www.MINEPORTAL.in

(All Mining Solutions)

DOWNLOAD MINEPORTAL APP FROM GOOGLE PLAY STORE

- **ONLINE TEST SERIES FOR**
  - **DGMS COAL/METAL FIRST & SECOND CLASS**
  - **GATE MINING**
  - **COAL INDIA EXAMS**
  - **OTHER PSUs MINING EXAMS**
- **FREE STUDY MATERIAL-MINEPORTAL NOTES & USER NOTES**
- **MINING VIDEO LECTURES**
- **DISCUSSION FORUM**
- **WHATSAPP CHAT SUPPORT FOR MINING EXAMS & QUERY RELATED TO MINING**

CALL/WHATSAPP- 8804777500

VISITING SITE- www.MINEPORTAL.in **Facebook-** www.fb.com/mineportal.in

EMAIL- INFO@MINEPORTAL.IN

MINE PLANNING-I

www.MINEPORTAL.in

28/1/15

Mine Planning (AK Sir)

Chapter 2 → Hustrulid
- ✱ NPV
- ✱ Payback period
- ✱ interest rate

4/2/2015 AK Sir

Mining Revenue and Costs:- → chapter 2, Hustrulid

Estimating Costs

Types of Costs
- → Capital Costs
- → Operating Costs
- → General and Administrative Cost

Capital Costs are those type of cost which are directly related to the capital investment required in a mining project. The operating cost is the cost which reflects direct operations of mining cost. General and administrative costs includes all the services related with the setting up the project. These include area supervision cost, mine

supervision cost, mine office expenses, head office expenses, mine salary insurance, etc.

O-Hara cost estimates

Daily Tonnage

$T = \frac{5}{7} T_0$

Personnel Number

2.4.6 Detailed Cost Calculations

5/2/2015 RK Sir

Feasibility Report

→ Basis of approval → all approvals are accorded to this document.

→ Basis for monitoring → activities, inter-related activities.

→ Basis for execution → It gives the sanction of manpower, equipment and funds.

It is revised when there is a time

overrun or cost overrun.

Explanation of ~~ex~~ ~~activity~~ ~~full production~~ ~~overrun~~ above -

The feasibility report is a very important planning document to be prepared before the undertaking of a mining project. It indicates all the technically and economically viable options. All approvals are granted on the basis of this report. The entire project is continuously monitored on the basis of the feasibility report. It helps in monitoring all the activities along with all the related activities to also to be performed. This document indicates the inter-relationship between various activities and identifies the areas that need attention during monitoring.

ex.) Ventilation is related to capacity of fan installed and ~~with the~~ its operating cost is related to the evasee size and design to be installed along with the fan size.

A pert analysis is performed for each activity (Project evaluation and resource technique) and the ~~time~~ cost for the activity and the time is estimated. This is a resources based pert ~~ex~~ ex.) For the drivage of an incline we require ~~p~~ to procure equipment and (cost element) and subsequently support system is to be installed to stabilize the opening. So By the pert analysis we find out the cost of drivage and time of drivage.

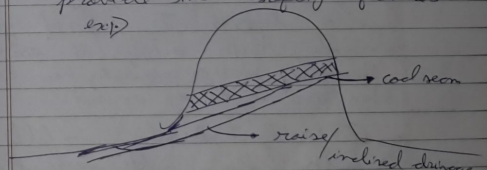
The feasibility report helps in continuous monitoring to ensure that the activity is within the estimated cost and time. This report also forms the basis of sanction. The sanctions of manpower, equipments and funds is totally based on this document. If we require more manpower and equipment vehicle operating, then the feasibility document is revised for further sanctions. It is revised in case of time and cost overrun. ex.) Suppose the project has to come to full scale production in 10 years and if it does not do so then there is a time overrun. Suppose another project has to come to ~~full scale~~ a production of 5M T/year in 5 years and it is able to reach this but its coal handling plant is not yet completely prepared then this is a time overrun. So whenever we require more money than what is sanctioned by the report, it is a cost overrun

Topics to be covered in Draft/Feasibility Report:

1.) Location and communication → For each mine to be planned we have to provide detailed location of the mine (latitude, longitude, district, tahsil) and how to reach the mine (communication). All features like roads, rail, telephone, airport, Mast (multi access radio telephone), walkie-talkies, etc. that the mine uses. The idea is that any one can locate the mine easily.

2.) Topography → How is the area located (Hilly, river, nalla) Topography is important to provide the safety features.

ex.)



ex.2.) In O/C mines often the nalla and river are diverted.

Date / /
Page

3) U/g mines are not worked below a nalla or a river. They are diverted for these purposes if possible.

3.) **Geology :-**

- Geological structure – geological age / sedimentary / Metamorphic
- Strata formation – Thickness, sequence, Depth, gradient
- Rock properties – physico-mechanical / chemical properties

All these above are necessary because we should know the strength of surrounding rock to know the stability of structures made and knowing the age of the formation. The formations of younger age are friable, soft compared to older deposits. The study of age of surrounding rocks helps the ascertaining whether mineralization has taken place in that age or not.

