GEOSPATIAL WORLD FORUM

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IMPLEMENTATION OF TERRESTRIAL LASER SCANNER FOR OBR MEASUREMENT IN COAL INDIA LIMITED

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Importance of Coal and Coal India Limited

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- Coal meets around 55% of primary commercial energy needs in India against 29% the world over. Around 70% of India's power generation is coal based.
- India is the 3rd largest coal producing **country** in the world after China and USA.
- **Coal India Limited: Maharatna Co. – Largest Coal Producing Company in World**
- Accounts for 76% of total thermal power generating capacity of the Utility sector.
- Supplies coal at prices discounted to international prices, Insulates Indian coal consumers against price volatility.

Thus, CIL plays a key role in "India Growth Story"

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Brief Introduction About CMPDI

CMPDI is a Premier Consultant in Mine Planning and Design in Coal, Lignite and Other Minerals

➢ Services Offered by CMPDI :

- *Exploration*
- *Planning & Design*
- *Coal Preparation*
- *Geomatics*
- Management Services
- Research and Development
- Environment
- Mining Electronics
- Laboratory Services
- Coal Bed Methane

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GEOMATIC SURVICES

- REMOTE SENSING
- SURVEY

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IMPLEMENTATION OF TERRESTRIAL LASER SCANNER (LiDAR) FOR IN-SITU MEASUREMENT OF VOLUME OF OVER BURDEN REMOVAL IN OPEN CAST MINE

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The Challenge in 2007

- Overlaying strata or OverBurden (OB) to be excavated prior to Coal Mining.
- Volume of excavation to be measured accurately for payment and internal governance.
- Not possible by conventional methods and even by ETS (Electronic Total Station).
- ***Then, how to measure OB with high level of accuracy in time-cost effective way?***

Note: OB Volume (~835 MCM in 2015-16)

The way forward…?

- TO OVERCOME THE CHALLENGE IN 2007 CMPDI IDENTIFIED THREE PROBABLE TECHNOLOGIES TO DETERMINE THE QUANTITY OF IN SITU OB REMOVAL

These Are…..

- Using Satellite Data
- Air Borne Laser Terrain Mapper (ALTM) – Digital Photogrammetry
- Using Terrestrial Laser Scanner (TLS)

And to benchmark the results with ETS

- **A CIL funded R&D Project had been taken up jointly by CMPDI and National Remote Sensing Agency (NRSA), Hyderbad, in March 2008**

- **STUDY OBJECTIVES**

✓ **Determine Best Practice for OBR Measurement**

➢ Assess new measurement techniques

➢ Validate against conventional measurement with ETS

➢ Attempt to determine cost effective methodology

✓ **Implement Best Practice**

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The task in R&D Project was to-

- Identifying Test Site
  - Gevra Opencast Project of SECL
  - Belpahar Opencast Project of MCL
- Measurement of Volume using current & new techniques to compare :
  - Results
  - Costs
  - Ease of use
- Recommend the best technique for implementation

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Test Site-I: Gevra OCP

Test Site-II: Belpahar OCP

Equipment Used in the Study

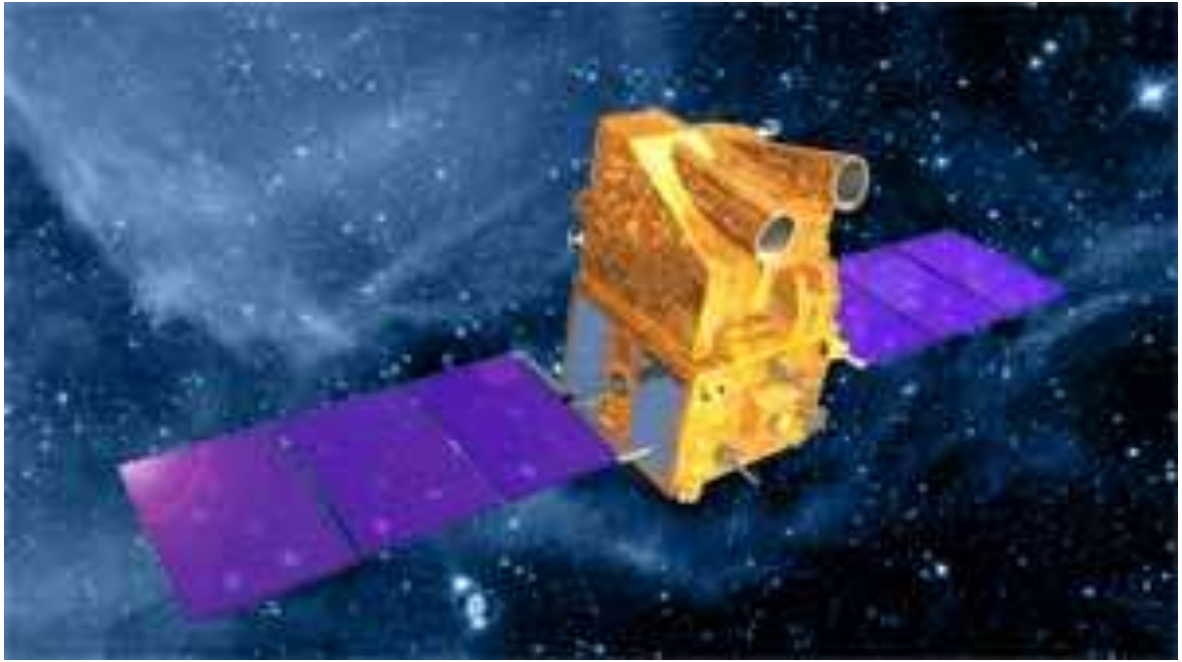
I) Electronic Total Station (ETS)

