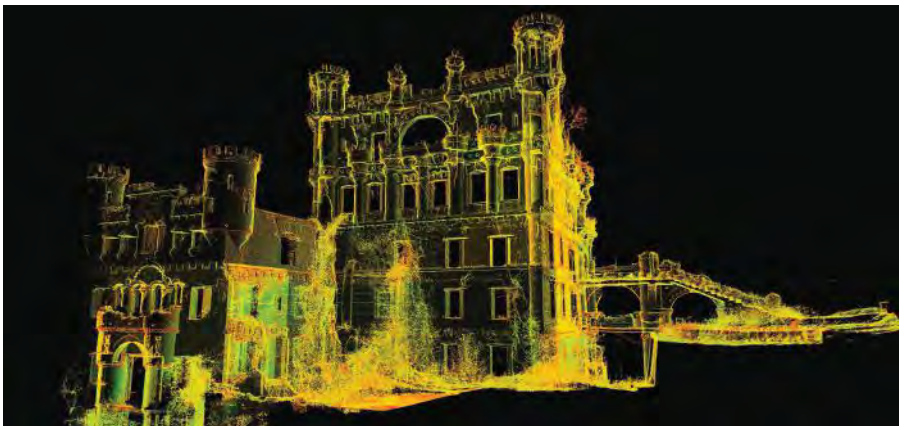
At Langan, an international engineering and environmental consulting firm headquartered in Elmwood Park, N.J., staying on the leading edge of 3D laser scanning technology is a chief objective for the firm's surveying and mapping group. An early adopter of scanning technology, the company has rapidly expanded its arsenal of laser scanning equipment and expertise within the last several years. In 2006, the firm purchased one of the early Leica Geosystems ScanStation units. Since then, the firm has added a Leica ScanStation 2, a Leica HDS6000 and a Leica ScanStation C10. Recently Langan became the first to purchase the new Leica ScanStation P20, an ultra high-speed laser scanner that provides high scan density and high accuracy.

At any given time, all five of the scanners are in operation on various projects, from large infrastructure surveys to building information modeling (BIM) for a wide range of facilities and clients, and Langan sometimes needs to rent additional scan-

[With technology changing rapidly, making the business case to invest in new equipment can be a challenge. How do you know the investment will provide a return? Here are six strategies from a surveying and mapping group on the leading edge.]

ners to meet demanding project deadlines. How has the firm made laser scanning such a successful part of its business? According to Joseph Romano, PLS, vice president of the firm's surveying and mapping group, there are no shortcuts. "With technology, everything is very dynamic; it's always changing," he says. "You have to keep track of the latest advances and make smart decisions to stay on the leading edge."

Following are six strategies that can be implemented by any firm seeking to get the best return on their technology investment.



Opposite: Greg Jensen, Langan scanning technician, adjusts settings on the firm's new Leica ScanStation P20. Above: Colorized point clouds from laser scans of Bannerman's Island Arsenal in New York. All images courtesy of Langan.

IDENTIFY YOUR NICHE

The rapid pace of technology innovation presents exciting new opportunities, but trying to keep up with all the latest advances can be both frustrating and futile. Instead, investments should be made strategically and aligned with the company's primary areas of expertise. "We can't jump on every new technology as it comes out just because it's new," Romano says. "We have to make sure we're making the right decision. Each piece of equipment has a specific role and fits a niche for us. We have to stay within our core strengths."

UNDERSTAND YOUR CAPABILITIES

Investing in new technology is just one part of the equation. Although some clients might actively seek service providers who use the latest piece of equipment or software, most are more interested in how a firm's capabilities fit a specific need. "As clients become more knowledgeable about the equipment and options available, having current technology is important," says Matt Sipple, PLS, project surveyor for Langan, "but being able to explain why we use that equipment is just as critical."

For example, being able to share how the density of data captured by the latest laser scanner can save time and money downstream compared to an older technology can be big selling point. "On some of the long term projects we're involved with, we have been asked to rescan for details that previously we were unable to obtain," says Sipple. Equally important is the ability to convey the benefits that experience and skill bring to a project.

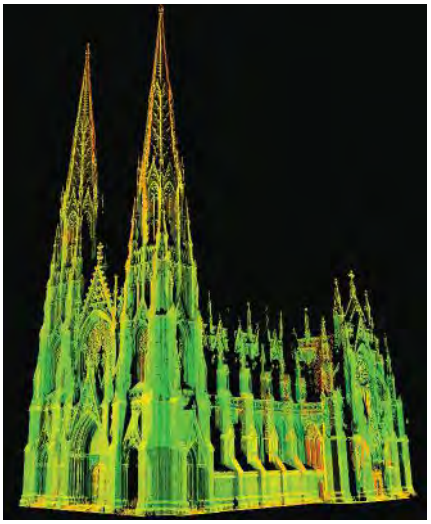
An important step in any new project or client relationship is to understand the expectations of everyone involved and avoid the temptation to oversell capabilities. The technology alone is not enough to guarantee success; having adequate training and knowing when and where to apply the technology are vital.

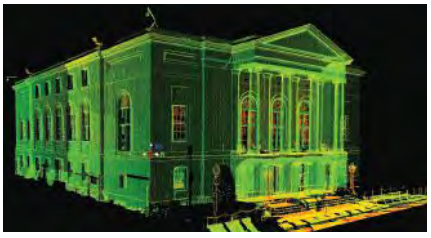
STAY UP TO DATE ON SOFTWARE

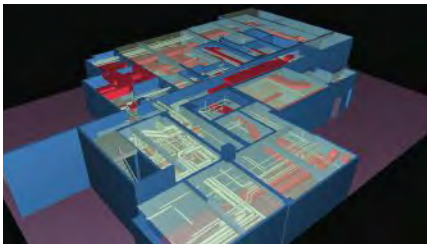
With the trend toward building information modeling (BIM) and integrated project delivery (IPD), clients are looking for ways to add intelligence to their datasets. Often software can be a differentiating factor in choosing a service provider. "BIM and IPD are becoming more common as a final deliverable, and there's a lot more demand for 3D design," Sipple says. "Clients want more working models and datasets they can integrate into their own workflows. Staying on top of software development is critical to meeting these needs."

Technology manufacturers and independent software developers have introduced new software solutions in the last few years that automate and streamline data processing and management. One example is Leica CloudWorx for Revit, a plugin that allows as-built point cloud data captured by laser scanners to be manipulated directly within Autodesk Revit software for an improved BIM workflow. "Previously we'd have to export the point cloud out of Cyclone and import it into Revit, and we'd lose our coordinate system and orientation because the software wasn't compatible," Sipple explains. "As surveyors, we have to ensure that everything is survey-accurate, so that meant a lot of time on our end correcting the model. CloudWorx for Revit has allowed us to bring in point clouds accurately, which saves us a lot of time in transferring files and checking for discrepancies."

The streamlined workflow has allowed the firm to provide accurate deliverables much faster, which is a benefit to clients on a tight timeline. It also allows Langan to make better use of its internal resources. "Now we can have one person working on one side of the building and another person on another side of the building, each on a different part of the point cloud, and they're all tied together because they all go back to Cyclone," Sipple says. "It reduces the chance of error because we don't have







to split the data up and transfer to it other software packages. If additional data is brought in, everyone has access to it. And we don't have to worry about the loss of data due to software incompatibility."

GO BEYOND THE MINIMUM

A benefit of modern technology is that it can expand a surveyor's capabilities far beyond what was traditionally possible. Although there is such a thing as providing too much data all at once (does the client really need billions of points in that model?), it can be difficult to predict the downstream requirements of a project. "Once we've collected the data, we can't increase its accuracy, so it needs to be collected correctly and for more than its intended purpose," Romano says. "We try to anticipate our client's needs and structure our data collection efforts accordingly."