- Geological Disturbances → folds and faults (they dictate method of mining and how these need to be negotiated.)
- Thinning of the seam, syncline

Date / /
Page

and anticline are also mentioned

- Physical details of the mineral i.e seam thickness – number and sequence, depth, gradient, physical and chemical properties of the mineral (This determines the value of mineral, cost at which we can mine and what percentage of mineral can be mined)

4.) **Qualitative characteristics of the mineral (coal :-**

Proximate Analysis, sulphur content, caking property, chemical analysis if coal, is to be used for steel plant or specialized usage, GCV, physico-mechanical properties (It determines usefulness of mineral and the applicability of mineral and the value of the mineral. Chemical analysis is important because it decides how the mineral can be used in making good quality products. Physico-mechanical properties are required to understand that when we make a drivage in mineral, then whether it will stand or not, what is the support

requirement, the level of subsidence, damage to overlying strata) All these studies are to be done before we start writing feasibility report.

(5) **Boundary of the mine** → Generally natural boundary (incrop or outcrop). It could be separated by a fault, river or railway lines.

(6) **Reserve of the mine** →

- Proved → (ore which has been geologically proved by drilling holes at interval not more than 200m. Quality, quantity, geological structure is very well defined so the feasibility report has to largely depend on the proved reserve because it is a document on which financial and technical decisions are to be made)
- indicated
- inferred → (those reserves which have be calculated by drilling at intervals of 1 Km or more. Not certain about quality, quantity, geological structure / geological disturbance. We prescribe that the indicated reserves will be converted to proved reserves and in such cases, the level of production will increase.

Inferred are those where there is not drilling done. It is based on GSI report and other reports and on the geology of the area. All inferred should be brought under indicated and proved category.

Mineable reserve → all reserves of which mining can be done ex) reserve between 2 faults, reserve under rivers are unmineable But the entire mineable reserve is not extractable. Only the extractable quantity is mentioned under the extractable reserve category.

Extractable reserves are also to be mentioned.

The proved reserve must be distributed quantity wise and grade wise.

(7) **Mode of entry** → shaft, incline / Rising Drifts, Box cut (in opencast) — we give complete design, size and specification of the drivage, length of drivage (full details)

— For box cut, its design, its location, etc. (Design of box cut depends: the
- foundation depends on load of equipments
- width on the width of machines (2-lane or 4-lane)
- gradient not more than 1 in 16)
Means of drivage (drilling - blasting, roadheaders, sinking methods)
[sinking rate on a average of 20 m per month is reasonable]

But if the detailed information is not available then basic report is given and then details report are made commensurate with the mentioned basic information. The idea is that the process of approval should start for early mining in case detailed study is not yet completed.

(8.0) **Method of work →** opencast vis-a-vis underground (a) opencast is prefered for the sake of easy operation, high productivity, and low capital cost per ton.

(b) The stripping ratio is 1:1 in manual, 1:2 in semi-mechanized, 1:4 or 4.5 in highly mechanized)

(c) Opencast beyond 200 m is not practiced because high dump, high space requirement, long lead distance, ventilation problems.)

The above is the technical viability. There may be situations where both O/C and U/G are technically viable (ex.) 4 m seam at 50 m depth) then the economic criteria is the important thing i.e. the cost of production is cheapest. So a complete technoeconomic feasibility study is performed and a method is selected.

8.1 Opencast → manual, semimechanized, mechanized [shovel-dumper, dragline, surface miner, inpit crushing and conveying, bucket wheel excavators]

[In india only in NLC, overburden is blasted but lignite is extracted by BWE. All the lignite is under water and so it is very soft]

In-pit crushing for ore and waste both can be done.
— where conveying distance is very large so conveying cost become large and conveying units are reduted to a higher level)

Dragline is used when the OB is very thick (30-50 m) and the strike length is large (because it take months to site a dragline so

once it sits, it should operate at that position for atleast an year) and where the gradient is low.

Shovel-Dumper → Depending of the quantity of material to be mined, the shovels and dumpers sizes are decided.

Shovel (max) = 20 m^3
Dumper (max) = 250 T
} In India

↳ Dumpers also have a volumetric restriction but still dumpers are rated as per the tonnes of material they carry.

~~Underground~~

There is no specific reason but the no. of trips of a dumper are counted and the total production by the dumper can be estimated by = (no. of trips) x (rated capacity in tonnes)

So we talk of dumpers in terms of tonnage capacity

11/2/15. AK Sir

Cost Estimation

Step 1 → Given the annual production requirement for ore and waste plus the operating schedule, determine the daily production rate.

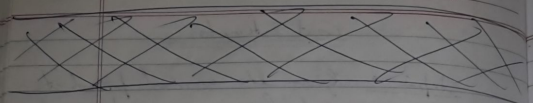
Step 2 → Select a basic equipment fleet.

Step 3 → Calculate the expected production rate of each type of equipment.
Calculate the no. of machines required. Determine the amount of support equipments needed.

Step 4 → Determine the no. of production employees required. Determine the no. of support employees.