- Leica Make
- TCRA 1100
- Angular Accuracy : 2”
- Linear Accuracy: ±(2mm +2ppm)

II) CARTOSAT- I Stereo Satellite

Spatial Resolution : 2.50 m

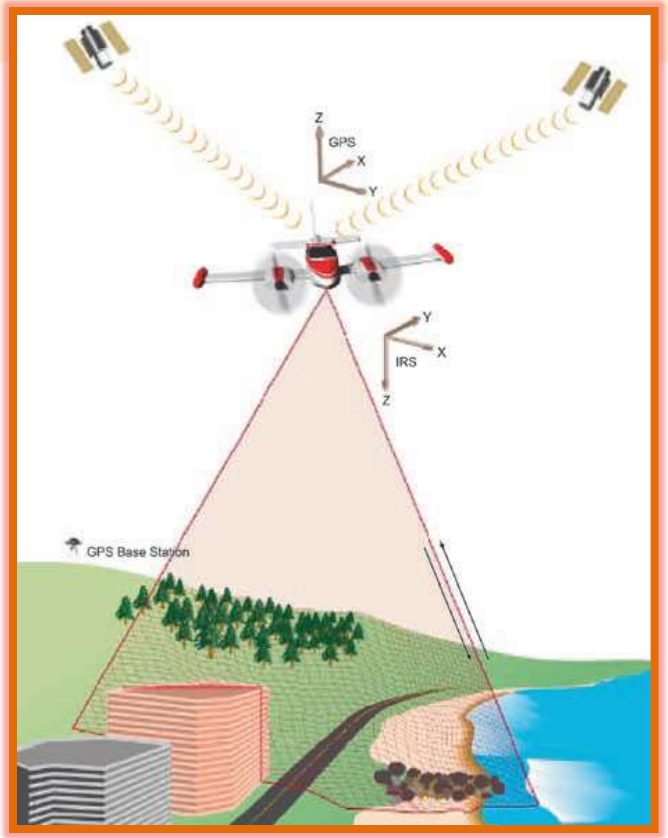
Vertical Accuracy : 4.00 m

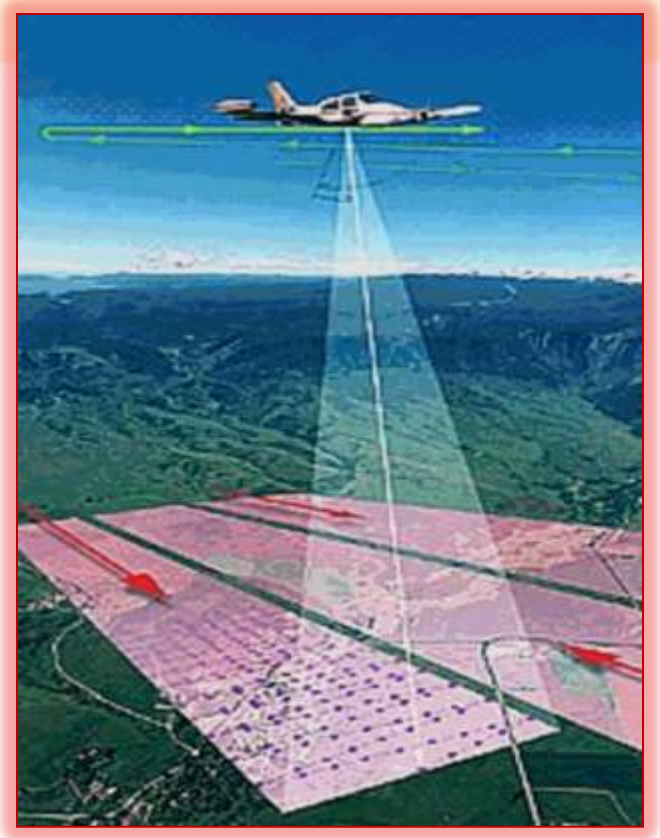


III) Airborne Laser Terrain Mapper (ALTM-ALS-50)

- Vertical Accuracy – 10 – 15 mm

Satellite and ALTM





IV) Terrestrial Laser Scanner (TLS)

- *RIEGL* LMS-Z420i
- Vertical accuracy : 10mm
- Maximum Scanning Range – 1000m (80% reflectivity)
- Scans 11000 points /second
- Active remote sensing sensor
- It consists emitter and receiver
- It emits laser rays which hit the object and comes back to receiver
- Depending on total travel time, scanner calculates three dimensional position (X, Y, & Z) of the point on surface where the laser hits in respect of its own position
- Point clouds data used to create 3D models.

Results: ETS Vs.TLS, ALTM & Satellite

Sensor	Belpahar Volume m.cm	Variance In Volume	Gevra OC Volume mcm	Variance In Volume
ETS	2.597	-	5.460	-
TLS	2.628	***1.19%***	5.536	***1.39%***
ALTM	2.652	***2.12%***	5.531	***1.30%***
Satellite	5.609	***115.98%***	-	-

Evaluation of the Study

- **ETS**

  ✗Time consuming
  ✗Accuracy depends on data density
  ✗ Higher Manpower
  ✓ Less Expensive

- **Terrestrial laser Scanner**

  ✓Faster than ETS
  ✓High Accuracy
  ✓Lesser Manpower
  ✗ Expensive Instrument

- **ALTM**

  ✗ MoD Clearence for Airborne Survey
  ✓Quick (Faster) once airborne
  ✓Higher Accuracy
  ✗ Limited by weather conditions
  ✗ Very Expensive

- **High resolution Stereo Satellite**

  ✓Quick (Faster)
  ✓Less expensive
  ✓No Field Survey required (Except for GCPs)
  ✗ Not Delivered required Accuracy (in the Project with Cartosat-I)
  ✗ Limited by weather conditions

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Conclusions

•The results from Terrestrial LiDAR and Airborne LiDAR were comparable and indicated that **Terrestrial LiDAR** was the cost-effective solution of OBR measurement in Coal India Ltd. at that time. It **reduced 75% time and with respect to conventional survey.**

•Satellite based OBR measurement would be very fast and inexpensive solution provided it attains ± 2% accuracy level and resolve the limitations in coal mining area, which may be possible with new generation stereo satellite data.