For example, the group frequently uses its ScanStation C10 when working on building exteriors due to the instrument's speed, range and color capabilities, as well as its ability to capture a full 360-degree dome scan. Although the dome scan requires a few extra minutes of scan time, the additional data is invaluable. "It allows us to capture the scene–to get data everywhere surrounding the project site in case any other needs arise," Sipple says. "We've had projects where the client has contacted us several weeks later wanting to know the elevation of the building next door, or an MEP designer needs models of the building's existing mechanical, electrical and plumbing, and we were able to provide that data without having to go back onsite.

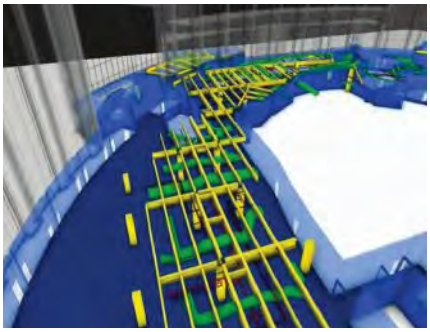
"Making additional data available as needed keeps the costs manageable for the client while streamlining the process. It also allows us to continue to add value as a project progresses."

Left: Langan's 3D laser scanning projects have included St. Patrick's Cathedral in New York (top) and the U.S. Court of Appeals of the Armed Forces in Washington, D.C. (middle). A benefit of laser scanning is the ability to provide MEP models (bottom) without having to return to the site. Right: Langan's survey technicians used a combination of 3D laser scanning technology and traditional surveying methods in support of renovations at the 21,000-square-foot Madison Square Garden arena.

BREAK DOWN BARRIERS

Achieving success with a new technology requires identifying the potential barriers as well as knowing how to skillfully remove them. For example, individuals within a firm might be resistant to change or may lack the understanding needed to fully embrace a new technology. Creating a seamless flow of information often requires adapting to new processes and breaking down silos between roles or departments.

Barriers can also exist in a client's understanding of a technology or process. "Everyone is at a different stage in technology adoption," Romano says. "Some clients want everything in BIM, and others just want 2D drawings. Whenever we meet with a new client, we try to assess their level of technology awareness and identify any preconceptions they might have about the process. Then we either have to adapt to what they want or guide them to alternative solutions based on our knowledge and expertise. We have to spend a lot more time in planning to ensure a successful outcome."



INVEST IN RELATIONSHIPS

Relationships are crucial in business, and this is especially true when investing in new technology. Having a strong network of partners and clients can make all the difference in how quickly a new technology investment provides a return. "We value the relationships we have with our hardware and software providers," Romano says. "The feedback we give to them is critical, and they've never let us down."

Langan also maintains relationships with past clients and participates in professional and community events to make sure the firm understands where the needs are in the market. "Some of our past clients that didn't have an interest in 3D previously now have a client that wants something in 3D or BIM. They're calling us up saying, 'Hey, I remember you guys had that 3D laser scanning technology,'" Romano says. "In other cases, we've made connections at a trade show or professional event that took time to come to fruition but led to new projects eight to 12 months later. It's all about relationships, and you have to nurture those wherever you are in the process."

As clients seek increasingly complex deliverables, technology advances will continue to play a key role in enabling surveying and mapping professionals to add value. With the right strategy–and perhaps a little patience–firms can reap the benefits of a good technology investment.

"This has been a long road for us in scanning," Romano says. "It's rewarding to see our efforts paying off."

Christine Grahl is the editor of POB. She can be reached at pobeditor@bnpmedia.com. For more information about Langan, visit www.langan.com. Additional details about Leica Geosystems laser scanners and software can be found at www.leica-geosystems.us.

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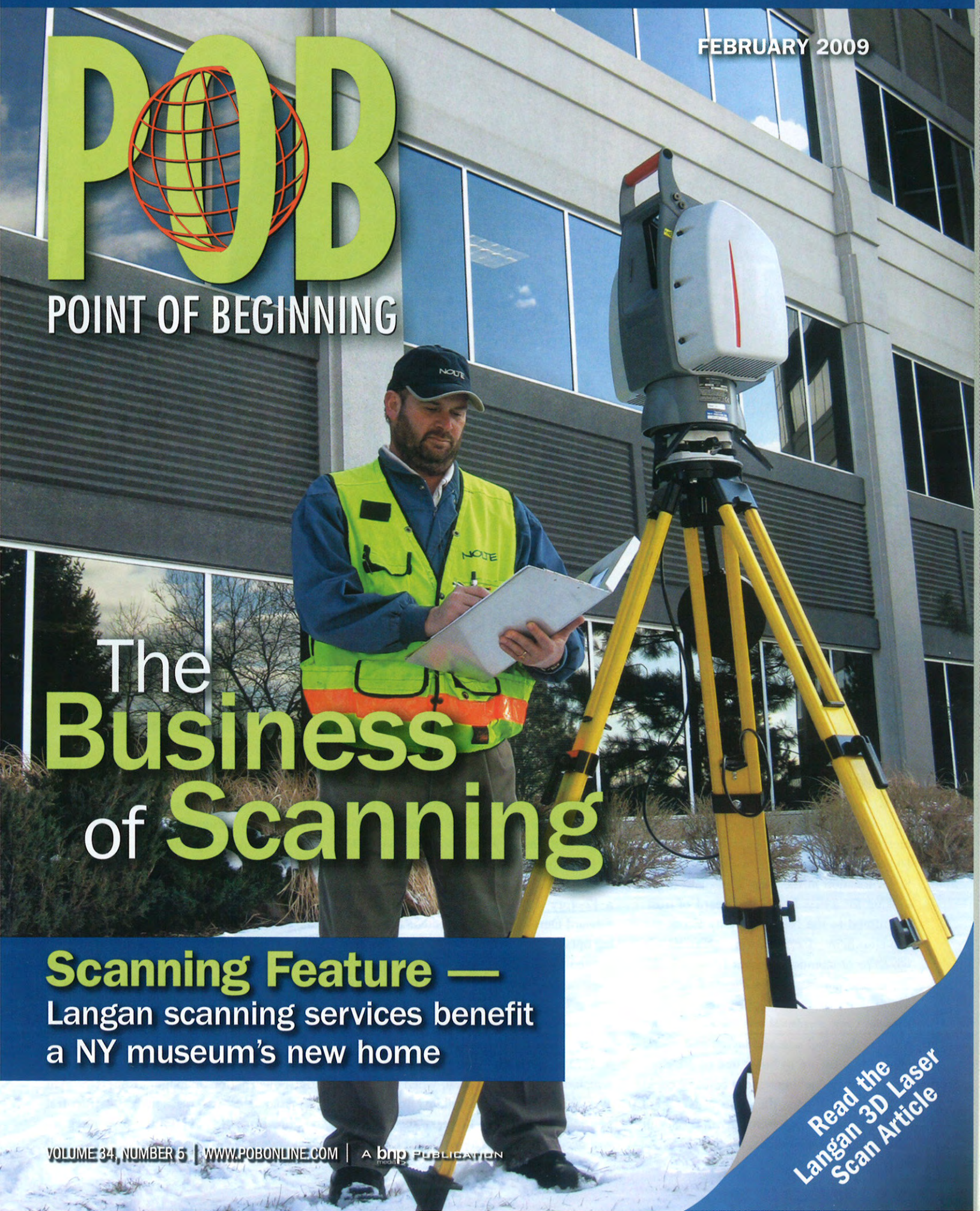