Step 5 → Calculate the owning and operating cost for the equipment

Step 6 → Calculate the other costs



Step 1 → Calculate the overall cost per ton.

Assumptions:-

→ Molybdenum ore
→ ground type → granite
→ 32.3 MT of waste
→ 53 MT of ore
→ Stripping ratio = 06:1
→ avg ore grade = 0.28 % MoS_2
→ The waste will be hauled by truck to dump area
→ The ore will be hauled by truck to one of the ore passes
→ The ore is crushed and then transported by U/G conveyor to the mill

Step 2:- Daily production rate determination

- Annual production rate = 3MT of ore and 2MT waste
- Mine operates 2 shifts per day

Working days/year = 250 days

Daily production = 6000 tons ore per shift and 4000 tons per shift of waste.

Step 2:- Selection of a consistent set of mining equipment.

Major types of production equipment to be selected are:
- Drilling Machinery
- Shovel
- Dumper / Truck

The Bench height has been chosen to be 30 ft (10m). The basic equipment selected are:-

- 6 yd^3 electric shovel
- 35 T rear dump truck
- rotary drill capable of drilling 9.88 inch dia holes

Step 3:- Production Capacity and no. of machines

mycompanion

Based upon a detailed examination of each unit operation, the following production rates were determined:-

- Drill → 35 ft of ore per hour
- Shovel → in waste, 630 T per hour
- Shovel → in ore, 750 T per hour
- Dumper → in waste, 175 T per hour
- Dumper → in ore, 280 T per hour

~~Mine of ore today~~

See Hustrulid (Production Scheduling ~~capt~~ chapter)

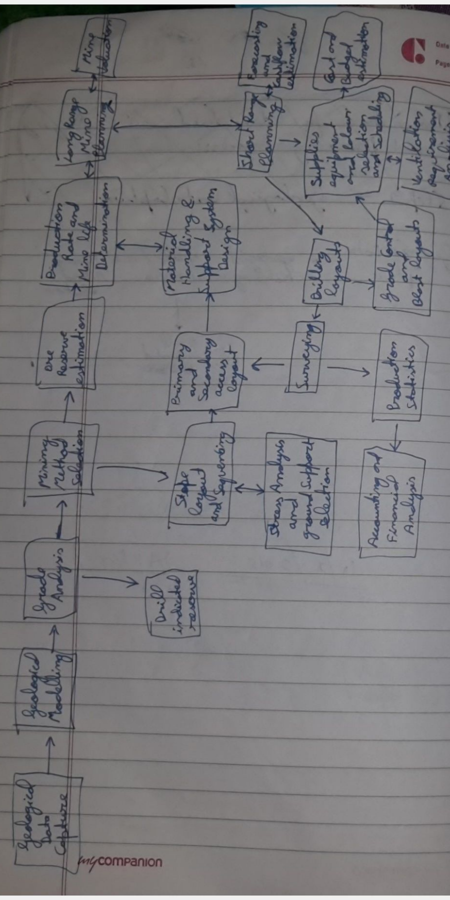
Flow chart for traditional mine designing and planning process:-

Steps → Geological Data Capture

Geological Data Capture → Geological Modelling → Grade Analysis → Mining Method Selection

Drill indicated ~~Resource~~

18/1/2015 AKSin



FLOWCHART FOR TRADITIONAL MINE DESIGN AND PLANNING PROCESS

19/2/2015

RK Sir

8.2 Underground → Bord and pillar/ Longwall/ speed methods like hydraulic mining, coal gasification, sublevel caving.

Bord and pillar → applied when shallow depth, relatively higher seam thickness, more geological disturbance, area being small, production is less

Longwall → seam thickness not very high, large production, high depth, cavable roof.

→ With increase in seam thickness, support requirement varies as the square of it so if seam thickness is high then longwall support is very high and such high capacity supports are not available so for higher seam thickness is developed by Bord and pillar mining

→ Hydraulic mining can be adopted where the rocks is soft and the gradient is

very high because the coal cut should flow under gravity automatically. But the water requirement is high and so ~~high~~ to large water reserves the required near mine and the problem of ventilation is there because humidity is high.

→ In-situ gasification is applied where the coal cannot be mined by conventional methods. The idea is that some coal is partially burnt and energy is recovered. In conventional methods recovery is upto 70% and in gasification energy recovered is only 20 - 25%. used in ~~diffe~~ seams which are highly steep, very thin, very deep and highly geologically disturbed. Cumbersome process and requires ~~bed~~ meticulous planning.

→ Sliced caving adopted when seam thickness is more and

cannot be exploited by O/C mining. Depth of seam is high so U/G is the only option. When seam thickness is large (7-9m) single slice mining is not done so ~~multiple~~ 2 slices are developed, one along roof and one along floor and intermediate coal is blasted down.

