MODELING FOR THE STEADY STATE PRODUCTION OF LARGE OPEN CAST MINES- CASE STUDY

A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF

BACHELOR OF TECHNOLOGY

IN

MINING ENGINEERING

BY

CHITRANSU MANADHATA

109MN0203

Dept. of Mining Engg.

National Institute Of Technology

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Under the Guidance of

Dr. B.K.Pal

Dept. of Mining Engg.
National Institute Of Technology
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Department of Mining Engineering
National Institute of Technology, Rourkela-769008, India

CERTIFICATE

This is certify that the thesis entitled **"MODELING FOR THE STEADY STATE PRODUCTION OF LARGE OPEN CAST MINES- CASE STUDY"** submitted by **Mr. CHITRANSU MANADHATA (Roll No-109MN0203)** in partial fulfillment of the requirements for the award of Bachelor of Technology Degree in Mining Engineering at National Institute of Technology, Rourkela is an authentic work carried out by him under my supervision and guidance.

To the best of my knowledge, the matter embodied in the thesis has not been submitted to any other university/ Institute for award of any Degree.

Date: 28/06/2013

Dr. B. K. Pal
Professor
Dept. of Mining Engineering
National Institute of Technology
Rourkela-769008

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CHITRANSU MANADHATA

Dept. of Mining Engineering,

National Institute of Technology,

Rourkela-769008, India

CONTENTS

ABSTRACT

The steady state production mainly depends on the availability of the machines, their breakdown, maintenance schedule and reduction in their idle-time that is increasing their availability increases/ maximizes their utility. I have prepared the work-sheet for a shovel-dumper combination and following it I have analyzed break-down record by the distribution of random numbers so as to minimize the preventive maintenance and increase their availability to maximize productivity.

The break-down of different machines was analyzed with random numbers distribution. The events falls under a fixed random number distribution range. Hence a clear idea can be made for the break-down of machineries and thus precautions to be taken to maintain a steady-state production.

Keywords: *Steady-state, Random Numbers, Shovel-Dumper*.

LIST OF SYMBOLS AND ABBREVIATIONS

AT	=	Arrival Time
LAT	=	Last Arrival Time
IAT	=	Inter Arrival Time
IATSR	=	Inter Arrival Time Sub-Routine
ILT	=	Inter Loading Time
ILTSR	=	Inter Loading Time Sub-Routine
CLET	=	Current Load End Time
PLET	=	Previous Load End Time
LBT	=	Load Begin Time
DWT	=	Dumper Wait Time
SWT	=	Shovel Wait Time
TDWT	=	Total Dumper Wait Time
TSWT	=	Total Shovel Wait Time
ADWT	=	Average Dumper Wait Time
AILT	=	Average Inter Loading Time
RN1	=	Random Number 1
RN2	=	Random Number 2
ADWT	=	TDWT/Count
IATSR	=	IASR/ (RN1=IAT)
AILT	=	TILT/Count
ILTSR	=	ILTSR/ (RN2=ILT)
C	=	Pay load capacity of the trucks in tons
F	=	Fill factor for trucks

K	=	Co-efficient for truck utilization
M	=	No of faces working simultaneously in the mine,
N	=	No of trucks employed per shovel
Db	=	Backward haul distance in kms.
df	=	Forward haul distance in kms
q	=	Output from a truck in an hour,
Q	=	Face output per hour,
t1	=	Truck loading time in min.
tf	=	Forward haul time for the truck in min.
tb	=	Backward haul time for the truck in min.
td	=	Time required for dumping and turning for the truck near the . primary crusher in min.
ts	=	Spotting time for truck near the shovel in min.
tsh	=	Cycle time for the shovel in min.
T	=	Total cycle time for trucks in min.
Vb	=	Backward haul velocity in km/hr
Vsh	=	Specific volume of shovel in cubic meter
γ	=	Density of broken material in tons/cubic meter
μ	=	Mean for the normally distributed random number
σ	=	Standard deviation for the normally distributed random Number.
m	=	No of faces working simultaneously in the mine.
Fsh	=	Fill factor of the shovel,

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Chapter-1

INTRODUCTION

INTRODUCTION

1.1 OPENCAST MINING

Open-pit mining, open-cut mining or open cast mining is a method of extracting rock or minerals from the earth by their removal from an open pit. Open pit mines are used when deposits of commercially useful mineral or rock are found near the surface; that is where the over burden (surface mineral covering the valuable deposit) is relatively thin.