The Business of Scanning

Scanning Feature —
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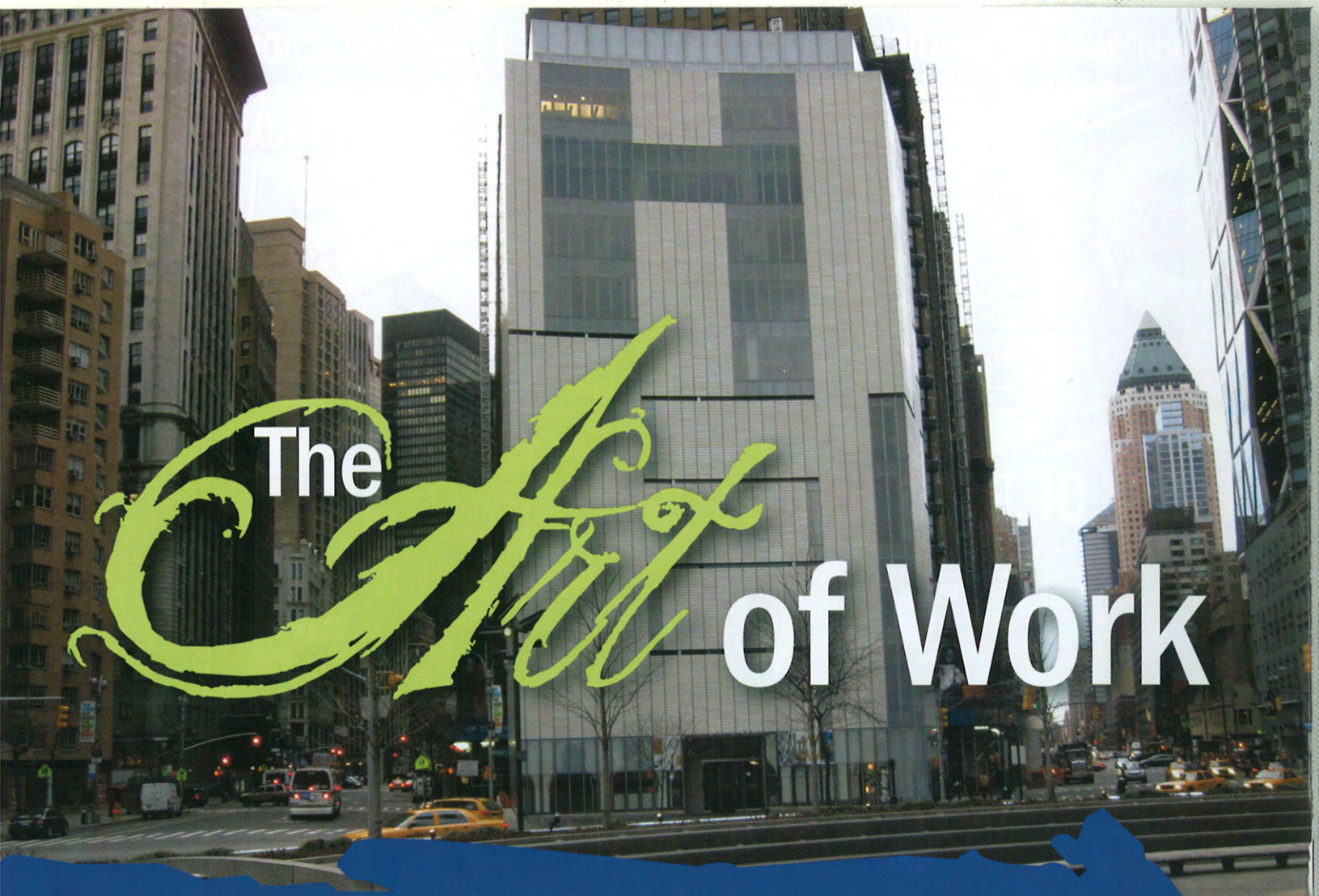


The Art of Work

Laser scanning and advanced CAD capabilities transform a historic façade into a modern work of art.

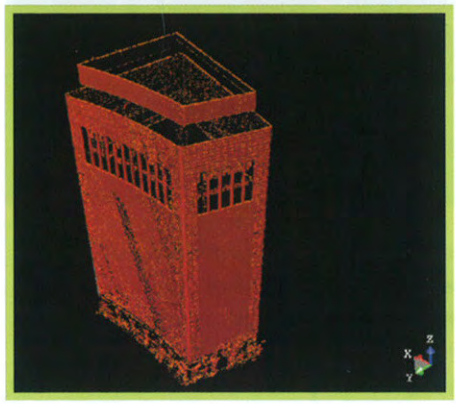
BY JOSEPH E. ROMANO, PLS

New York City's Museum of Arts and Design (formerly the American Craft Museum) has showcased contemporary objects made from clay, glass, wood, metal, fiber and other media for more than 50 years. When the museum outgrew its 53rd Street location in the early 2000s and began looking for a new home, the board of trustees turned to the New York City Economic Development Corporation (NYCEDC), which recommended a vacant 12-story building at 2 Columbus Circle. Situated between Manhattan's Midtown, Upper West Side and Lincoln Center cultural corridors, the building was the ideal size and layout and would allow the museum to boast one of the city's most renowned addresses. But before it could lay claim to the space, the museum's board of governors would first have to win a difficult battle with preservationists.

Historic Boundaries

From 1874 to 1960, the Columbus Circle property was home to the seven-story Pabst Grand Circle Hotel where more than 100 stage performers joined together in 1913 to form the Actors Equity Association. The hotel was demolished in 1960, and in 1964, a 12-story modernist building designed by Edward Durell Stone was erected. The building opened as the Gallery of Modern Art and housed the art collections of A&P's founder Huntington Hartford. In 1969, the building was gifted to Farleigh Dickinson University and was operated as the New York Cultural Center. The building was then purchased in 1975 by Gulf and Western Industries and remained vacant until 1980, when Gulf and Western presented the building to the city as a gift. For the next 18 years, the building was occupied by the Department of Cultural Affairs and the Convention and Visitors Bureau. Then, in 1998, the Landmarks Preservation Commission began holding hearings on designating the building as a landmark. Although the NYCEDC named the Museum of Arts and Design as the site's developer in 2002, it took the museum nearly three years and several lawsuits to overcome the attempted landmark status and obtain a permit to renovate the building.

During this time, the museum's board of governors, which was chaired by Jerome A. Chazen, began assembling the design team for the project. Allied Works Architecture was named as the team's design architect; F.J. Sciame Construction Co. was chosen as the construction manager; Robert Silman & Associates was assigned to structural engineering; R.A. Heintges & Associates was named to manage the curtain wall



Left: The redesigned museum features a luminescent ceramic exterior. Above: The original façade dated back to 1964. Right: Advanced CAD work created high-quality point clouds of the building.

design; and Langan Engineering joined the team to act as project surveyor and site/geotechnical engineer.

The conceptual design for the building's exterior was to remove the original curtain wall and construct a new façade in front of the remaining structural wall. Under normal building conditions, achieving this objective would not be a problem. However, this building was originally constructed as a zero-setback condition–a review of historic hand-drawn surveys showed the building to extend to the right-of-way (ROW) lines on all four sides. The team realized that the proposed curtain wall might encroach into the adjoining street ROW. Such an encroachment would require a franchise agreement with the city–a license that would allow the use of the ROW encroachment area for specific fees and under certain terms.

Using original building design plans and select field measurements, the design team back-calculated the location of the structural wall in relationship to the property lines. These calculations were then used in conjunction with the thickness of the proposed curtain wall and bracketing system to provide an estimate of the encroachment condition and minimize the franchise fees that would be required. The team settled on a 4-inch franchise requirement, submitted an application and received approval from the city.

