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A Brief History of Digital Surveying

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Introduction.

Surveying dates back to the ancient times, having a recorded land register in Egypt in 3000BC. The construction of the Great Pyramid of Giza, the re-establishment of farm boundaries that was followed by the floods of the Nile River belongs about the same time. It was in the under the rule of Roman that land surveying was accepted as profession (Bingham et al., 2010). The Roman Empire was divided by the land surveyors as they established the basic measurement, like the tax register of conquered lands (300AD). The method of surveying was introduced in Europe in the eighteenth century, it was known as triangulation that was based on the measurement of angles.

The purpose of using was to build a hierarchy of networks so that the point positioning can be done within a country. Most of the surveying work that was undertake in order to open up the country and also provide land holdings to settlers (Dotson, 2010). It was done in the early days of British Colonization of New Zealand and Australia. The work was carried out measuring wheels, Kater's compass, Gunter's chains, circumferentor (Bisman, 2012). Moreover, it was also done without variation where approximation was served. So long as the land corners were marked by the surveyor. However, the accuracies of the measurements and directions were given on chance.

20th Century

Surveyors had developed the older chains and ropes by the turn of the century, but they still had a problem measuring long distances accurately. During the 1950s, Dr. Trevor Lloyd Wadley invented the Tellurometer. It uses two microwave transmitter/receivers to test long distances. Geodimeter introduced electronic distance measurement (EDM) equipment in the late 1950s. To find a distance, EDM units use a multifrequency phase shift of light waves. By measuring between points kilometres apart in one go, these instruments eliminated the need for days or weeks of chain measurement. Electronic advancements allowed EDM to be miniaturized. Complete stations, or devices that combine angle and distance measurement, first appeared in the 1970s. Manufacturers gradually introduced more equipment, resulting in increased measurement accuracy and speed. Tilt compensators, data recorders, and on-board measurement programmes are all major advancements.

The US Navy's TRANSIT system was the first satellite positioning system. In 1960, the first successful launch took place. The main goal of the device was to provide location data to Polaris missile submarines. Field receivers were discovered to be useful in determining the position of a point by surveyors. Because of the lack of satellite coverage and the size of the instruments, observations were time-consuming and unreliable. The main application was for setting benchmarks in far-flung locations. The first concept satellites of the Global Positioning System (GPS) were deployed by the US Air Force in 1978. To boost precision, GPS used a wider constellation of satellites and increased signal transmission. To achieve survey accuracy requirements, early GPS observations needed several hours of observations by a static receiver. Real-time broadcasting is now possible thanks to recent advancements in satellites and receivers.

21st Century

Theodolite, complete station, and RTK GPS surveying are still the most popular methods. Remote sensing and satellite imagery are improving and becoming less expensive, making them more widely available. Three-dimensional (3D) scanning and topographical surveys using lidar are two of the most prominent emerging technologies. Photogrammetric image processing and UAV technology are also on the rise.

Evaluation in Surveying Tools

As the time passed the Gunter's chain was switched by the invar tapes and steel bands, later on with Electromagnetic Distance Measurement (EDM) equipment, and afterword's Global Positioning System (GPS) devices. As the new devices came into the frame each was of improved efficiency and higher level of accuracies of measurements. Similarly, as the compasses was replaced by the transits, theodolites and later on by the Total Stations. It was able to combine the distance measure and angular in a single survey instrument (Brusaporci, 2015). It can be observed in these situations the status of measurements and the previous times was the reason to alternate forms of evidence. Like for instance, where the land boundary was intended to be located and what was intended to be. The measurements and mathematics alone do not provide the correct answers (Campbell, 2017).

Surveying Techniques.

Determining a position

Astronomical observations are the primary method of determining one's location on the earth's surface when no established locations are nearby. Navigational methods could be used to make observations of the sun, moon, and stars. The bearing can be moved to a reference point on the planet once the instrument's location and bearing to a star have been determined. The point can then be used as a starting point for further research. Since survey-accurate astronomical positions were difficult to detect and calculate, they continued to be used as a starting point for many other measurements. Astronomical observations have been uncommon since the invention of the GPS device, which enables accurate location determination over the majority of the earth's surface.

Measuring distances.

Distances were measured using several methods prior to the invention of EDM (Electronic Distance Measurement) laser instruments. This included measuring tapes made of steel or invar, as well as chains with recognized length ties, such as a Gunter's chain. These chains or tapes were pulled taut to minimise sagging and slack when measuring horizontal distances. Heat expansion necessitated adjusting the width. It will also be attempted to keep the measuring instrument level. When measuring up a slope, the surveyor may need to "break" (break chain) the measurement by using an increment that is less than the chain's total length. Longer distances were measured with perambulators, or measuring wheels, but not with great precision. When rough terrain made chain measurement impossible until the invention of EDM, tacheometry was sometimes used. Tacheometry is the science of calculating distances by measuring the angle formed by two ends of a known-size object.

