SURVEYING INSTRUMENTS (Part2)

Alidades

Continuing on with optical surveying instruments, an important device was called an Alidade and these allowed geologists, engineers and navigators to undertake Plane Table Mapping. In its simplest form it was just a stick with two V-notch sights but from about 1800 small telescopes were used. The Alidade is set up on a horizontal board with a sheet of drawing paper attached (the Plane Table). By sighting up with a distant object a bearing line can be traced on the paper and the distance to the object measured (or estimated) and marked on the map at an appropriate scale. Plane table mapping was used extensively to record the topographic features of the landscape well before aerial photography (and satellites!).

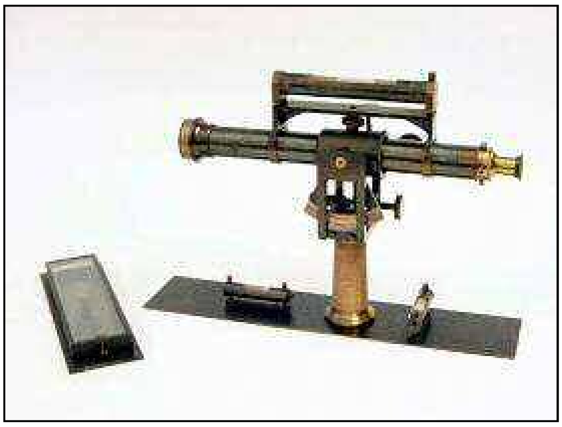

Figure 9 1893 Alidade used in Plane Table Mapping, the box to the left contains a compass so that magnetic bearings can be ruled onto the map (not owned by me, curses, curses).

Surveyor's accessories

Measuring chains and tapes are the most important historic accessories. Thanks to Napoleon Bonaparte metric scales became obligatory and 20m chains generally had 100 links each of 200mm. The British system used Imperial scales including Engineer's Chains of 100 feet containing 100 links and Gunter's Chains of 66 feet containing 100 links (each 7.92 inches). Who would be a surveyor?!

Levelling Staffs

Graduations on metric staffs are usually spaced at 10mm and readings over short distances can be as accurate as 1mm. On the Imperial side, staffs were marked in feet with alternate blocks and spaces of 1/100 of a foot. Inches were not used!

NEW DEVELOPMENTS IN SURVEYING AND INSTRUMENTATION

Self tracking, automatic ranging Theodolites

Next time you see a surveyor at work he will probably be wandering around with a pole fitted with an odd looking mirror. The unattended theodolite will be automatically tracking the mirror using infrared technology and will be transmitting the position of the mirror to the surveyor's "black box" (often attached to the pole). The exact distance between the theodolite and the mirror will also be transmitted for recording purposes.

Laser levels

In my youth I attended a demonstration of a LASER (**L**ight **A**mplified and **S**timulated **E**lectromagnetic **R**adiation). The lecturer did not think that there would be any practical application for this newly invented device. How wrong he was! Lasers are now common in CDs, barcode scanners and of course, surveying. The laser beam is special in that the radiation is coherent (unlike randomly batched photons in a light beam) which means less scatter and the ability to put pulses in the beam that can be read after reflection. Many laser levels are a simple application of an intense beam: they often uses a spinning mirror to make the beam sweep out a horizontal plane which can be picked up by an aerial on, say, a grader or earthmoving scaper to control "dig or dump" instructions.
Most of the huge cotton plantations in outback Australia were installed using this survey method.
Other laser levels use the time taken for a pulse in the beam to travel to a reflecting surface (and back) to calculate a distance. Builders use them when measuring up internal distances.

GPS

The Global Positioning System (GPS) is another amazing invention developed by the U.S. military in the 1970's but now commonly found in everyday vehicles and even mobile phones!

The system uses signals from satellites to calculate a precise position on the globe of the receiving device. Each satellite sends out regular time "blips", as well as information on the ID and position of the satellite. The receiver measures the different arrival times of each blip, of course a longer time indicates greater distance. This all happens at fractions of a second at the speed of light.

3D Laser Scanning

The next step from a mirror spinning in a horizontal plane is a mirror which tilts as it spins. The laser beams reflected back to the scanner are recorded and interpreted as a "data cloud". If the scanner is moved to a nearby known location the next cloud can be combined with the first to provide a Three Dimensional model of the reflected points. The model can then be manipulated by specialized software to show the shapes of an open cut, for example, and also calculate volumes, road gradients, zones of potential failure etc etc. One big advantage is that you don't have to send a crew into a potentially dangerous area to obtain the survey. Figure 10 shows a 3D laser scanner at work and Figure 11 is an example of the results of a survey.

Figure 10. Three Dimensional laser scanner surveying an open cut

Figure 11. Computer model of scanned open cut

The applications of 3D scanners are limitless. At the time of the Bali bombing a scan was made of the craters which allowed forensic detectives to estimate the trajectories of boulders from the crater and other vital data. A further example is provided in Figure 12 which was made *inside* a cement silo, a location not accessible to a survey crew.

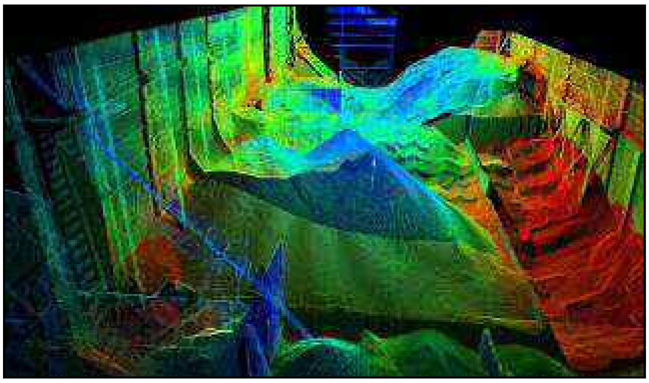

Figure 12 Scanned model inside a cement storage silo. Conventional surveying could not possibly achieve this accuracy.

Another surveying breakthrough is the combination of laser scanning and GPS positioning. A survey team (usually one bloke) can drive into an open cut mine (for example) in a specialized vehicle fitted with GPS and a scanner and "take a shot" at both ends of the pit to produce a computer model of the pit. All the details including roads, benches and volumes mined since the last survey are available at a fraction of the cost and time normally required (see Figure 13)

Figure 13 Combined laser scanning and GPS location has made surveying a computer art!

I plan to have some surveyor's Golden Oldies at Power of the Past 2013 which I hope you will enjoy.

Mark Randell