Creative Exploration

During the preliminary design phase, Langan prepared a detailed CAD-generated site survey supported with digital terrain models (DTM) and a triangulated irregular network. The survey included boundary, topographic, utility and Builders Pavement Plan (BPP) data. (The BPP, which is unique to New York City, includes detailed curbing, walk, pavement elevations and utility data and is used to assist in the overall grading of the city's public spaces.)

While working on the site survey, Paul Fisher, PLS, project surveyor and manager of Langan's Laser Scanning Group, was approached by members of the design team with a request to confirm the building's façade and plumb status in relationship to the site's property lines. The team also requested clearance distances on a 2-foot by 2-foot grid across each façade of the building. These distances were intended to be used to design the brackets for the curtain wall. The design team detailed concerns relating to the possible building ROW encroachment and the sequence of the proposed construction and asked Fisher to provide a proposal.

Fisher met with the other survey project managers to determine the best methods and equipment for obtaining the required data. The survey team decided that laser scanning combined with an unconventional use of CAD options would provide the level of detail requested by the design team. However, while Langan had routinely used laser scanning to collect façade/planimetric data and had produced CAD models and paper prints of those data, the firm had never had been asked to provide detailed clearance distances. "Langan had produced similar elevation surveys in the past to check for deformation in building walls and encroachments," Fisher says, "but those point data sets were collected on a very large grid using Trimble reflectorless total stations. With the laser scans, Langan would have to address the amount of data produced and how to decimate the data to make it usable in CAD and [useful] to the client."

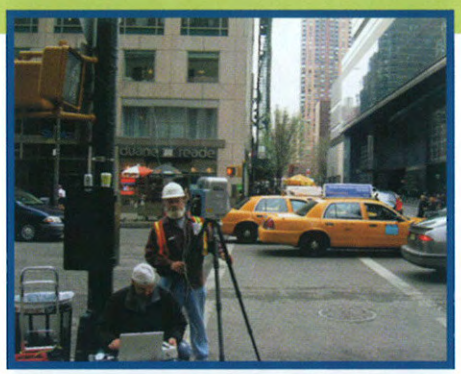
To further complicate the project, the building would be wrapped in scaffolding during the field work. "We knew we had a difficult task to complete," Fisher says.

Scans and Models

Using the horizontal and vertical controls that had been established during the site survey, the three-person crew began obtaining multiple scans of the building using a Trimble GS200 3D scanner. The first set of scans captured data with the marble panels still on the building. If the crew was unable to obtain enough data with the scaffolding and netting installed, these data sets would allow the team to back-calculate to the concrete structure using some general thickness measurements of the marble. However, Fisher

notes, "our hope was this data would only be for backup and we would not have to use this data for the final calculations."

A second set of scans was completed with the scaffolding in place and with the marble panels removed. To observe the building façade, the scan sessions had to be completed not only from grade level but also from various vantage points adjoining the site. "The crew needed to perform multiple scans of the same area to enable the scanner to obtain data on the building face that was obscured by the scaffolding," says Crew Chief Tim Hydrusko. "We were able to use a fourth-floor office, which had an overlooking window, as well as the roof of a seventh-floor apartment and a balcony of a 15-story building. The large number of scan sessions required the setting of over 60 building-mounted scan targets, which by far is the the greatest number of targets that we ever had to set."



Left: The building was scanned with the scaffolding in place, and the survey team had to digitally remove the scaffolding from the point cloud. Above and right: The Langan survey crew used a Trimble GS200 3D scanner for the scan work.

After the scan data were collected, technicians began the registration process using Trimble's RealWorks Survey software. The massive amount of targets made the registration process far more complex than most of the firm's previous scan projects, and a lot of time was spent registering the clouds together. Once registration was complete, the firm began the tedious process of removing all of the scaffolding from the cloud. "We had to be sure all of the point data we would be using to create our offset plans was real wall data and not scaffolding or other construction components," Fisher says.

Technicians spent a lot of time working on the model to remove anchor plates and other fixtures used to hang the scaffolding. Chris Tarzia, senior scanning technician, was tasked with this critical portion of the project. "Removing the scaffolding from the point cloud proved to be the toughest part of the project," Tarzia says. "Every object along the building face had to be removed, from the wooden planks down to the bolts holding the scaffolding into the building. It was the toughest 'noise-removal' task from a scan project I have ever completed to date, but in the end the process worked perfectly."

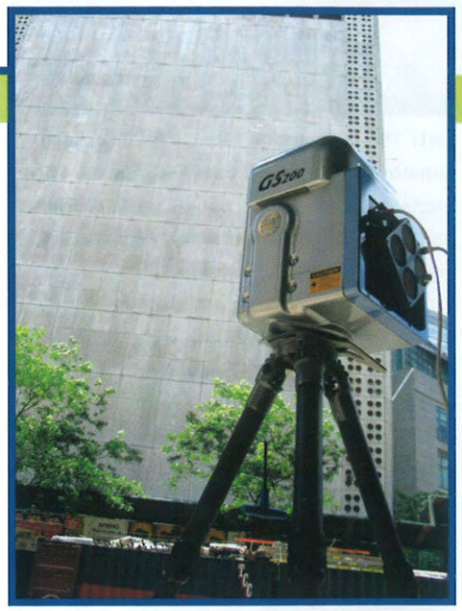
Once the cloud was reduced to only the concrete structure, technicians decimated the point data to make it usable. After some experimentation, the team reduced the point cloud to a 1/2-foot grid, which made the data "light" enough to work with in a standard CAD program. The point data were then exported as an ASCII file into Trimble's Terramodel, a stand-alone CAD/survey/modeling program, which is one of several CAD platforms Langan employs for modeling.

Each elevation was prepared in a separate file that included the franchise line adjacent to the building face and the point data. Each face and franchise line was rotated to either due north or due east. Elevations were assigned to the franchise line to produce a 3D plane that ran parallel with the vertical wall of the building. These data were then exported as an ASCII file and imported into a new CAD file. The coordinate values were changed so that the z value was entered as a northing. This provided a scaled elevation of the building that served as a DTM surface and allowed a horizontal plane to be created from the franchise line.

The final step was to create an isopach model from the two surfaces using standard surface modeling options within the Trimble Terramodel design and surveying software. A dense grid was then overlaid on the isopach data, and offset values to the franchise line were extracted. The deliverables to the design team were a CAD file in the original dense-grid format as well as paper prints created with a 2-foot grid to make the data legible and to coincide with the curtain wall grid. The curtain wall designer was then able to overlay its bracketing plan onto the wall offset drawing and determine the exact size of the bracket required to place the curtain wall on the franchise line.

A Work of Art

In February 2005, the New York State Supreme Court ruled in favor of the city regarding the sale of 2 Columbus Circle, and the museum was finally able to move forward with the renovations. The new Museum of Arts and Design at 2 Columbus Circle opened to the public in September 2008 boasting a luminescent ceramic exterior that, according to the museum, "symbolizes the revitalization of an important urban space and underscores the museum's dedication to modern materials and processes." In the end, laser scanning and the creative insight to push common CAD options to their limits proved the correct approach for a unique design and construction project that created a cultural work of art.



