GPS BASED TRUCK DISPATCH SYSTEM (TDS) IN HIGHLY MECHANIZED BAUXITE MINES A CASE STUDY.

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NALCO

- **Asia’s largest integrated Aluminium Complex,**
  
  Encompassing bauxite mining, alumina refining, aluminium smelting and casting, power generation, rail and port operations.

- **Formation of the Company in Jan, 1981** and commissioning of
  
  - Port Facilities (Visakhapatnam, AP) in Sept, 1985
  - Bauxite Mines (Damanjodi, Orissa) in Nov, 1985
  - Alumina Refinery (Damanjodi, Orissa) in Sept, 1986
  - Captive Power Plant (Anugul, Orissa) in Sept, 1986
  - Smelter Plant (Anugul, Orissa) in March, 1987
## UNIT WISE CAPACITY

<table>
<thead>
<tr>
<th>Unit</th>
<th>Product</th>
<th>Original Capacities</th>
<th>Expanded Capacities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bauxite Mines</td>
<td>Bauxite</td>
<td>24,00,000 MT</td>
<td>63,00,000 MT</td>
</tr>
<tr>
<td>Alumina Refinery</td>
<td>Alumina</td>
<td>8,00,000 MT</td>
<td>21,00,000 MT</td>
</tr>
<tr>
<td>Aluminium Smelter</td>
<td>Aluminium</td>
<td>2,18,000 MT</td>
<td>4,60,000 MT</td>
</tr>
<tr>
<td>Power Plant</td>
<td>Thermal Power</td>
<td>600 MW</td>
<td>1200 MW</td>
</tr>
</tbody>
</table>
PANCHPATMALI BAUXITE MINES, NALCO
LOCATION OF UNITS

- Aluminium Smelter & Bauxite Mines & Alumina Refinery
- Smelter & Captive Power Plant
- Bauxite Mines & Alumina Refinery
310 MT of flat Bauxite deposit spread in 16 sq km area, on the top of the Panchpatmal hill in Koraput District of Orissa.

Average thickness of about 14 mts lies below about 3 mts of overburden, best for opencast mining.
CROSS SECTION OF Bauxite DEPOSIT

Soil  
Laterite  
Bauxite  
PLK
IMPORTANT FEATURE OF THE PANCHPATMALI BAUXITE MINE

- Trench Mining Method is adopted as mining method.
- 14.6Kms single flight multi curve cable belt conveyor from Mines to Refinery for bauxite transportation.
- Deep hole Blasting with ANFO is used for both Overburden and Bauxite.
- Mechanised Mines with all the modern opencast machines are used.
- High capacity Ripper Dozers is also used for excavation and supporting jobs.
- Wheel Loaders and Hydraulic shovels for loading and Haulpac Dumpers for hauling of Overburden and Bauxite are used.
- Surface Miner operation is in the experimentation stage; if it becomes successful, it will help in phase out Blasting and a major step towards clean and continuous mining in the mine.
- TDS system for Mine operation and pit optimization since May-2005.
- Surpac mine planning software is being used since 2007.
CONVENTIONAL MINING

- MANUAL ATTENDANCE
- LISTING OF AVAILABLE EQUIPMENT.
- MANUAL ALLOCATION OF EQUIPMENT.
- MANUAL INFORMATION OF EQUIPMENT. GETTING B/D.
- REALLOCATION OF EQUIPMENT. BY INCHARGE.
- TRIP COUNTED BY TRIP MEN.
- MANUAL MAINTENANCE SCHEDULE.
- MANUAL REPORT PREPARATION.
GLOBAL POSITIONING SYSTEM (GPS) TECHNOLOGY

- GPS is a satellite based tracking system.
- 24 satellites orbiting the earth twice everyday, in 6 different orbital planes at an altitude of 20,200 kms.
- Each satellite is equipped with an atomic clock to let it broadcast signals coupled with a precise time message.
- A GPS receiver on the earth surface takes this signal, compares it with its own time and uses the difference to calculate its distance from the satellite.
- By checking its time with the time of three such satellites,
- A receiver could pinpoint its longitude, latitude and altitude on the earth surface.
OBJECTIVE OF TDS

• REDUCTION OF IDLE TIME OF MACHINERY.

• OPTIMUM UTILISATION OF HEMMS.

• HEALTH MONITORING OF HEMMS.

• QUALITY CONTROL

• ONLINE B/D REPORTING OF MACHINES

• CRUSHER THROUGHPUT MANAGEMENT.

• IMPROVED MINE SAFETY.

• EXTENSIVE ONLINE REAL TIME REPORTING.

• FEEL OF MINE ACTIVITY THROUGH ELECTRONIC EYE.
USE OF GPS IN MINING

- Automatic and optimized haul truck assignment.
- Auxiliary equipment tracking.
- Equipment vital signs monitoring.
- R & D for different parts of a machine by 3D plotting of the GPS Traces.
- Quality control of ore /material blending.
- Subsidence Management.
- Dump/Slope management.
- Automation.
Since May-2005.

Provided by Modular mining System, US.