Board and pillar

- manual (property small, production requirement is low) — (drilling, blasting, coal manually removed to a coal bin)
- semi-mechanized — (drilling, blasting and transportation by belt conveyor)
- Auger mining — large dia hole to provide free face to increase fall, and in highly gassy seams to drain out gas ~~to~~ before blasting. If coal is hard then augers or cut face blasting is done. If coal is medium to soft then solid blasting
- mechanized — LHD, SDL

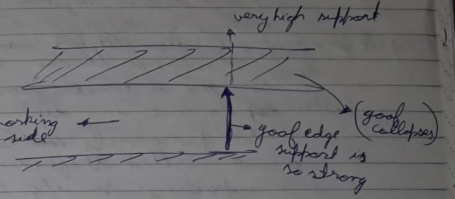
Depillaring

Diagonal
better strata Control.

Skip diagonal
(high mechanization possible so high productivity but requires greater support and greater strata control)

Depillaring by LHD
Earlier depillaring did not allow mechanization so production was slow and low.
In case of depillaring the most important thing is supporting of goaf edge.

The entire mining trick is →
You retain the roof and face when you are working under it but when you stop working then cave the roof and face to collapse or else there will be a large overhang and if it collapses then there would be air blast, etc.



Adequate support at goaf edge developed so we can cause the roof to collapse safely to ensure safety of operation during depillaring. So we now use LHD (s) while depillaring.

Longwall

Manual
(nearly obsolete)
(drilling, blasting, props ~~dead~~ erected manually, stowing is done so rate of advance is low so mechanization not possible.)

Semi-mechanized and mechanized with individual support
→ If property is low so if mechanized then property consumed before 9 years (life of u/g equipments)

Shearer/plough with hydraulic support
→ plough used for soft coal, thin seams and seams at higher depth. But now obsolete so equipment have to be transformed.

9) Transport of Men and Material:-

9.1) Man transport → shaft & cage, man-riding system, trolley, roadway, Conveyor (Top belt for material and bottom belt for man), etc. Mining has become extensive so the distance from pit bottom to face is upto 10 kms so personnels waste a lot of valuable shift in commuting so U/G transport has become important.

9.2) Transport of coal/mineral/material →

coal/mineral → outward transport

material → inward transport.

Haulage, Locomotives, Conveyors can be used.

⇒ Endless haulage used in levels and one way can be used for men and other way for material (advantage)

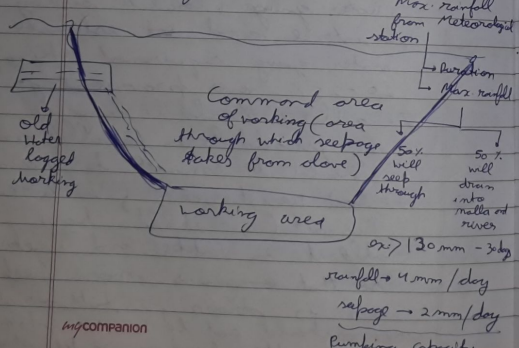
10.0) Ventilation → (Related to Coal production and no. of persons employed)

Requirement of ventilating air at various locations, size of the fan (In a large mine NVP is very small so not of much relevance so ignored. Calculate air quantity and pressure requirement taking into considerations leakages. Fan is for entire life of the mine unlike other equipments which have a life of 8 to 7 years. The ventilation efficiency is taken to be 50%. so the size of fan should be double the requirement.)

, water gauge (Calculate airway resistance and estimate water gauge requirement taking 20-25% over provisioning. The galleries should be large in size, should be in parallel and should be smooth to provide low resistance), Ventilation Circuit (we should have atleast 2 intake and 1 return so that more fresh air is drawn, intake air shaft should not be near a chimney and intake and return routes should

not cross over), establishing arrangement for measuring the quantity and quality of ventilating air. (quality – inflammable and noxious gases, heat and humidity, respirable dust) → prevention against fire dumps and coal dust explosion.

11.0) Pumping drainage →
Assessment of water make up during raining and dry season, based on max. rainfall and water from surface and seepage underground (old workings)



eg) 130 mm - 3 day
rainfall → 4 mm / day
seepage → 2 mm / day
Pumping capacity depends on this.

Garland drain made on the surface around the ~~boost~~ lease area to reduce water seepage underground.

→ providing drainage arrangement on surface and underground and sump.

→ Assessment of pumping capacity required, including reserve capacity and emergency requirement.

pump and sump capacity :- Suppose 3 mm/day X area = ~~drain~~ seepage

~~Sump Capacity depends on area~~

→ Sump capacity → 15 days or 30 days but larger sump requires larger area but if sump is large then pumping capacity can be kept low. So depending on area available for sump we decide the ~~sump~~ sump capacity and subsequently the pumping capacity.

Reserve capacity
- 10-20% extra capacity
- unforeseen situation
- failure of pumping capacity due to
  - Breakdown of pump
  - Failure of electricity

→ Providing adequate size and number of pumps including their maintenance and arrangement (a maintenance schedule of pumps is provided in the report)

12.9 Surface transport including CHP / CPP →

The price difference between a prepared and unprepared coal is very high.

ex:) stone picked by hand → price increased by 10%.

coal crushed → price increased by 20%.

CHP → Activities does not include quality improvement. Includes coal receiving, coal crushing and coal loading into customers vehicle.

CPP → Activities include stone removal, coal beneficiation, magnetic separation, washing and also all activities of CHP.