- Presently TLS is The time-cost-effective solution for OBR.

Survey Work

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OBR Measurement using TLS (Riegl VZ 4000)

- Scanning Range – 4000m
- Accuracy – 10mm
- Data collection – 37000 to 222000 points / sec depending on distance

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Methodology of TLS Survey

- DATA CAPTURING :

➢ Selection of suitable scan positions to scan the entire mine area.

➢ Fixing of control station near to these scan position using ETS w.r.t. the reference base stations of the Project

➢ During scanning of the visible mine area from each scan position, 4 to 5 target points are placed surrounding the scanner. Co-ordinates (X,Y,Z) of these Targets are to be determined using ETS. However, ETS survey is not necessary for TLS having equipped with RTK DGPS or Backsight orientation technique

Reflectors for Geo-referencing of Scan Data

Processing of TLS Data

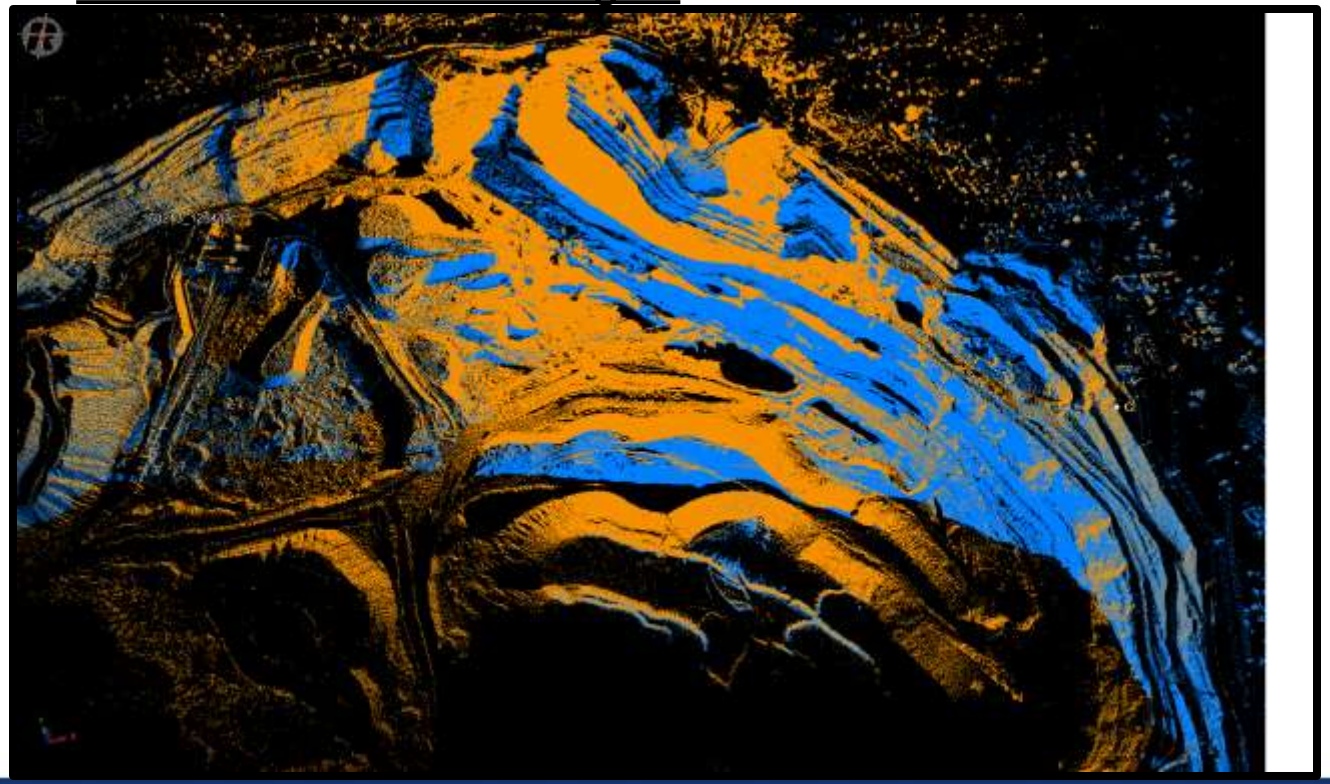
- Geo Referencing and Merging of data acquired from different scan position
- Cleaning of Scan data i.e Removing the unwanted Scan Data
- Preparation of Digital Terrain Model(DTM)
- Generation of Toe and Crest Lines
- Identification of Roof and Floor of Coal Seam
- Preparation of Plan and Cross Sections
- Determining Cross-Sectional area
- Calculation of volume