LANGAN

ENGINEERING & ENVIRONMENTAL SERVICES

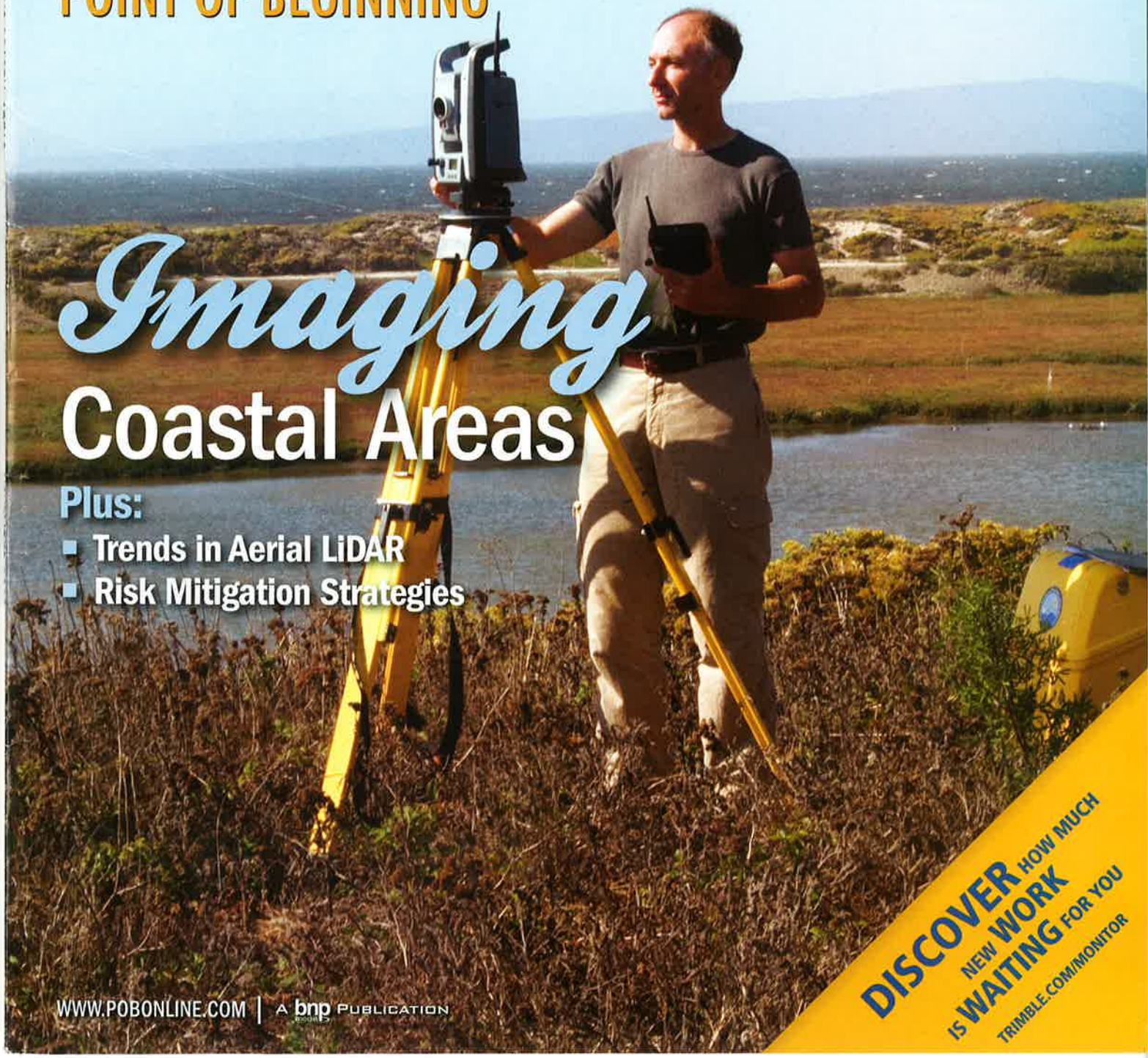
Joseph E. Romano, PLS, oversees the surveying and mapping efforts for Langan's 12 national offices. For more information, e-mail jromano@langan.com or visit www.langan.com. More information about the Museum of Arts and Design can be found at www.madmuseum.org.

GOLF IN 3D | SCANNING HISTORICAL STRUCTURES | HURRICANE RESPONSE

NOVEMBER 2008

POB

POINT OF BEGINNING



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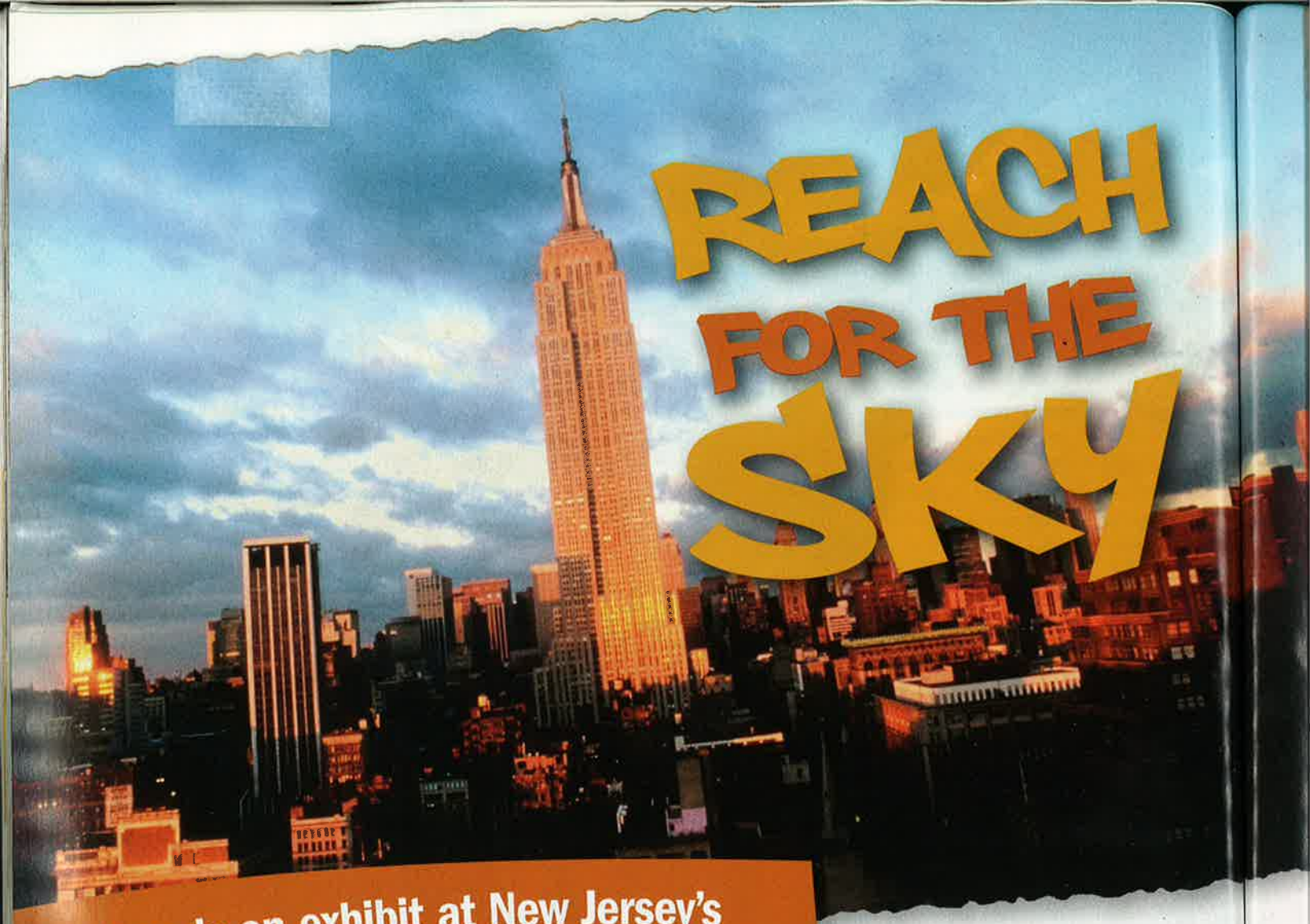


REACH FOR THE SKY

A hands-on exhibit at New Jersey's Liberty Science Center inspires the next generation of surveyors.