1.2 STRIPPING RATIO

It is generally expressed in the proportion of over burden to coal/mineral removed.

Stripping ratio= weight of recoverable mineral reserve in tone / volume of over burden in cubic meter

1.3 BREAKEVEN STRIPPING RATIO

The point beyond which the mineral/ coal cannot be economically extracted out is called the break even stripping ratio.

Factors which play a great role in the stripping ratio calculation are:

- Cost of stripping
- Extracting cost of mineral/coal
- Percentage of rejects
- Cleaning cost of coal or ore dressing cost
- Sale value of clean coal/dressed ore
- Reclamation cost
- Cost of transportation
- Overhead and sale of ore/coal

Before going for any surface mining operation an economic comparison is necessary between the underground mining cost per ton of ore production and surface mining and reclamation cost per ore production and a stripping ratio is to be calculated.

Break even stripping ratio = (mining cost per tone of minerals by u/g method – open cast mining cost & reclamation cost per ton of minerals) / (cost per cubic meter of over burden by the open pit method)

The break even stripping ratio is generally much higher than the ordinary stripping ratio and can be increased if the price of mineral is increased or if the technology of mining is improved. The factors like degree and types of operation, economy, reclamation etc. effects the break even stripping ratio. So ultimately selection of mining methods and equipments, production requirement, various sub systems, geometry and geotechnical aspects of the deposits, capital operating and overhead expenses, gross cost, environmental and social consideration etc. play a role for deciding stripping ratio.

1.7 QUARRIABLE LIMIT AS PER STRIPPING RATIO

- Manual quarrying	1.5:1
- Semi- mechanized	2:1
- Mechanical quarrying:	
With shovel dumper combination	4 to 5:1
With draglines	8 to 10:1
With bucket wheel excavator	3 to 4:1

1.5 LONG-TERM PRODUCTION PLANNING:

The long term production planning design is a key step in a planning, because its purpose is to maximize the net present value of the total profits from the production process while satisfying all the operational constraints, such as mining slope, ore production, mining capacity, grade blending, mining capacity, etc. During each scheduling period with a pre-determined high degree of probability. It also acts as a guide for the medium-term and short-term mine planning.

1.6 MEDIUM-TERM/INTERMEDIATE-RANGE PLANNING MINE PLANS

The period of medium-term mine plan is between 5-10 years. This is further divided into 1-6 months of range for more detail scheduling.

The Goals: -

(1) Waste productions requirements.

(2) Earning optimum or near optimum cash flows within the total reserves as outlined in the long range plan.

(3) Maintain the necessary pit slopes. This planning technique allows the removal of material in large increases while maintain the required pit-slops and providing the operational and legal constraints.

(4) The mine management is also delivered with sufficient time for analyzing critical requirements, especially equipment units with long-delivery times.

1.7 THE SHORT RANGE MINE PLANNING:

The period for this phase of the mine design is concerned with daily, weekly, monthly and yearly mine schedules and plans.