Data Taken From 1ST Scan Position

- Dipka OCP, SECL

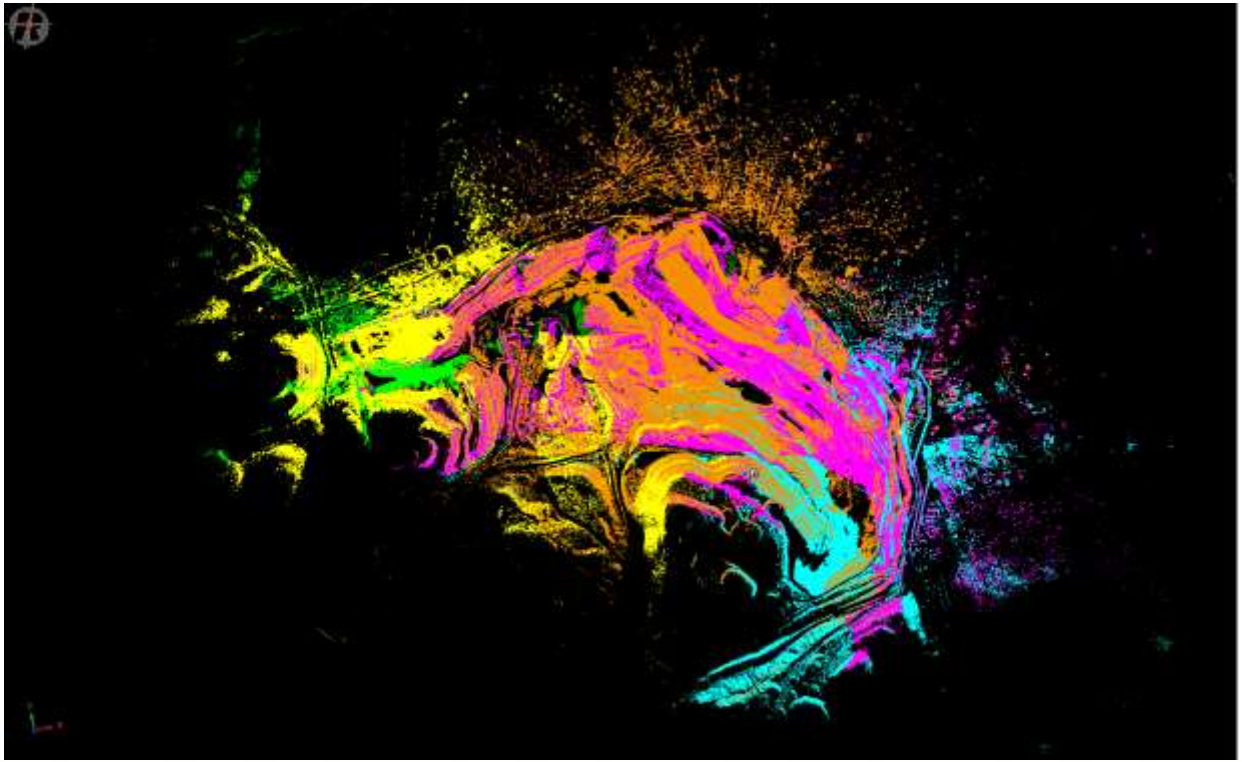
Merging of Scan Data

- 1st and 2nd SCAN Merged



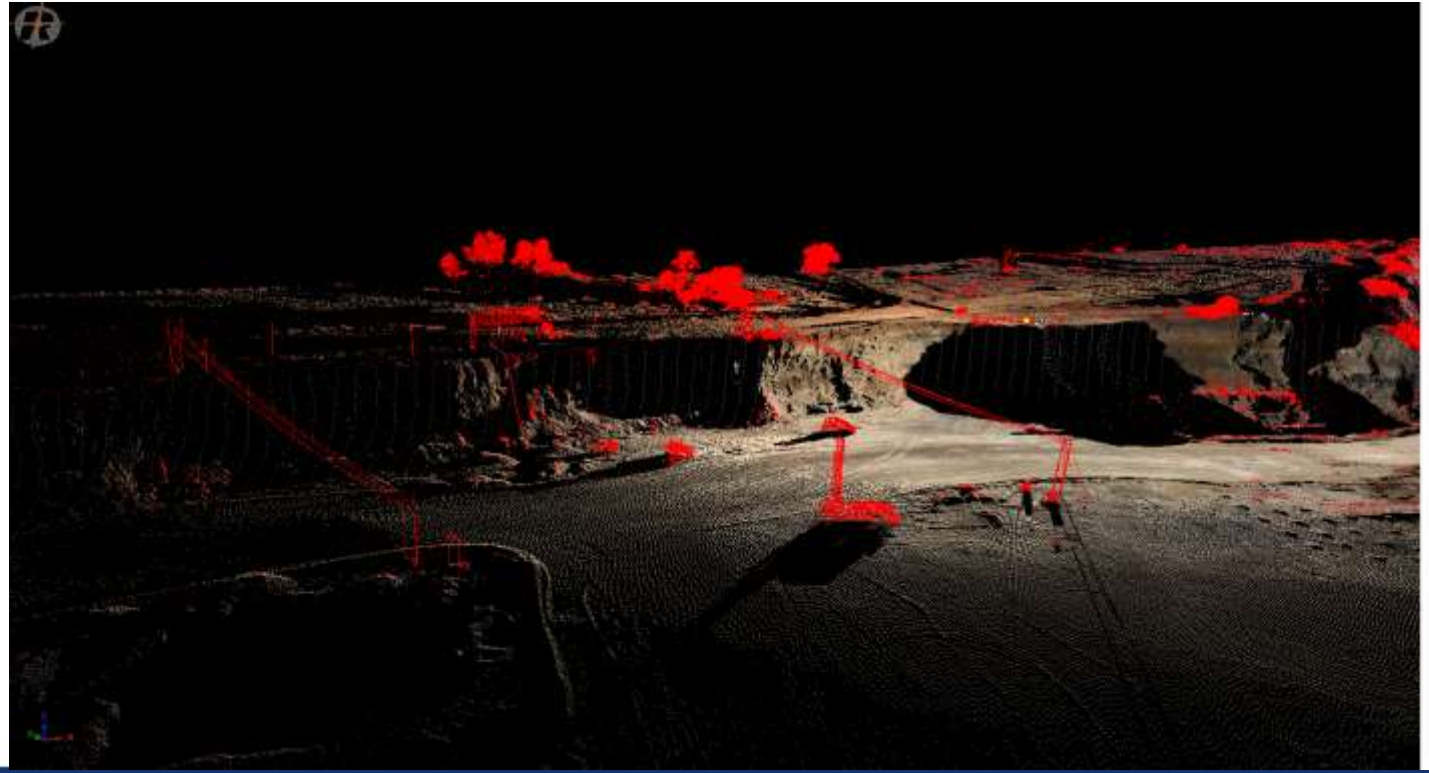
Complete Point Cloud

- Scan Data Taken From 5 Positions Merged Together