It is a GPS based Truck Dispatch System.
WHAT IS TDS

[Diagram showing a truck with communication equipment connected to satellites and a radio mast, with labels for client node, local area network, main server, communication server, and terminal server.]
TYPICAL SYSTEM

- Field Computer Systems (FCS), including Hub and Color Graphical Console (CGC) for each truck and shovel
- Wireless radio network
- Central computer equipment
- GPS ground reference station
- The Field Computer Hub contains:
  - Global Positioning System (GPS) location system
  - Data radio
PANCHPATMALI BAUXITE MINES, NALCO

CALL POINT
PURPOSE OF TDS

OPTIMIZATION of the mine operation based on real-time data

HOW DOES IT DO IT?

By providing all of the following and more:

- Automatic, optimised haul truck assignments
- Auxiliary equipment tracking
- Automatic fuel assignments
- Equipment vital signs monitoring
- Maintenance tracking
MINE OPERATION SCENARIO WITH

DISPATCH

- Optimal production circuits.
- Dynamic assignments.
- Real-time blending control.
- Dynamic adjustment of cycle times

DISPATCH AS A TOOL

DISPATCH as a tool has many functions

- An integrated data collector
- A massive database, and
- A high-speed, real-time problem solver
DISPATCH AS A DATA COLLECTOR

- DISPATCH is constantly receiving data, referring to data and storing data. It uses the data, real-time and historical, to update records, make assignment decisions, and to generate reports.

INTERACTIVE DATA COLLECTION

- Operator responses (button presses)
- Dispatcher interaction
  - Changing operator names
  - Altering a truck assignment
  - Changing the status of equipment

DISPATCH requires a certain amount of interactivity from the operators and the dispatchers in order to update its records, keep its data free of error, and to make sound decisions.
DISPATCH AS A REAL-TIME PROBLEM SOLVER

✓ Constantly receiving data and updating its databases.

✓ It is always calculating travel times, load times, queue times, fuel levels, tire usages, load counts, and a host of other events that affect overall mine operations.

DISPATCH AS A REAL-TIME PROBLEM SOLVER

✓ The primary question being solved is

“what is the best assignment for each piece of equipment right now in order to achieve the mine’s goal?”
HOW DOES IT SOLVE THESE PROBLEMS?

Equipped with the data in the pit database, DISPATCH uses three computer (OR) models to help it solve these questions and others like them:

• The best path (BP) model,
• The linear programming (LP) model, and
• The dynamic programming (DP) model

THE BEST PATH (BP) MODEL

• Used to determine the shortest path between two points in the mine.

• DISPATCH calculates the shortest path (by distance, not time) from each point in the mine to every other point in the mine whenever there is a change in the mine road network and whenever the LP model is recalculated. The results of the best path calculation are included in the LP model.
Haul Cycle Model

1. Truck Full
2. Receive Dumping Assignment
3. Travel to Dump
4. Arrive at Dump
5. Receive Loading Assignment
6. Travel to Shovel
7. Arrive at Shovel
8. Truck Spot Start Loading (First Bucket)

Load / Haul / Dump Cycle

Complete Dumping
THE IMPORTANCE OF THE HAUL CYCLE MODEL

- DISPATCH bases many decisions on this operational model.

- DISPATCH always expects the next event in the haul cycle to occur for each shovel and each truck and anticipates its occurrence within a certain computed timeframe.

- Based on that expectation of the next event or action for each truck and shovel (and other operational considerations), DISPATCH makes a decision that is necessary right now, such as an assignment request from the field.
Path Options for Dispatching
Configuration of DISPATCH
PIT OPTIMIZATION

It is a powerful mathematical algorithm when generating optimized haul truck assignments, including:

**Best Path (BP)** - Uses distance as the criteria as the shortest,

**Linear Programming (LP)** - Uses production and operational constraints,

**Dynamic Programming (DP)** - It uses the LP’s Master Plan as a reference, and builds “future” scenarios when generating assignments.
Pit graphics
Four Loading machines and 10 dumpers running with TDS system in the mines.
BENEFITS

DUMPER PERFORMANCE REPORT

- Automatic trip count.
- Idle time and used time recording.
- Performance of any machine or operator can be seen at any time during and after the shift.
- Performance for a period of time can also be analyzed instantly by multiple shift report.
LOADER PERFORMANCE REPORT

- Loader performance, like the dumpers, can also be seen at anytime and compared for further improvement.
- Low tonnes/used hrs of a loading machine means insufficient number of dumpers and it can be deployed in other jobs immediately which was not possible without the system.
PRIMARY BENEFITS

- Improved equipment utilization
- Absolute control over material origin and destination
- Changes the nature of technical and operational decision making
- Focuses employees on performance
- Provides feedback on the effect of variations in their own contribution
BENEFITS

Increase in utilization by:

✓ Real-time display and monitoring of the entire mining operations.

✓ Instantaneous generation of alarms for stationary dumpers.

✓ Equipment Tracking and automatic warning against movement into unsafe zone and breakdown dumper movement.

✓ Bauxite Grade control.

✓ This utility contains all the logic required to manage the flow of material movement in the mine. This utility uses the ore body quality data files.
BENEFITS

 ✓ Key performance Indicator (KPI) for various parameters of pit management.

 ✓ **Crusher System.**
   It manages the flow of traffic at the crusher. The system automatically or manually by the crusher supervisor directs arriving trucks to the appropriate bin or dumping bay.

 ✓ Online Reporting and report generation as desired.
THANK YOU!

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