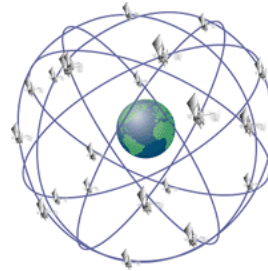
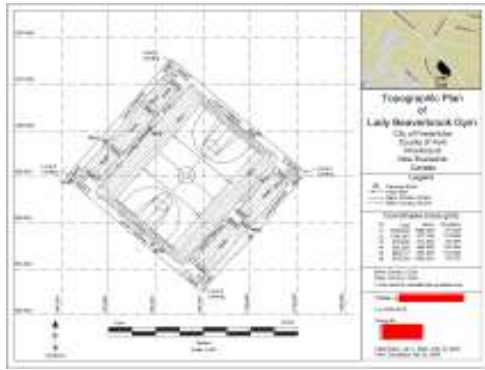


Method of Detail Surveys

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of New Brunswick, Canada
y.ahn@unb.ca



1/00

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Detail Survey - Methods

- **Tacheometry**
 - Optical theodolite (or any other stadia instruments)
 - Angle and staff interception reading, calculation needed
- **Total Station (EDM)**
 - Total station or attached EDM
 - Direct angle and distance measurements
- **Photogrammetry**
 - Larger area, aerial photos
- **GPS (or GNSS)**
 - Kinematic GPS (or GNSS) surveying
 - Instantaneous location
 - No distances and angles

(Dare, 2007)

2/00

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Detail Survey - Methods

- Reflectorless EDM.
- Kinematic positioning using GPS (or GNSS).
- Satellite imagery (e.g., Landsat, Ikonos).

(Dare, 2007)

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Detail Survey - Methods

◆ One Man Total Station

A surveying system, with which one person can handle the entire surveying job, with full control of the results from the reflector station.

- Consist of a Servo-driven Total Station and a Remote Positioning unit (RPU)

- Different from other Total Station

in (Geodimeter 4000)

- Built-in telemetric link
- Tracking device
- Infrared detector

- Components of RPU (RPU 4400)

- Telemetric link, Vertical sensor
- Infrared diode, On-board battery

- Sighting telescope, Control unit

<http://www.monsenengineering.com/assets/images/5600Robotic2.gif>



4/00

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Detail Survey - Methods

◆ Servo-Driven Total Station

- Two-Way Communication
- Control of the instrument via the keyboard of RPU
- Automatic aiming or tracking of the target



Topcon GTS-802A Servo-Driven TS

Max. Turning Speed: 50 deg/sec
Tracking Speed: 5 deg/sec
Tracking Range: 700m
Laser Class: Class 2
Distance Measurement (1 prism): 2 km
Distance Accuracy: $\pm 2\text{mm} + 2\text{ppm times } D$ (m.s.e)
Angle Accuracy: 3 seconds
Internal Memory: RAM 640 KB
Operating Condition: $-20 \text{ deg} \sim +50 \text{ deg. Celcius}$
Waterproof, Dustproof

5/00

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Detail Survey - Methods

◆ Other Servo-Driven Total Station or Spatial Station



Focus® 10 Servo-Driven TS

Trimble VX

Leica

- ◆ Others: Leica, Sokkia, etc.
- ◆ Trimble 5600 is available in our GGE department.

6/00

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Detail Survey - Methods

◆ Reflectorless EDM

- EDM *without a reflector!*
- Laser beam *reflects off* target.
- Visible dot shows target.
- Extended range with a prism.
- Accuracy and range depends upon *reflecting surface*.
- E.g., Leica TPS1100. At 200 m range, accuracy 3 mm + 2 ppm. TPS300 has 80 m range.

Detail Survey - Methods

◆ Reflectorless EDM

- Accuracy and range depends upon *reflecting surface* ??? Is there any paper regarding on this?
- One of the technical paper (TR) for GGE4471 in our department examined the instrument accuracy based on the different reflecting surfaces. The report was *written by David A. Long* in April, 2002
- *“Reflectorless EDMs: is what you see, what you can get”*

Detail Survey - Methods

◆ Reflectorless EDM

ABSTRACT

Currently there is little information available on reflectorless EDMs and the information that is available is produced by the instrument manufacturer. The purpose of this paper is examine and discuss the general performance of a reflectorless EDM.