Removing Unwanted (Noise) Data

- Identification OF Unwanted data Through Software



Clean & Merged Data of Mined Area

Demarcation of Coal Roof & Floor

- **Upper Kusmunda Coal Seam**

- **Lower Kusmunda Coal Seam**

Generation of Toe & Crest Lines

- Software Generated Toe & Crest Lines

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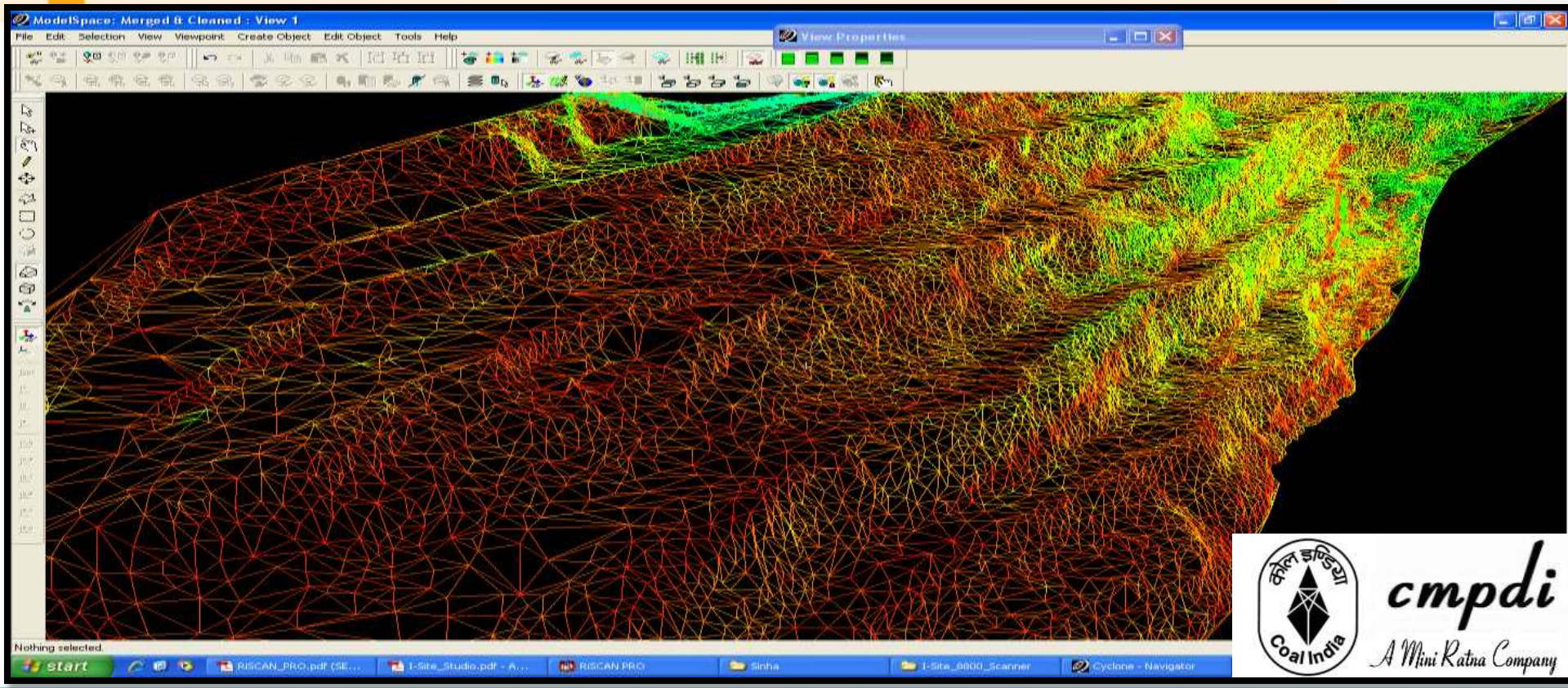
TIN Model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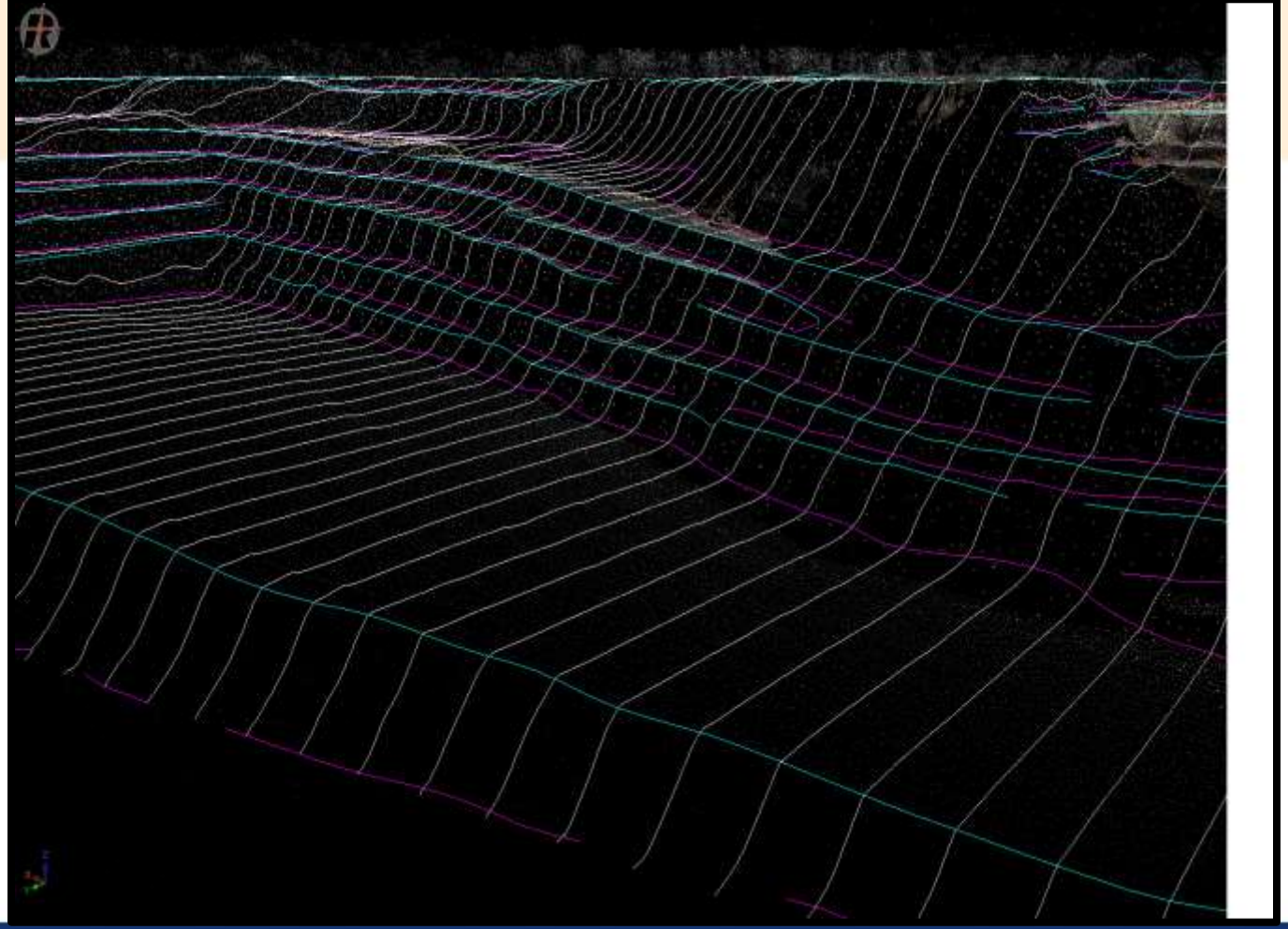