Levelling

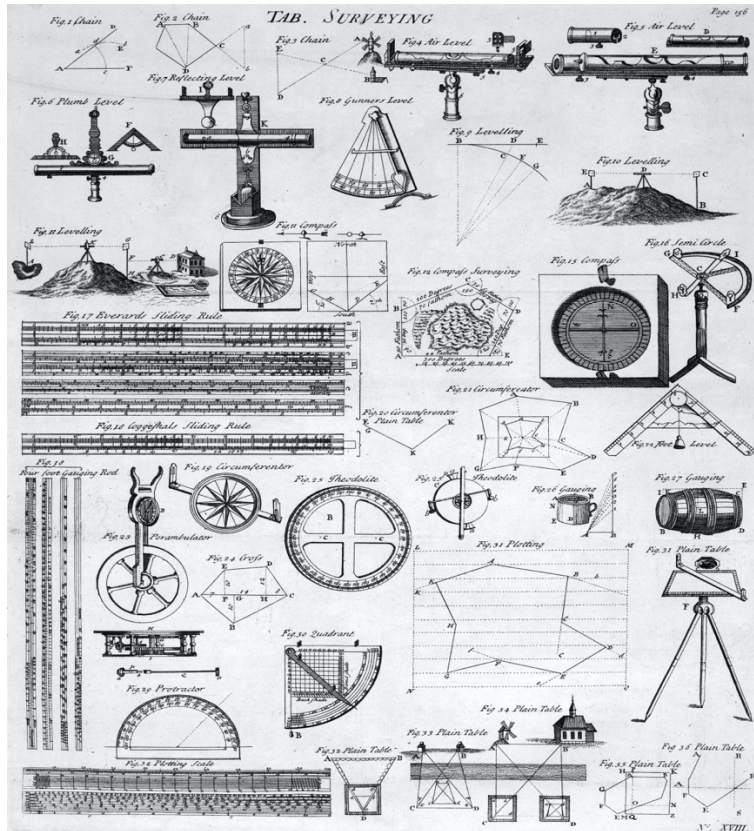
The most basic technique for determining height is to use an altimeter that uses air pressure to determine height. Precision levels (also known as differential levelling) are used where more accurate measurements are needed. When accurate levelling, an instrument and a measuring rod are used to take a series of measurements between two points. To calculate the net difference in elevation between the

two endpoints, the height differences between the measurements are added and subtracted in a sequence. Elevation can be measured using satellite receivers and the Global Positioning System (GPS). GPS is usually less precise than conventional precise levelling, but it can be comparable over long distances. When using an optical stage, the endpoint can be outside of the instrument's effective range. Between the endpoints, there could be obstacles or significant elevation changes. Extra setups are needed in these circumstances. Changing the level to take an elevation shot from a different position is referred to as turning. To transform the level, take a reading and write down the elevation of the point where the rod is. The level is relocated to a new position where the rod is still accessible, although the rod remains in its original location. The new elevation of the level gun is determined by taking a reading from the new position of the level and calculating the height difference. Therefore it's referred to as 'differential levelling'.

This process repeats until all measurements have been taken. A valid measurement requires a degree that is horizontal. As a result, if the instrument's horizontal crosshair is lower than the rod's base, the surveyor would be unable to see and take a reading. The rod may typically be raised to a height of 7-8m, allowing the level to be placed far higher than the foundation.

Measuring Angles

Horizontal angles were traditionally calculated by using a compass to determine a magnetic bearing or azimuth. Angular resolution was later improved by more accurate scribed discs. The use of reticules atop the disc made for more accurate sighting (see theodolite). Vertical angles could be measured using levels and calibrated circles. The plane table allowed for a more graphical method of recording and measuring angles, reducing the amount of math needed. Francis Ronalds invented a reflecting instrument in 1829 for graphically recording angles by changing the octant. A surveyor will calculate around a figure by looking at the bearings from each vertex. The final observation would be a 180° difference between the two points first observed. This is referred to as a close. If the first and last bearings vary, this indicates a survey error known as the angular misclose.



Digital Surveying Technologies

As the time is passing, new and more competent inventions are being done in order to make thing work smoothly and efficiently. If we take example of the surveying technologies the two most commonly used are “Map Digital Technology” and “Digital Mapping Technology” (Kennie, 2014). We first map from the digital technology to start. It has been observed in the traditional engineering survey work that the technology and science have not reach a certain level. Therefore, it is difficult to input more accurate data in the map scale. As the savior when the invention of “Digital Map Technology” was done this problem got resolved. As by using the scanning vector instrument, digital mapping technology, good hand tracking digital technology and entering a data that is more accurate in the large-scale map. (Krawatzek, 2020).



Furthermore, it can be said that after the use of digital mapping technology, the efficiency and quality of work has improved. In order to accomplish this work, the staff needs to go and work out in the field. It is a complex environment to do the field surveying and mapping work and also the working hours are long. However, it is important to complete the surveying and mapping work as soon as possible and attain the accurate data, as afterward's it would be possible to meet the requirements of the buyer. If we compare the traditional surveying, then mapping technology and the digital mapping technology obviously has some advantages. First of all, the digital mapping technology makes the mapping and surveying work more convenient (Puente et al., 2013). It also helps in accurately displaying the mapping objects and also the data that is obtained is more accurate. Moreover, it helps the staff in the mapping and surveying and saving time (Uren, and Price, 2010).

It also gives the advantages to avoid the traditional ways of surveying that usually comprises of inaccurate data. While the accuracy of the digital mapping technology is much higher. In the procedure of surveying through this technology automatically three-dimensional coordinates can be saved. The only thing that is required by the staff is to calculate and analyse. The other significant advantage that digital mapping technology gives is the leverage to work comfortably. As the surveying is done in the fields and the traditional surveying and mapping technology would give the staff workload and increase the timings (Wang, and Wang, 2011). Summarizing it all the newly developed application is more convenient and user-friendly for the staff.

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