At the reinvented Liberty Science Center (LSC) in Jersey City, N.J., exhibits go beyond the conventional science center model and seek to actively engage visitors and impact society on a local, national and international level. The center focuses on interactive experiences that inspire lifelong learning. In the center's Live Science program, visitors can perform a live surgery on a "vegetative" patient after diagnosing the patient's mystery ailment, delve into the survival strategies of invertebrates through hands-on live animal presentations, or experience eye-popping films in what is reportedly the nation's largest IMAX dome theater. With all of this innovation, it makes sense that an interactive exhibit focused on surveying would also find its home here.

The surveying exhibit is found in "Skyscraper! Achievement and Impact," a 12,800-square-foot exhibit originally conceived by Helene Alonso, an LSC creative leader and project manager, as part of the science center's ambitious 22-month, $109 million expansion that began in 2005. For the surveying portion of the exhibit, Alonso envisioned a permanent physical display where guests would be able to use surveying equipment for themselves. To explore the feasibility of such a plan, Alonso contacted Langan Engineering & Environmental Services headquartered in Elmwood Park, N.J., the survey, site/civil and geotechnical engineer for the center's original design and expansion.

"The excitement in the room was unmatched when the team unveiled the schematic interior configuration of the exhibit area and the plan for a survey exhibit," says Joseph E. Romano, LS, a senior associate at Langan Engineering who oversees the surveying and mapping functions for the firm's nine offices. "I remember the enthusiasm I felt first during my first survey class at NJIT, in Newark, N.J. More then 15 years later while working on the Liberty Science Center project, I felt the same enthusiasm."

The development team at LSC, which included Alonso as well as designer Carlos Fierro and graphic

designers Judeann Hook and Elizabeth Grotyohann, had designed an exhibit that encompassed various remote measurements, including details for horizontal and vertical survey observations. However, having never used or seen a transit or total station, the team was at a loss for the details that would be required for a hands-on exhibit. "After learning that the entire survey exhibit would be required to be fully operational by the visitors and that none of the results could be predetermined, we decided we required assistance from an equipment vendor," Romano says.

The Tools of the Trade

Romano contacted John White, a long-time friend and local Leica representative. "John's dedication to the surveying profession and to the education system is unparalleled," Romano says. "He and Leica are supporters and equipment suppliers to many local educational institutions including NJIT and their surveying program."

After meeting with the team and reviewing the goals and requirements for the exhibit, White suggested that the team use the intuitive Leica TCR703 (3-inch) reflectorless total station with a red-laser-dot pointing scope as the exhibit's centerpiece. (White later recommended the Leica TCR705 [5-inch] instrument instead.) During the exhibit, visitors would be able to make three distance and two angular observations and calculate three missing distances. To complete these tasks, the team proposed to have the total station set in the lobby area with the points to be measured located on portions of steel I-beams that were part of other exhibits, such as the "Walk the Beam" exhibit, in which visitors would walk an elevated I-beam to experience the thrill of skyscraper construction.

Langan Engineering's graphics department developed a studio-generated 3D model of the proposed exhibit using Autodesk 3ds Max software. From there, the necessary equipment was secured from Leica and other suppliers, and a temporary exhibit was set up at the science center. In addition to the total station, equipment in the exhibit included a tripod, prism pole and tilting prism, various tapes, a Gunter's chain, a measuring wheel, plumb bobs, corner markers and other small survey tools.

The next step was to complete a "hands-on trial," which LSC staff would use to assess the feasibility of the exhibit and determine whether it would be a permanent display. The trial was conducted on a weekend in early 2007 as construction of the expansion area was under way. Overall, the exhibit was deemed a success. However, the team believed that having the visitors complete the measurements was too difficult. While the summary reports showed that visitors enjoyed the exhibit, the sensitivity of the total station coupled with the need for the operator to aim, adjust and focus was overwhelming for some. The team decided to change the surveying display into a "rolling exhibit" that would have scheduled experience times guided by an LSC staff member. This approach would retain the hands-on experience for visitors without the frustration of trying to figure out how to use complex surveying tools on their own.

Opposite: Scaled models of some of the world's tallest and best-known buildings, including New York's Empire State Building, are on display throughout the exhibit. Above: In the "Walk the Beam" exhibit, visitors walk an elevated I-beam to experience the thrill of skyscraper construction.

An Inspiration for Learning

When the newly expanded Liberty Science Center reopened in mid-July 2007, the skyscraper exhibit was an immediate success. "This exhibition is impressive enough that it would merit its own visit," noted a museum review in The New York Times shortly after the LSC expansion opened to the public.[1] A writer in Living Media described the exhibit as "the ultimate expression of human engineering" and noted that visitors would be "sure to leave this exhibit with a new appreciation and completely changed outlook regarding the impressive skyline that so many take for granted."[2] Yet another reviewer called the exhibit "spectacular."[3]

But perhaps the best reviewers have been the children who visit the science center. "The kids love looking through the total station and using the measuring wheel; it's the hands-on thing," notes Andrew Prasarn, one of the LSC science educators who presents the surveying exhibit. "We have scaled models of some of the world's tallest and best-known buildings throughout the exhibit. Using the total station, each visitor gets to measure the slope distances to the base and to the top of one of the models and also record the vertical angle. Using trigonometry, we then calculate the horizontal distance to the base and the scaled height. Then we use pacing and the measuring wheel to the same building and compare our findings. The kids really get it and ask a lot of questions; the interaction is great. I hope it's planting a seed and providing some vision."

The exhibit features a Leica TCR705 reflectorless total station that was donated to the center as well as a Sokkia 630R reflectorless total station purchased by LSC. The surveying activity is scheduled for peak periods when large numbers of visitors are in the building. Recently, the center decided to also take the activity on the road as part of its traveling science and math program. "This way, instead of just three to four people an hour getting to learn about surveying, we'll be able to introduce up to 120 kids a day to the skill–it's very exciting!" says Elizabeth Romanaux, vice president of communications at LSC. Romanaux notes that there might also be opportunities for engineers and professional surveyors to accompany the LSC team to talk directly to students.

Left: The surveying activity in Liberty Science Center's skyscraper exhibition introduces guests to a real-world application of math in everyday life. Above: The proposed layout of the skyscraper exhibit at LSC.

"Workforce development in surveying and engineering, math, science, and technology is one of our nation's most critical tasks," Romanaux says. "The surveying activity in Liberty Science Center's skyscraper exhibition introduces guests to a real-world application of math in everyday life, making their school work more relevant to young people. Additionally, students and parents alike will understand what workers are doing the next time they see surveying taking place along a road or at a construction site in their town."

Romano, who had the opportunity to visit the exhibit recently, takes personal satisfaction in his role in seeing the exhibit come to fruition. "It is very rewarding to have been able to assist in providing today's youth with a small but effective experience in the world of land surveying," he says. "LSC board of trustee member William A. Tansey III, MD, could not have said it better: 'Today's childhood experiences do become tomorrow's careers!'"

For more information about LSC or the skyscraper exhibit, visit www.lsc.org. More information about Langan Engineering can be found at www.langan.com. Additional links can be found in the online version of this article.

References

1. Edward Rothstein, "Touch Me Feel Me Science," The New York Times, July '07.
2. Helene Dortheimer, "Daytripper: Liberty Science Center," Living Media, Nov. '07.
3. Jayne Gould, "Skyscrapers? They're Kid Stuff," New York Daily News, Aug. '08.