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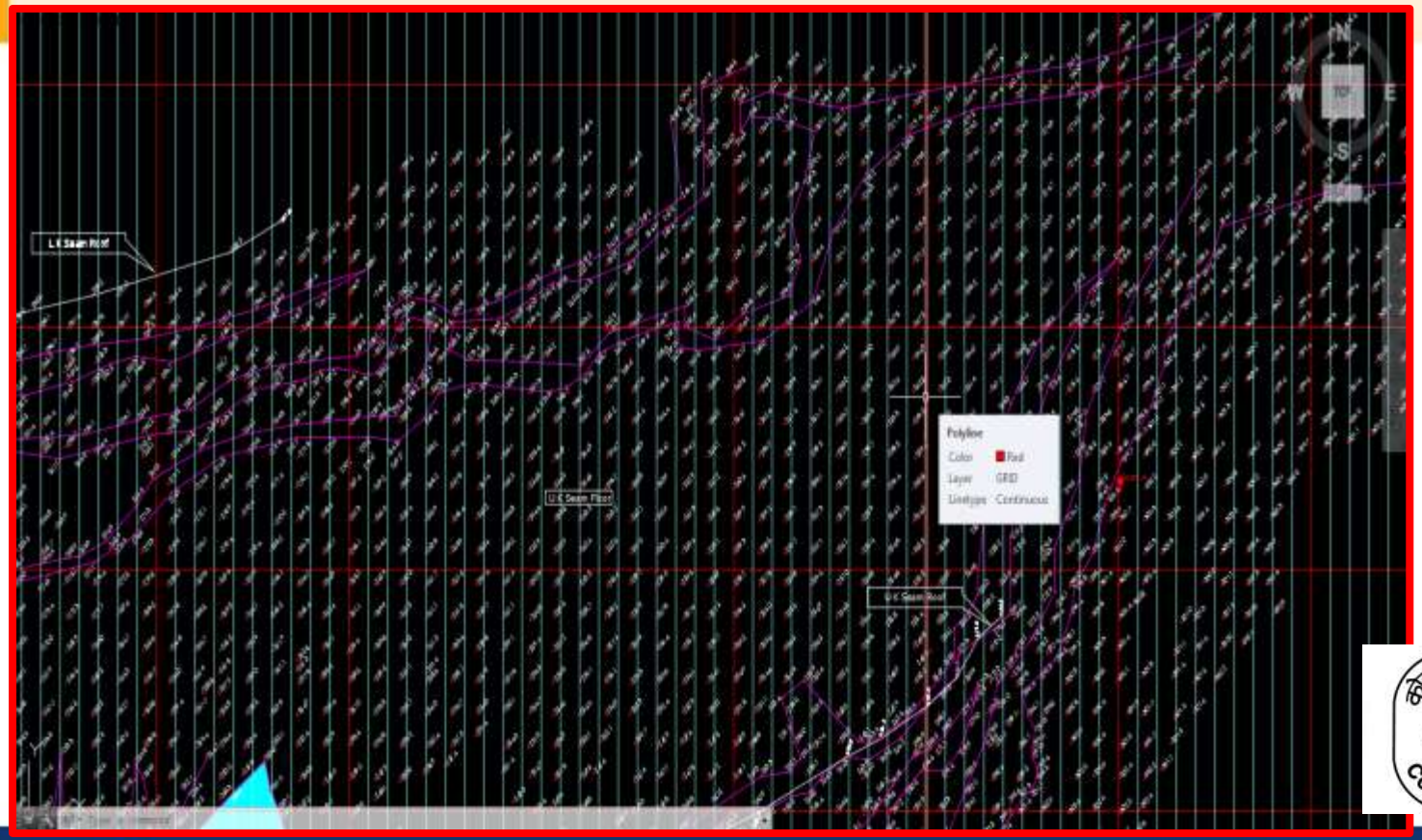
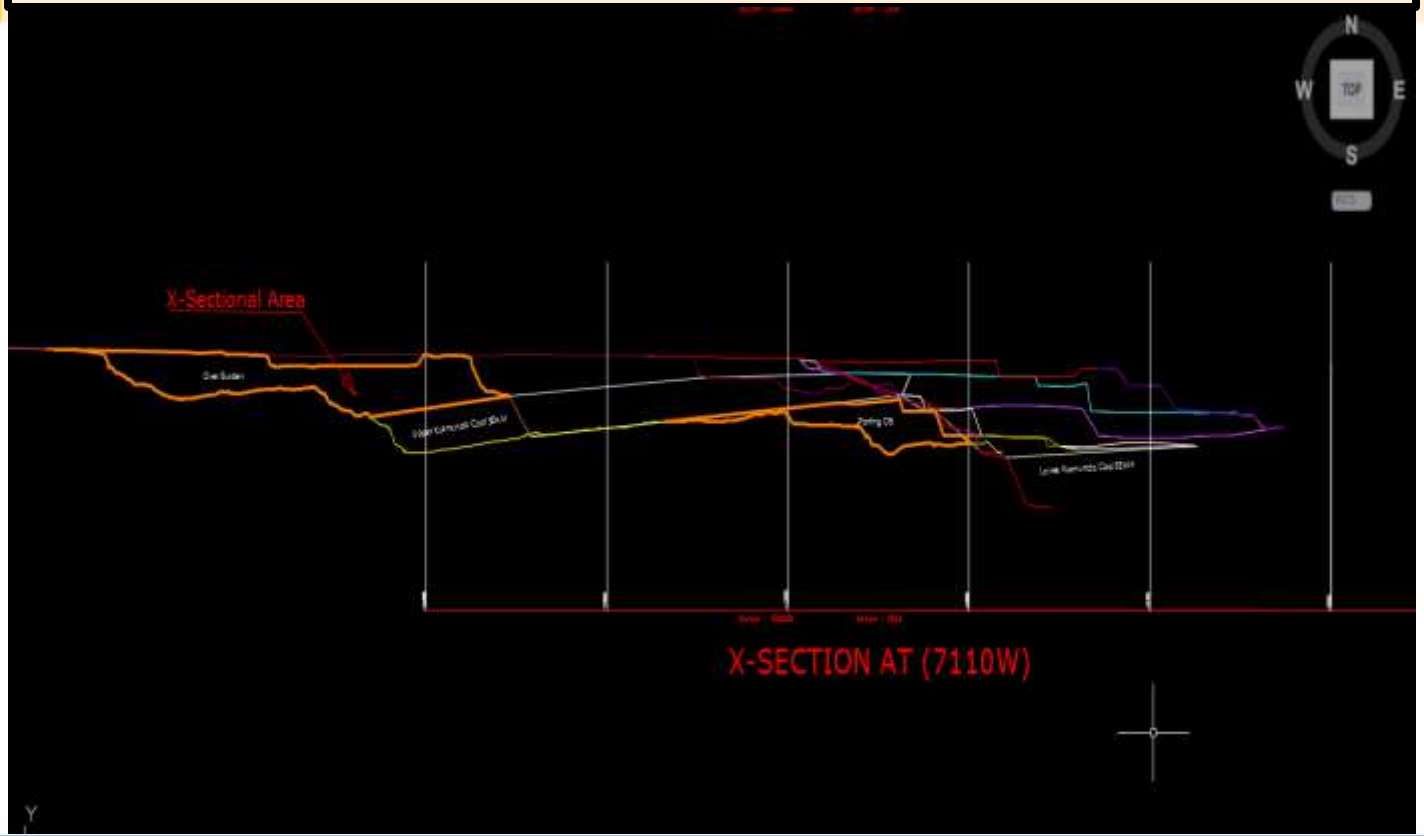
Preparation of Plan and Sections in CAD