CHP →

CPP

→ more customers.
→ Customer insists on high quality
→ Customer ready to pay for beneficiation

CHP

One customer and does not insist for high quality coal then go for CHP.
Customer is not prepared to pay high.

(26) Transport from pit top / pit mouth to CHP/CPP → Conveyor, truck used for haulage

Crushing can be one stage/ 2 stage (Depending on size of input coal. The size of input coal depends on size of equipments used in surface mines.)
(In U/G mining the size of coal is not very large so we use only one stage crushers)

Coal preparation — hand picking/ gravity separator

Coal beneficiation — ~~two~~ product/ three product

Coal evacuation — truck / Conveyor/ rail / Merry-go-round (MGR)

truck	Conveyor	rail	MGR
→ quantity low and transport distance is large	→ Consumer is captive to mine → Dist between Consumer and mine is not more than 6 – 7 Km → quantity is large	→ Consumer connected to rail, must have own sidings → ~~Rail~~ Rail route has adequate capacity to transport coal.	→ All NTPC have Plant Load factor nearly 95-110% due to MGR → Plant Load factor – the quantity Coal loaded into the boilers, compared to its capacity

13.) Power supply arrangement

(Captive power plant) → (State Electricity Board)

May be CPP / SEB supply

Power cost is about 10% of the total mining Cost so reduction in power cost ~~is~~ influences highly.

Location and size of substation/ input / output voltage —

Substation should be located as near to the mine as possible because ~~the~~ at substation ~~and~~ ~~to~~ the power is stepped down and transferred to mine and low voltage transmission ~~has~~ has losses so to minimize the losses, the substation should be close to the mine.

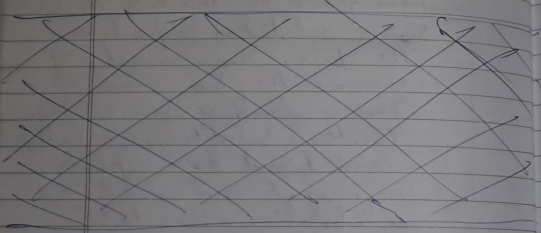
Size of substation depends on the power requirement. If you are the ~~one~~ owner of ~~the~~ a group of mines then locate substations centrally and find ~~total~~ power requirement and decide size of substation. Have to be futuristic in deciding size of substation. you cannot remake a substation in future, it is difficult

Power demand

Power supply to equipment 6.6 KV for draglines & high capacity shovel and 3.3 KV for U/G mine fan and lower for U/G equipments. For domestic it is 220 V. The power is ~~to~~ stepped down at various stages ~~and~~ before being used.

→ Distribution arrangement for industrial and domestic powers.

→ Illumination arrangement of mine office and residential area, etc.



(4) Workshop →

- Outsourcing our workshop
  - outside vendors come and maintain our equipments
  - → when requirement is small and not regular
  - → when mechanization is less
  - ↓ it proves cheaper
- workshop facilities and size of workshop
  - → All large mines have good workshops and its capacity facilitates the good working of a mine
  - → Highly skilled people with specialization on their equipments
  - → supplies workers in O/C of equipments drums and maintenance personnels
- Central workshop

Central workshop → when you have certain specialized things ex) dragline motor which have broken down then specialized large facilities which are not required regularly are available in central workshops. All big coal companies have central workshops where large, critical and special equipments come for workshop.

15.0) Manpower and productivity —

Decision of manpower is the responsibility of mining Engineers and team leaders. They have to have experience with regard to every operation to be carried out.

Category 1 → general laborers, most unskilled workers with no - technical experience, entry point of workmen

Category 6 → skilled and experienced people
ex) shearer operator.

Category is for the workmen for the officials we have scale system.

people in mines { executive and managerial cadre
Supervisory ~~cadre~~ Cadre
workmen ~~cadre~~ Cadre

Generally in an U/G mine:-

~~U/G~~ 1 executive — 6 supervisors — 70 to 80 in workmen cadre

(No. of) ~~Output~~
^ workers are on basis of:-
- operation ~~out~~ carried out
- machinery to be operated
- ~~out~~ requirement of regulation
- provision for leave and sick (16% extra for leave and sick)

Cumbersome job and whatever no. has been provided in the report, we cannot exceed that number. It is the sanctioned number and ~~we cannot~~ it is the maximum persons to be employed.

We have to prescribe the category of workers along with the skill requirement in the project report.

For each category, we have to prescribe in the project report
- the number
- the ~~of~~ category / grade
- the qualification

Productivity ~~of~~ men employed in the mine is indicated by OMS. (Index of efficiency of manpower and machinery employed in the mine)
1) Provide total output in a year
2) Total man shift in a year + 16% leave and sick provision
3) Divide to get OMS

⇒ individual performance does not affect OMS but group dynamics affects OMS. So manager's skill ~~and~~ ~~tool~~ dictate the OMS.