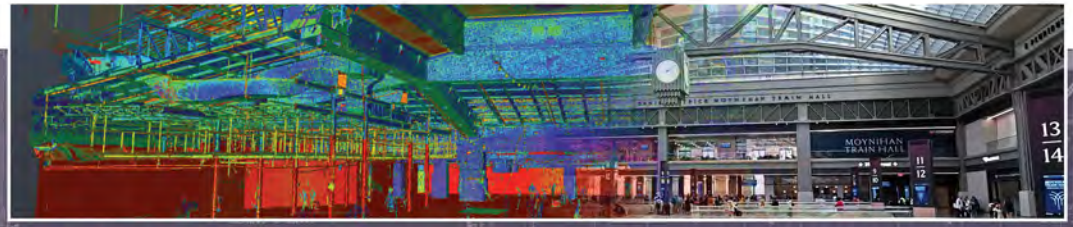
2022

MOYNIHAN TRAIN HALL

FROM MAIL TO RAIL

Over two decades of surveying supported the design and construction of Moynihan Train Hall, driving the conversion of the historic James A. Farley Post Office from a mail sorting facility to a world class transit station.

Located across from Penn Station, the $1.6 billion Moynihan Train Hall opened on New Year's morning 2021, months ahead of schedule and within budget after decades of financial and logistical obstacles. At 255,000-square-feet, the new world-class transit hub with access to Amtrak, NJ Transit, NYC MTA and LIRR nearly doubles the existing Penn Station concourse space and transforms the landmark post office to a facility reminiscent of the original Penn Station.



Surveyors document the subsurface train shed rails and structure for design of the new concourse.

Point cloud data was used to prepare detailed plans. The density and quantity of this data reduced mobilizations and costly track outages.

"Scan to BIM" was utilized to develop existing condition models of critical clearance areas.

A surveyor performs a laser scan as-built of the completed train hall, two decades after the initial survey.

100 1921-2021 ACEC New York

EEA Engineering Excellence Awards

NEW YORK STATE OF OPPORTUNITY. Empire State Development

PROJECT TITLE: Moynihan Train Hall, New York City, NY

CLIENT NAME: Empire State Development Group

ENTRANT NAME: LANGAN New York City, NY

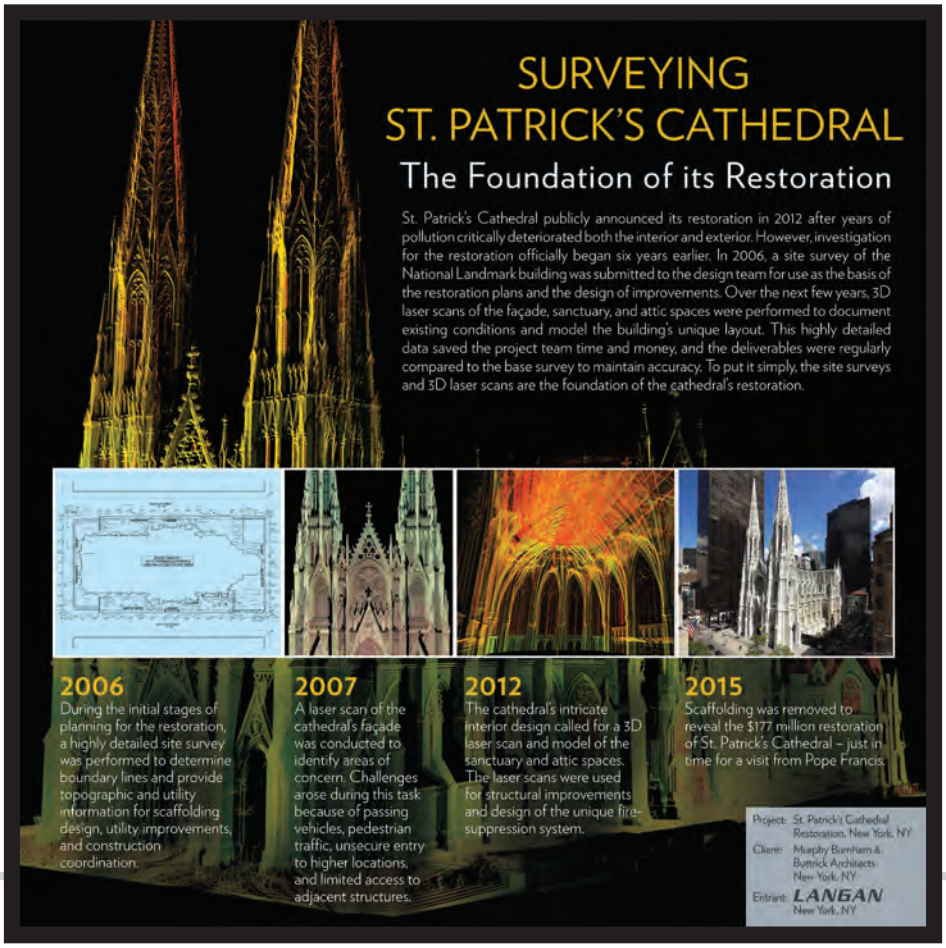
2019


TWA
FLIGHT CENTER SOARS AGAIN THROUGH POINT CLOUDS!
Surveyors Pilot the Second Departure of Saarinen's Masterpiece into a World-Class Hotel
Designed by Eero Saarinen, the TWA Flight Center's history encompasses its unique "wing-shaped" design from 1962 and its cultural significance. Reimagined as a hotel in 2014, documenting and preserving the landmarked building's integrity was vital during the restoration. The survey team's innovative use of multiple methods and technologies provided the hotel design team with a highly detailed existing conditions 3D model of the building along with a comprehensive site survey. Combined, these two approaches provided the basis of the restoration efforts, soaring above expectations and allowing Saarinen's masterpiece to take flight once again!

2016


WORLD'S FAIR-NEW YORK STATE PAVILION
GOES FULL CIRCLE
3D LASER SCANNING PROVIDES CATALYST TO DIGITALLY RECREATE THIS 1960'S LANDMARK
The 1964/65 World's Fair drew more than 51 million visitors from around the world, showcasing the most cutting edge technological and architectural innovations of the time. While the fairgrounds have begun to show its age after 50 years, the remnants of the exposition stand as a monument to a special time in American history.
UCF, CyArk, and Langan joined forces to create a highly accurate digital model of one of the World Fair's most recognizable features, the New York State Pavilion. Framed by its dual Asto-View Towers, a Theaterama, and the Tent of Tomorrow, the Pavilion now serves as an anchor to Flushing Meadows Park. Captured utilizing full-color survey-grade high-definition 3D laser scanning technology, the simulation will provide people around the world the opportunity to experience a very important cultural milestone of the 20th century.
WORLD'S FAIR SITE IN 1964/1965
DATA ACQUISITION:
Scanning the pavilion to start the documentation
DIGITAL EXPERIENCE: Detailed model in an interactive video based viewer
The result is a 3D modeled digital experience that returns the user to the wonder of this 1960s American landmark.
ACCURATE POINT CLOUD: Scanned data collected of the site
ACEC
American Council of Engineering Companies
Project: World's Fair - New York State Pavilion, Flushing Meadows, NY
Client: University of Central Florida (UCF), Orlando, FL
Entering Firm: Langan, Parsippany, NJ
LANGAN