This experiment will examine what effect surface type and incident angle have on distance measurement. The instrument tested is the Leica TCR307, a construction grade total station. In the experiment five surfaces are measured at five different distances and at three different incident angles. The limit for asphalt was 40 m and the instrument had significant trouble resolving the incident angle at all distances except at the first station (20 m). This experiment provided insight on the instrument functionality and one of the major findings of the experiment was that surface type and incident angle significantly limit the instrument usefulness.

Detail Survey - Methods

◆ Equipment list for the test

- Leica TCR307 (low cost construction grade EDM)
- Leica TC2002 (high precision geodetic EDM) with high precision Leica Prism
- Different incident angles for various surface tested

Table 4.1
Measurement variation for the 20 m data set.

TC 2002 Distance: 19.984						
Measurement Variation (m)						
Angle (°)	Asphalt	Concrete	Rock (dark)	Rock (sand)	Wood	Steel
90	0.002	0.002	0.002	0.001	0.002	0.001
135	0.004	0.001	0.001	0.002	0.003	0.003
150	0.003	0.001	0.003	0.002	0.001	0.003

Table 4.2
Measurement difference for the 20 m data set.

TC 2002 Distance: 19.984						
Measurement Difference (m)						
Angle (°)	Asphalt	Concrete	Rock (dark)	Rock (sand)	Wood	Steel
0	0.002	0.002	0.007	0.004	0.002	0.008
45	0.002	0.003	0.003	0.005	0.005	0.008
60	0.010	0.003	0.006	0.005	0.005	0.010

Detail Survey - Methods

◆ Test Result

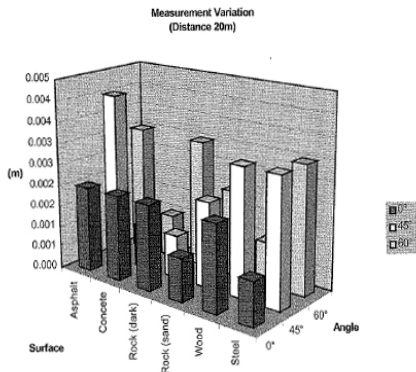


Figure 4.1
Graph of the Measurement variation for the 20 m data set.

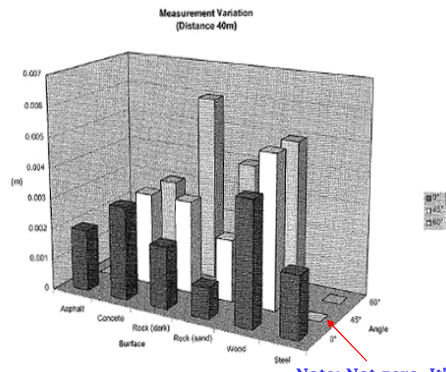


Figure 4.3
Graph of the Measurement variation for the 40 m data set.

Detail Survey - Methods

◆ Test Result

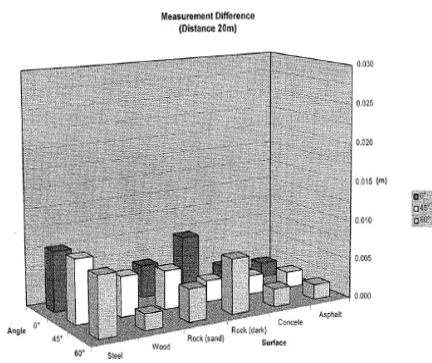


Figure 4.2
Graph of the Measurement difference for the 20 m data set.

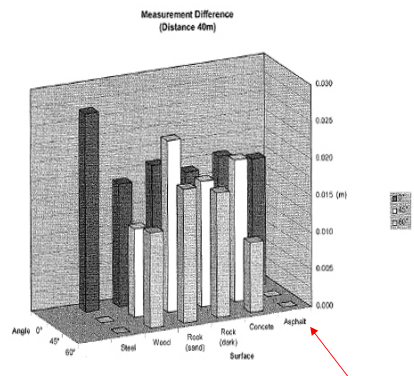


Figure 4.4
Graph of the Measurement difference for the 40 m data set.