Next important thing is:-
~~Cost~~ Earning per manshift (EMS) including benefits:-

It is the average earning (since the earnings varies along different categories and grades)

Total salary / wages + benefits (subsidized housing, subsidized electricity, subsised school fees, school bus, leave travel allowance, hospitalization cost) in the year

EMS = Total manshifts deployed in the year + provision for leave and sick

Wages Cost per ton = EMS / OMS

Wages per ton is only 6-7% of the total production cost in a mechanized mine while in a manual mine it is 90% of the production cost. (Manpower high, EMS very low). So in a mechanized mine wages can be increased with much affect to the cost of production while there is a high agitation regarding increase in wages in a manual mine. Mechanization is preferred now-a-days because:-

1) It is easy to manage a machine than a person
2) Productivity per manpower is high and so fewer manpower is required for the same level of production. Hence we expose fewer workmen to the hazardous situations / working conditions in the mine. So safety is higher.

16) Mine construction schedule →

The project report monitors both in terms of physical progress and in terms of financial inputs. It is a monitoring document.

Ex: Installation of haulage related to construction of foundation and then purchase of machines. So all these activities are interrelated.

→ Carries and activity chart and on interrelationship among various activities so that failure at any point can be indicated and corrected in time.

⇒ Carries PERT Chart.

There is a Resource based net work which provides that at what point of time, what amount of money is required for various activities. So that there is neither idling

(value of money decreases with time)

Of money ∧ near absence of money when required (You loose out on opportunity due to it)

⇒ It provides the time and cost for various activities (The work must be in accordance to the facts provided in the report)

→ Production scheduling:

Construction phase → no return only investment during this period

But when production starts → production scheduling provides the required check whether the activities are done as per schedule or not so as to ensure the anticipated target.

ex:) Suppose a mine has a construction phase of 6 years and from the 5th year production begins. The production is required to grow that the mine come to full production (planned target reached) in 10 years. Production Scheduling is done from day 0 (Date of approval of project report) upto the time when the mine comes to full production. Production scheduling indicates which activities are to be undertaken when and the required rate of progress and the time for the mine to be fully operational.

Bringing the mine to revenue account → Till mine comes in production, all expenditure comes in the capital account. But when production starts, then initially the revenue generated is insufficient to meet the operating cost requirements. So even after production, initially the (operating cost/annum − revenue Earning/annum) is put in the capital account. But as the production increases, gradually the revenue generated also increases. The point when the revenue is sufficient to pay for the entire operations of the mine (our entire expenditures during operation) is the time when the mine comes under revenue account.

ex) Suppose the mine has a construction phase of 7 years & the production starts in the 4th year and the mine comes to full production in 10 years. Suppose in the 8th year annual production of (40% of planned prod) and all the annual revenue generated annually is sufficient to pay off for the mining ops → then in the 8th year, the mine comes to revenue account. Subsequently (the mine production increases and it earns profits).

17) Safety measurements and statutory requirements →

We have Provided for all safety equipments prescribed by regulations.

ex) Safety lamp, gas measuring, safety boots, goggles, first aid, creche, pit head bath, rest shelter.

These have a capital account and revenue account requirement.

The acquisition of all equipments and construction of facilities is through the capital account and the maintenance of these facilities / equipments is through the revenue account.

18) EIA — Assessing the impact of various mining and related

activities on ambient air, water bodies and noise. We have to provide for control and mitigating measures as well. Every report must have an Environmental Impact Assessment done before preparation of the feasibility document.

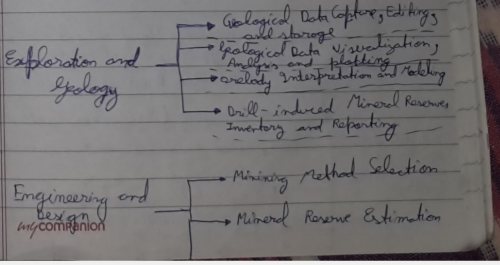
25/04/2015 | AK Sir

[Continued after Flowchart (Explanation)]

Functional Elements of Mine Design / Planning process

1) Exploration and Geology
2) Engineering and Design
3) Planning and Scheduling
4) Production monitoring and Control

U/g mines are designed to take advantage of the ore deposit because U/g mines are expensive to operate than open pit mines. Waste rock is not mined unless absolutely necessary for stope access. Stope access is generally limited and constrained due to the cost of excavation and required ground support of level and drifts. Ventilation is a serious issue as is ground control. Stope sequencing may well be dictated by ground control requirements. Backfilling may be required for support. The size of equipment may be varied depending on the ore body complexity, the variety of mining methods required and the number of workplaces required to operate simultaneously. This planning and scheduling for U/g mines tends to be much more complicated because activity tend to be much more inter-related and inter-dependent. Due to the limited number and constrained nature of all the ore body access points, ore and waste rock handling requirements must be balanced with the movement of supply and resources.

