Site/Inventory Mapping (GPS, LIDAR, RTS, RTN, or UAVs)
GPS (Global Positioning Systems). A satellite-based radionavigation system owned by the United States government. While it is principally a navigational system, GPS is also an important piece of mapping technology. Surveyors, and others can use GPS to determine with great accuracy the locations of objects to be shown on maps. GPS receivers installed on moving vehicles, for example trucks carrying nuclear materials, allow them to be continuously tracked and maps of their locations updated in real time. **When to Use:** PIP through Construction **Whom:** Core Constructability Team, Designers, Construction Team **References:** https://www.gps.gov/applications/roads/ **LIDAR (Light Detection and Ranging).** Also known as 3-D laser scanning, LIDAR is a geospatial remote sensing technology used to make high resolution maps. It is a method for determining ranges (variable distance) by targeting an object with a laser and measuring the time for the reflected light to return to the receiver. Lidar can also be used to make digital 3-D representations of areas due to differences in laser return times, and by varying laser wavelengths. Topographic lidar typically uses a near-infrared laser to map the land, while bathymetric lidar uses water-penetrating green light to also measure seafloor and riverbed elevations. There are three primary LiDAR applications: 1) Static LiDAR – system mounted at a single location that collects highly accurate data, but is slower than other applications, and exposes workers to traffic and other hazards. 2) Mobile LiDAR – system attached to a mobile object such as a vehicle or heavy equipment, which uses LiDAR, inertial navigation systems, and global positioning system (GPS) to measure roadway markings and cross sections. 3) Airborne LiDAR – system installed on an aircraft that can travel at speeds up to 115 miles per hour at maximum elevation of 1,600 feet. A key benefit of LiDAR technology is that its acquired data is useful for several applications. The data collected using LiDAR is in a digital point cloud format that allows for analyses of the data for mapping highway construction facilities and assets. Mining of the collected data for information can serve as suitable inputs for various construction related design and modeling applications performed by DOTs such as 3D and 4D digitized models and information for automated machine guidance (AMG). National Cooperative Highway Research program (NCHRP) Report 748 described various mobile LiDAR applications for delivering highway construction projects as follows: • As-built and maintenance documentation—Integration of LiDAR data into a centralized database that is continuously updated for future planning and construction, • Pavement smoothness and quality determination— LiDAR data collected at high resolutions can be used to evaluate pavement smoothness and quality, • Construction automation and quality control—Change detection and deviation analysis software uses digital models to identify deviations from LiDAR point clouds for construction quality control, • Performing quantity take-off—LiDAR data is used to calculate lengths, areas, or volumes of construction quantities, • Virtual and 3D Design— LiDAR data can be used for clash detection by checking for intersections of proposed objects with existing objects modeled in the point cloud, and • Inspections—LiDAR can provide overall geometric information and an overall condition assessment of various highway infrastructure assets (7, 11). **When to Use:** 30% CR through Construction **Whom:** Core Constructability Team, Construction Team **References:** Harper, C., Tran, D., Jaselskis, E., Implementation of Visualization and Modeling Technologies for Highway Construction: Current Practices and Future Trends, TRB, 2020. https://www.usgs.gov/special-topic/earthmri/science/topographic-lidar-surveys Olsen, M., G. Roe, C. Glennie, F. Persi, M. Reedy, D. Hurwitz, K. Williams, H. Tuss, A. Squellati, and M. Knodler, Guidelines for the Use of Mobile LIDAR in Transportation Applications, NCHRP Report 748, Transportation Research Board of the National Academies, Washington, D.C., 2013. Yen, K., T. A. Lasky, and B. Ravani, "Cost-Benefit Analysis of Mobile Terrestrial Laser Scanning Applications for Highway Infrastructure," ASCE Journal of Infrastructure Systems, Vol. 20, No. 4, December 2014. **RTS (Robotic Total Stations).** An RTS is an enhanced total station allowing a single operator to conduct site layout measurements. Total stations in general are an optical electronic instrument with onboard electronic distance measurement. They include onboard computing and storage capabilities such that they can communicate surveying calculations to the user instantaneously or provide for facility layout from input location points. The RTS can conduct typical horizontal and vertical measurements like most total stations, yet the RTS will automatically track the operator with the prism or can be remotely controlled by the operator. Additionally, the use of RTS supports e-Construction and paperless data collection. RTSs typically can entail surveying directly from the 2D or 3D models uploaded into the RTS. **When to Us:** PIP through Construction **Whom:** Core Constructability Team, Designers **References:** https://en.wikipedia.org/wiki/Total_station **UAVs (Unmanned Aerial Vehicles).** Commonly known as a drone, an aircraft without a human pilot on board. UAVs are a component of an unmanned aircraft system (UAS), which include a ground-based controller and a system of communications with the UAV. Drones have many constructability applications including aerial mapping, surveying, inspection, and data collection. **When to Use:** PIP Stage through construction **Whom:** Core Constructability Team, Designers **References:** https://www.researchgate.net/publication/260529522_UAV_for_3D_mapping_applications https://www.tandfonline.com/doi/full/10.1080/00396265.2016.1268756 **GIS (Geographic Information System).** GIS is a geographic database of assets. GIS allows users to digitally store, retrieve, analyze, and display maps of all kinds including site mapping and inventory mapping. Provides information for asset management & checking that a project meets specification. Applications range from ROW to ITS (traffic monitoring) to drainage systems compliance with specs. **When to Use:** PIP through Construction **Whom:** Core Constructability Team, Designers, Construction Team **References:** **https://www.usgs.gov/faqs/what-a-geographic-information-system-gis?qt-news_science_products=0#qt-news_science_products**