Detail Survey - Methods

◆ Test Result

Table 4.6
Measurement difference for the 60 m data set.

TC 2002 Distance: 59.966						
Measurement Difference (m)						
Angle (°)	Asphalt	Concrete	Rock (dark)	Rock (sand)	Wood	Steel
90	N/A	0.017	0.017	0.015	0.016	-0.018
135	N/A	0.023	N/A	0.014	0.022	N/A
150	N/A	0.027	N/A	0.013	0.026	N/A

Table 4.8
Measurement difference for the 70 m data set.

TC 2002 Distance: 70.419						
Measurement Difference (m)						
Angle (°)	Asphalt	Concrete	Rock (dark)	Rock (sand)	Wood	Steel
0	N/A	0.005	N/A	0.006	0.006	-0.008
45	N/A	N/A	N/A	N/A	N/A	N/A
60	N/A	N/A	N/A	N/A	N/A	N/A

Table 7.1
General Instrument Behaviour

Distance (m)	Avg Error (m)	Unresolved Distances
19.984	0.005	0 of 18
39.980	0.017	4 of 18
59.966	0.019	7 of 18
70.419	N/A	12 of 18
80.966	N/A	14 of 18

Note: "Practically", TC2002 may not be good for over 40 meters as you can see in this table.

Detail Survey - Methods

◆ Conclusions of the test

- **Asphalt was returned the "weak signal".** The maximum range was about 40m.
- **Only at 20m did asphalt and steel resolve all incident angles tested.**
- The dark rock, with a perpendicular incident angle was the surface of "weak signal". The limit was about 60~70m.
- The lighter surfaces were the ones that instrument had the fastest times and the longest distances resolved.
- Generally, **the accuracies of the measurement deteriorated as the incident angles and distances increased**, but were minimally affected by surface type, except for steel.
- The performance of the instrument is **significantly influenced by instrument angle and surface type.**

Note: Typically, it's hard to reach to the manufacture's specifications!!!

Detail Survey - Methods

◆ Satellite or Aerial Imagery (advantage)

➤ Accurate, Instantaneous, Remote, and Permanent Record

- Each Photo provides a comprehensive record of phenomena and landscape at a single instant.
- Use for many different purposes
- Ease of acquisition
- Instantaneous recording
- Convenient Analysis (i.e., at user's convenience)
- Continuous measurement
- Opportunity for digital output

(GGE4313 Lecture Notes)

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Detail Survey - Methods

◆ Satellite or Aerial Imagery



16/00

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Detail Survey - Methods

◆ Satellite or Aerial Imagery



- Landsat 1~7 (from 1972 to 1999), Landsat 8 (2010)

(Landsat 7 has 8 spectral bands with spatial resolution of about 15~60 meters)

- IKONOS (commercial, 1~4 meters resolution)

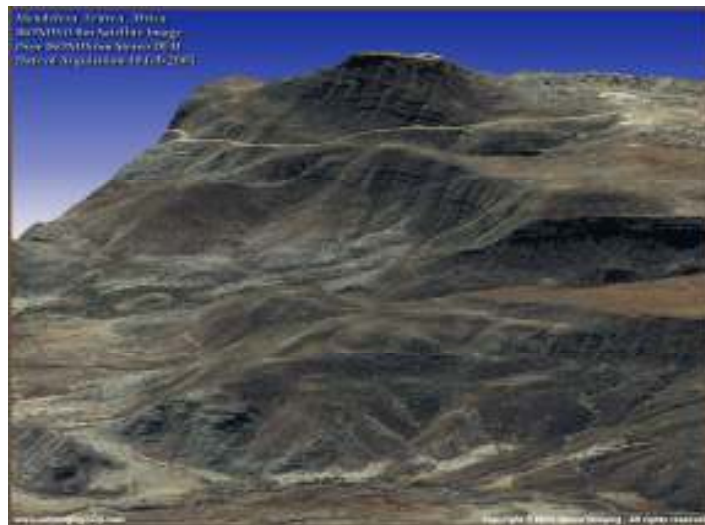
(has multi-spectral bands and panchromatic (~0.8m) imagery, RGB and near IR, on-board GPS receiver, swath - 11 by 11 km single scene)