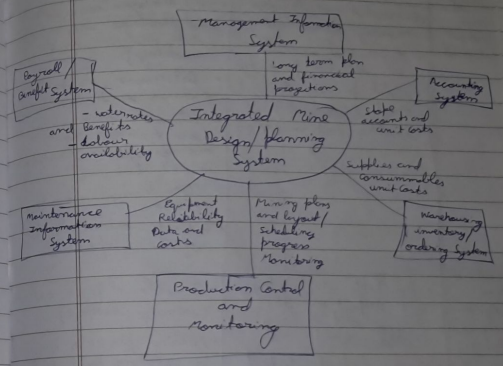


- Mine Ventilation
- Stress Analysis and Modelling
- Ground Support selection
- Stope Sizing, Orientation, Sequencing and Extraction Direction
- Primary Access Design
- Secondary Access Design
- Material Handling System Design
- Mine Systems (Power, water, Compressed Air, fans, pumps, network)

Planning and Scheduling
- Price, Metal Demand, Inflation forecasting
- long-term planning and Economics Analysis
- Short-term planning and Economics Analysis
- Equipment selection and Life Cycle Analysis
- Ventilation design and planning
- Drilling and Blasting Design
- Scheduling (Equipment, labour, backfill, supplies, maintenance)

Production Monitoring and Control
- Estimated Production statistics and Cost
- Surveying (Excavation Control)
- Actual production statistics and costs (Cost Control)
- Fragmentation and Grade Control
- Incident Investigations and statistics (injuries, fatals, falls of ground, etc.)
- Environmental Monitoring (Ventilation, power, water, slurry, rock mass)

Links between Mine planning and other Mine Systems



Production Control and Monitoring

- Schedule - Machine Instruction Translation
- Production Cost reporting
- Machine monitoring and Control
- Process monitoring and Control
- Ventilation monitoring and Control
- Mine monitoring and Control
- Material tracking and inventory Control
- Development and production tracking
- Survey Data Acquisition and updating
- geological Data acquisition and updating
- Rock mass response Data
- short term plan updating
- Production Cost reporting

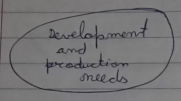
Mine planning Stages, Factors and Objectives

Stage	Factors	Objectives
Ore Reserve Determination	• Estimated overall ore recovery percentage • Estimated overall ore dilution percentage • Metal prices forecasted • Metal recoveries/Net smelter returns (NSR)	• Sort the geological data and mineral distribution (data analysis and modeling) • Determine deposit features and dimensions • Calculate mineable ore tonnage and average grade based on initial cut-off selection • Plot tonnage-grade curve • Estimate potential value of the deposit.
Mine Design or Pre-production planning	• Available technology will impact on the mining and milling methods used. • Mining method selected depends on deposit features and dimensions • Grade cut-off selected affects available ore reserve and depends on economic value of the deposit. • Production level/rate selected depends on available ore tonnage available • Metal prices impacts economic value of deposit	• Feasible deposit extraction (mining method) • Milling process required as well as predicted ore recovery • Capital and operating cost estimates • Optimum production level/rate. • optimal grade cut-off policy • Economic value of the deposit (mine valuation)

Stage	Factors	Objectives
Long-Term planning or Development planning	• Mine and mill plant size (as well as required capital expenditures) depend on selected production level/rate. • The development work required depends on the orebody layout and physical dimensions as well as the mining method selected.	• Maximize profitability from the extraction of the entire ore reserves (mine sequencing) • Optimize the development work required to access the deposit (mine layout) • Optimize the ore extraction process (drilling, blasting and handling)
Short-Term planning or operations planning	• The profitability of the selected mining blocks depends on all previously made assumptions and determined objectives.	• Maximize profitability from the extraction of selected mining blocks (minimize product costs) • Optimize the mining sequence (minimize process time)

11/03/2015

Mine planning and Scheduling information flow



12/3/2015

RK Sir

19.0 Civil Construction and water Supply

Is important for 2 reasons
- 30% of total Capital Cost of project therefore a prudent examination of these aspects will save a lot of money for the company
- These areas are the cause of satisfaction/dissatisfaction for working people and person living around the mine. If workmen are happy they are more dedicated employee.

Construction of road, offices, hostel, dispensary, school, guest houses etc.

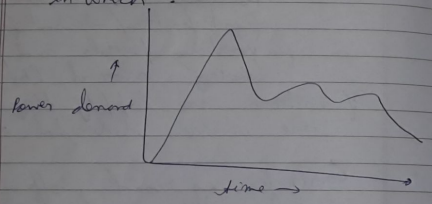
20) Energy conservation —

Some factors that need to be included to make it bankable, dependable and economic report are —

- Automatic stopping of street

light during day time (Power cost varies from 4% to 20% depending of degree of mechanization)

- Controlling the total max demand etc. (Power tariff is in 2 parts, one is the max demand charge in which:



Power charged as per the max demand so such charts are not desirable so this ~~max demand~~ chart should be smoothened by staggering the operations (ex stagger starting of draglines so that all do not start at a same time.)

- The size of equipments should be controlled and optimized. Unnecessary high capacity equipments should not be purchased. This cause high capital cost and high power consumption uselessly.

2) Capital Investment → most important job which a mining Engineer is required to perform although it is not much technical.

- for a good capital planning the team should have a blend of

High technical knowledge
Finance knowledge
} added with experience

So it is the total managerial and technical competence that is required to decide the capital.