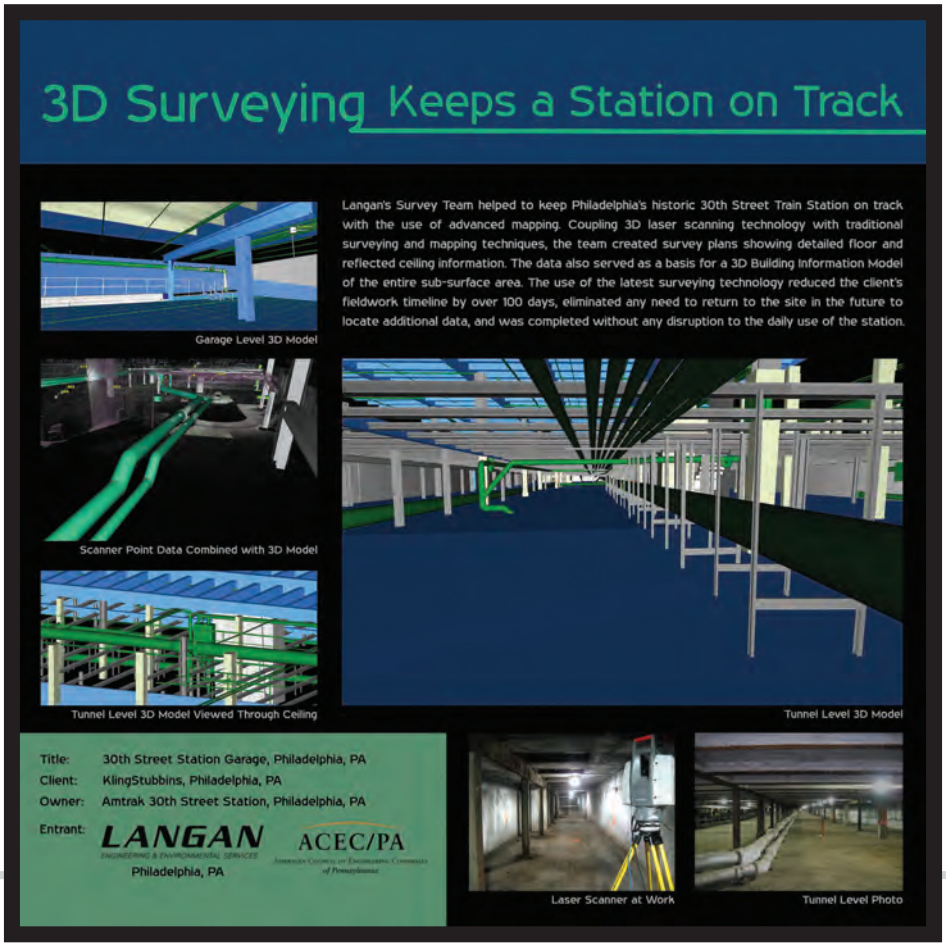
2015


SURVEYING
ST. PATRICK'S CATHEDRAL
The Foundation of its Restoration
St. Patrick's Cathedral publicly announced its restoration in 2012 after years of pollution critically deteriorated both the interior and exterior. However, investigation for the restoration officially began six years earlier. In 2006, a site survey of the National Landmark building was submitted to the design team for use as the basis of the restoration plans and the design of improvements. Over the next few years, 3D laser scans of the façade, sanctuary, and attic spaces were performed to document existing conditions and model the building's unique layout. This highly detailed data saved the project team time and money, and the deliverables were regularly compared to the base survey to maintain accuracy. To put it simply, the site surveys and 3D laser scans are the foundation of the cathedral's restoration.
2006
During the initial stages of planning for the restoration, a highly detailed site survey was performed to determine boundary lines and provide topographic and utility information for scaffolding design, utility improvements, and construction coordination.
2007
A laser scan of the cathedral's façade was conducted to identify areas of concern. Challenges arose during this task because of passing vehicles, pedestrian traffic, unsecure entry to higher locations, and limited access to adjacent structures.
2012
The cathedral's intricate interior design called for a 3D laser scan and model of the sanctuary and attic spaces. The laser scans were used for structural improvements and design of the unique fire-suppression system.
2015
Scaffolding was removed to reveal the $177 million restoration of St. Patrick's Cathedral – just in time for a visit from Pope Francis.
Project: St. Patrick's Cathedral Restoration, New York, NY
Client: Murphy Burnham & Buttrick Architects New York, NY
Entrant: LANGAN New York, NY

2012


GOVERNORS ISLAND:
MARCHING FORWARD
WITH A NEW RETREAT
Transformation of a Military Facility into a Peaceful Park
Fort Jay
Castle Williams
Liggett Terrace
Hammock Grove
Future Development Zone
Historic District
The Hills
Future Development Zone
Future Development Zone
Rendering Credit: West 8
DETAILED TOPOGRAPHY AND BOUNDARY SURVEY
The detailed survey is vital to the core design principle of "Transformation through Topography" and will continue to guide the future development of this "Beacon in the Harbor."
Liggett Terrace
Historic District
Hammock Grove (Credit: West 8)
The Hills (Credit: West 8)
Project: Governors Island Survey, New York, NY
Client: West 8 Urban Design & Landscape Architecture, New York, NY
Entrant: Langan Engineering, New York, NY

2011


3D Surveying Keeps a Station on Track
Langan's Survey Team helped to keep Philadelphia's historic 30th Street Train Station on track with the use of advanced mapping. Coupling 3D laser scanning technology with traditional surveying and mapping techniques, the team created survey plans showing detailed floor and reflected ceiling information. The data also served as a basis for a 3D Building Information Model of the entire sub-surface area. The use of the latest surveying technology reduced the client's fieldwork timeline by over 100 days, eliminated any need to return to the site in the future to locate additional data, and was completed without any disruption to the daily use of the station.
Garage Level 3D Model
Scanner Point Data Combined with 3D Model
Tunnel Level 3D Model Viewed Through Ceiling
Tunnel Level 3D Model
Title: 30th Street Station Garage, Philadelphia, PA
Client: KlingStubbins, Philadelphia, PA
Owner: Amtrak 30th Street Station, Philadelphia, PA
Entrant: LANGAN ENGINEERING & ENVIRONMENTAL SERVICES Philadelphia, PA
ACEC/PA
Laser Scanner at Work
Tunnel Level Photo

2008


DEVILS SCORE A GOAL
WITH THE CITY OF NEWARK
•Innovative Foundation Design Saves Millions
•Transit-Oriented Design Reduces Automobile Emissions
•Former 17th Century Cemetery Disinterred By Over 60 Archaeologists
•Premier Urban Core/Brownfields Redevelopment
Prudential Center
Demolition and Clearing of Site
Upgrade in Bearing Pressure Reduces Footing Size
Deep Dynamic Compaction Eliminates Need for Piles
Archaeological Excavation to Clear Former Cemetery
REVITALIZATION OF DOWNTOWN NEWARK
TITLE: The Prudential Center, Newark, NJ CLIENT: Devils RenaissanceDevelopment LLC, Newark, NJ
ENTRANT: Langan Engineering & Environmental Services, Inc., Elmwood Park, NJ
LANGAN
ACEC

2007


SCANNING THE SEAPORT
HIGH DEFINITION LASER SCANNING Relocates History
3D laser scanning coupled with traditional surveying techniques was used to create a building recordation plan. The survey documented the architectural details of the 100-plus-year-old "Tin Building," serving as the roadmap for the building's relocation.
Original 1907 location
Capturing the data
Cross-sectional view of scan
Exterior view of scan
1907
FUTURE
Bringing the turn-of-the-century "TIN BUILDING" back to the water
Title: Pier 17 Redevelopment New York, NY
Client: SHoP Architects PC New York, NY
Entrant: Langan Engineering & Environmental Services New York, NY

2003


St. John's University
a campus grows in Queens
surveyors map the transformation of a commuter school to an on-campus community
survey master plan
as-built
design & construction
A unique survey cycle method was derived to supply a growing campus with a constantly evolving, cost and schedule efficient master plan survey. Combining advanced survey technologies and traditional survey techniques, a survey team plants the seeds of growth for a LIVING and LEARNING campus.
3-D digital terrain model
plan preparation
ground topography
utility tone-out
control network
aerial mapping
boundary
Project- St. John's University
Jamaica, Queens, New York
Client- St. John's University
Surveyor- Langan Engineering & Environmental Services, P.C., N.Y., N.Y.