Merged Cross Section for Different Spells



Infrastructure of Survey Department

Survey Department of CMPDI is well equipped with all types of Instruments and skilled Manpower to meet all the challenges of the In-House as well as Outside Consultancy Jobs – in Opencast as well in Underground mines

Conventional Instrument (still in use for survey of U/G gassy mine)

- Wild T2 1" Theodolite
- Carl Zeiss NI005 Precise Level with Invar Staff
- Auto Levels (Leica Make)

Modern Survey Instruments with software(s) for all

- High end DGPS – Topcon, Leica, Sokkia, Trimble
- Electronic Total Station (ETS) – Topcon, Leica, Spectra Precision, Nikon
- Terrestrial Laser Scanner (TLS) - Riegl
- Automatic North Seeking Gyroscope – DMT Gyromat 3000
- Handheld GPS – Trimble

Major Tasks of Survey Department of CMPDI

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- In situ measurement of Volume of OB Removal from all Outsourced and large departmental OC Mines of CIL and also one OCP of NTPC
- DGPS Survey for Demarcation of Coal Block Boundary.
- DGPS Survey for Geo referencing Mining Leasehold along with notified forest, GMK, GMA land, Cadastral Map and preparation of Shape / KML files there on.
- Correlation Survey Through Vertical Shaft using GYROMAT 3000 and LASER PLUMBING technology.
- U/G Check Survey.
- OB Dump Survey for monitoring dump height and slope.
- Void and Dump Survey for assessment of volume of void and dump for filling abandoned unsafe quarries.
- DGPS survey for superimposition of Mining Lease hold over satellite image and Cadastral Map.

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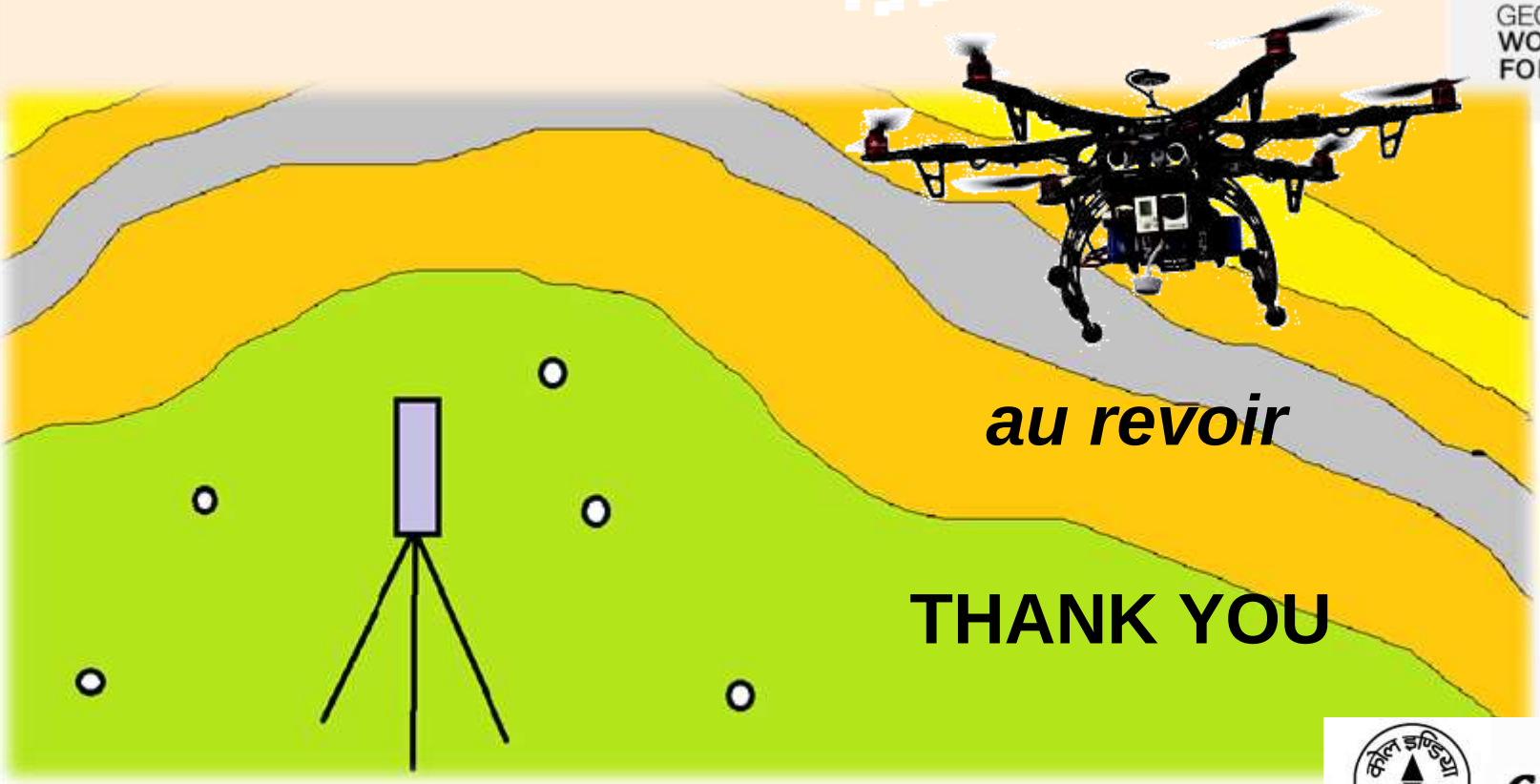

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THANK YOU

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