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Detail Survey - Methods

◆ IKONOS 0.8m PAN, Stereo DEM



18/00

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Detail Survey - Methods

◆ Kinematic GPS

- ◆ Points coordinated while receiver moves or at specific locations
- ◆ Corrections will be transmitted to the rover via radio, RTCM104 format. Thus similar to DGPS (differential GPS), but increased accuracy (approximately 2 cm horizontal)
- ◆ Need additional receivers at known points
- ◆ Based on carrier waves (100 times more precise than code itself)
- ◆ Important to maintain lock on satellites while moving due to quality check (QC) routines, including lock-on constant ambiguities (the similarity of the determination between light wave EDM devices), cycle slips, or etc..

19/00

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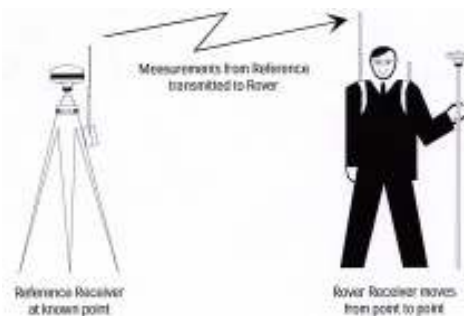
Detail Survey - Methods

◆ Kinematic GPS



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Leica



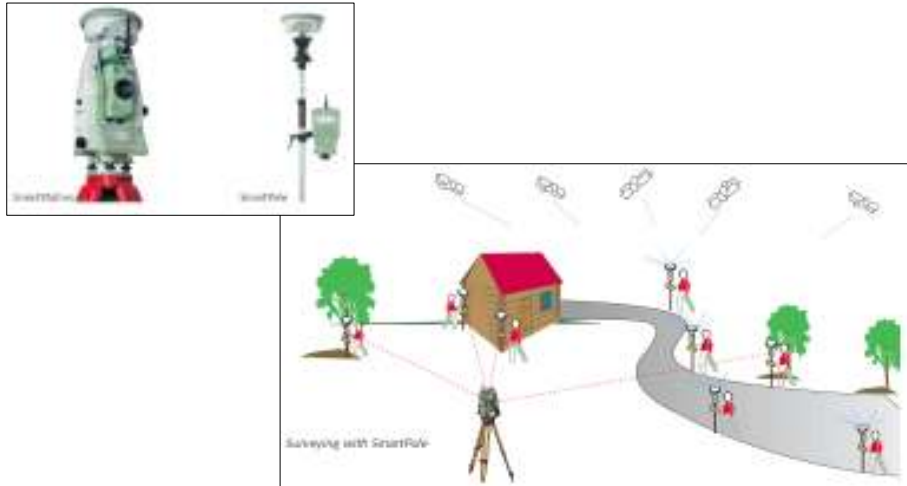
- ◆ *We will study GPS RTK in detail in our 2nd part of this course.*

20/00

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Detail Survey - Methods

◆ Most Recent Evolution for TPS with Kinematic GPS



(courtesy of Leica™)

21/00

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FYI: Laser Class

◆ Be Care with Laser Products!!!

(based on IEC* standards)

*IEC: International Electrotechnical Commission

- **Class 1:** safe under all circumstances (as normal use)
- **Class 1M:** safe except when passing through magnifying optics such as microscopic or telescope)
- **Class 2:** safe
- **Class 2M:** safe
- **Class 3R:** considered safe if carefully used, restricted viewing
- **Class 3B:** hazardous if eye is exposed directly
- **Class 4~:** more power than class 3, can burn the skin. potentially damage your eye permanently.

ex.) 3D Laser Scanner (**Leica ScanStation2: Class 3 (not safe!!!)**,
Total Station: Class 2, Nikon Laser Pulse Total Station: Class 1
870nm, Trimble 5600: Class 1 and Class 2)

22/00

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