It is the basis of approval it limits/ fixes the total cost that can be spent in the project, no excess investment is allowed.

You have to access the item wise cost :-
- what item are required
- what will be their quantity
- what will be the cost of each item

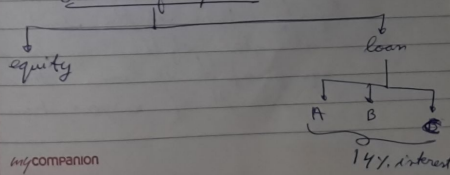
The requirement of fund should not be provided at once because it causes idling of money and money also has a cost (interest has to be paid to the bank) so money should not be kept at the disposal of the project at once. For effective utilization of capital phasing of capital is required.

ex) 200 crore project
50 cro - 1st year
70 Cro - 2nd year
70 cro - 3rd year
10 crore - 4th year

This is a very difficult to plan for a correct requirement at a particular time.

- If money is more than required in a phase then idling of money takes place There is an overprovision of money.
- If money is less than required in a phase then our activities are curtailed. There is our work suffers, there is a time over run and so there will also be a cost overrun.

So the best method is to resort to a technique where the correct amt. is available at the designated time by proper phasing of capital.



If you have all equity then problem is. it:

Profit is taxed (30%)

↓

Dividends - (30% interest)

The person is a promoter and he is taking risk and he is putting in efforts so he expects ~~the~~ a higher rate than bank.

In case of loan:-

You pay interest (14%)

↓

no tax

~~So equal~~ So equity is costly while loan is cheaper.

But if we keep equity capital low and loan ~~high~~ capital high then problem is:-

Equity Base is the internal strength of the company. If equity capital is low then strength of organization reduces.

- If profit is 10% and loan interest is 14% then the remaining 4% comes from the equity funds / capital. So the equity capital should be sufficient to pay-off your loan cost.
- Secondly during gestation period we get no returns so we require funds to meet our expenditure and to service the loan (pay back the interest) so we require equity funds to meet these.

Ratio of equity and loan capital should be optimum. There is no hard and fast rule but the guiding principle is that:

- It should not be too low ~~cost~~ to be incapable to meet our initial expenditure and service the loan (pay interest).
- It should not be too high that the cost of money becomes high.

~~E~~ equity	loan
40-60%	60-40%

22) Economics –

Economics ~~determines~~ determines.
- The Bankability of the project
- The profit of the project
- The investment of the project.

– ~~Depends~~ Selling price of the product

Power plant – 50 Km (higher price)

1000 Km (lower price)

The powerplant is ready to pay a higher price to this mine due to its reliability.

– Selling price can be changed by quality improvement (Sizing, washing, Blending)

We can go for:

1.) Product mix.

A wide range of products

2.) Consumer mix.

Serving various consumers.

ex.)

- −34% (send to power plant)
- +34% (Brick klin and cement industry)

3.) Price mix

ex1 FSA

- 0-5 MT — ₹1000/ton
- 5-7 MT — ₹1100/ton
- 7-10 MT — ₹1500/ton

ex2. FSA

- GCV 5200-6000 — ₹1000/ton
- GCV 6800-8500 — ₹1200/ton
- GCV > 6500 — ₹1500/ton

23.) Demand assessment and production planning – Cost of production

We have to assess the Demand vis-a-vis our command area which you can satisfy.

Then we go for production planning.

The cost of production vis-a-vis selling price should give a reasonable return.

The major components of Cost of production are
- Interest + depreciation
- Wages Cost
- Store Cost

Various economic criteria are:-
- payback period
- NPV
- IRR, etc.

CASE STUDY

Bijuri U/G Coal Mine

1.0 Location of mine - Sohagpur Coalfield of Sohdol district (All people involved in planning, investment and approval might not visit the mine but they must know the exact location of mine) in Chhattisgarh state, in the Command area of SECL, Lattitude - 23° 14' 5" to 23° 17' 5"

Longitude - 82° 5' 54" to 82° 10' 42"

- Nearest railway station Bijuri on Anuppur Chirimiri railway line.
- Place is connected to Sohdol and other important places by all weather roads.

2.0 Topography and drainage -

Mainly flat, elevation 561 to 583 m above MSL, has 2 drainage basins - one river in the west and Hasdeo river in the east.

Climate tropical, max temp 40°C in summer and min temp 7°C in winter, rainfall 164cm between June and October (facilities the drainage system of the mine)

3.0 Coal Quality → M - 4.6 - 6.5%.
VM - 42.5 - 15.5%.
Ash - 14.9 - 28.7%.

mycompanion

FC – 55.2 – 62.5%.

Ash fusion temp – 1200 – 1290°C [Ash Consumes heat and has a negative effect on the GCV of coal so higher this temp, larger is the heat absorbed by ash content]

Heat comes from (VM and FC) and is consumed by (Ash and M).

GCV → 5600 – 7600 kCal/kg.

(As a mining engineer ~~is~~ we ~~can~~ should attempt to segregate the coal to various qualities to fetch better prices.)

Sulphur content – 0.42%.

Detailed chemical analysis given