Chapter-2

METHODOLOGY

METHODOLOGY

2.1 INTRODUCTION:

When mining company gets the lease of a mineral deposit, the difficult is then how to mine and process that deposit the optimum way. The main problem facing managers or engineers who must select on equipment selection, mine plant site and long range scheduling is how one can optimize a property not only in terms of efficiency but also as to project duration. With the advanced technology different types of mechanization such as dumper, shovel, dozer, drill machine etc. Use of more machineries leads to more complexity in operation and as result it is very difficult to make the proper matching of those equipment and these Machineries are very costly. Hence unless they are properly matched reduction in production cost is very difficult. Increase in idle times of machineries leads to increase in production cost. In order to reduce the idle time or waiting time, the number of machineries may be increased. Due to greater cost of machineries additional investment is needed which ultimately contribute in higher production cost. Thus, unless you getting a perfect matching with optimum number of equipments reduction in production cost is impossible. So, we need to analyses the operations of equipments by repairing, considering their break down periods, maintenance of preventive maintenance, availability of spare-parts, efficiencies of operators and management philosophy etc. This study is based on use Monte –Carlo technique in operation of shovel- dumper combination.

2.2 REASONS FOR ADOPTING SIMULATION:

a) It is a proper tool for solving a business problem when investigating on the real system would be too expensive.

b) It is an appropriate tool when a mathematical model is also complex to solve and is beyond the capacity of available personnel. It is not detailed enough to deliver information on all important decision variables.

c) It may be the simply method available, because it is difficult to detect the actual reality.

d) Without proper assumption, it is impossible to develop a mathematical solution.

e) It may be too costly to essentially observe system.

f) There may not be adequate time to permit the system to operate for a very long time.

g) It delivers trial and error movements towards the optical solution. The decision maker chooses an alternative, experience the outcome of the selection, and then improves the selection.

2.3 TRANSPORT SYSTEM:

Mine transport may be of railway, truck, conveyor belt and skip transport. For truck transport, the output from a truck in an hour

$q = 60\ c.f/T$ and $T = t1 + tf + tb + td + ts$

where $t1 = c/\alpha.\ Vsh.\ Fsh. * tsh$ $Tf = df/Vf$; $tb = db/Vb$

The face output per hour (Q) = $K.q.n = K.60.c.f.n/T$

Output from the mine per day = $m.K.60.c.f.n/T *2*6$

Seeing two shifts production and 6 hours effective working in a shift

For the face output the average utilization and the net utilization are considered as:

Average utilization = Availability/Schedule hour

= (Schedule hour – Breakdown period)/Schedule hour

= 1 – (Breakdown/Schedule hour)

Net utilization = Utilization hour/Schedule hour

= (Availability – Idle Time)/Schedule hour

= 1 – (Breakdown period/Schedule hour) – (Idle Time/Schedule hour)

As the average and net utilization are much lesser than 100% so the production was hampered. Idle time is reduced by making Queuing models by loading capacity of the dumper, considering haul distance, capacity of the crusher, upward and downward slope minimization.

2.4 USE OF MONTE CARLO SIMULATION TECHNIQUE IN PRODUCTION OPTIMIZATION

Simulation is a numerical technique used for conducting experiments which involves certain types of mathematical and logical relationship required to describe the behavior and structure of a complex real world system over extended period of time. From definition it is the method of designing a model of a real system and conducting experiments with this model for the purpose of understanding the behavior (within the limit imposed by a criterion or a set of criteria) for the operation of the system. Using the simulation we can introduce the constants and variables related to the problem, set up the possible courses action and establish criteria which act as measures of effectiveness.

In this study, I illustrate the use of Monte-Carlo simulation technique in shovel dumper transport combination in the mines for a steady-state optimized production. All the experimental data are collected from the mines.

Chapter-3

CASE STUDY APPLICATION

CASE STUDY APPLICATION

3.1 Introduction

The technology was proposed to generate an optimum production schedule in large open cast mines by reduction in the break down hours of machineries by preventive maintenance and by simulating the shovel-dumper idle hour to improve production and productivity. There are figures which clearly show the process involved in the calculation of the idle hour and the reduction of idle hours and also the periodic breakdown maintenance improve the productivity of the mines. Detailed analysis and output are presented in the present chapter.

3.2 Description of the case study mine

Bolani mine is located in the Keonjhar district of Orissa, bordering on Jharkhand. Coordinates: 22°5'43"N 85°21'6"E. The Bolani mine was explored in the 1930s, and full-scale operation commenced in the early 1960s. Bolani has a proven reserve of about 154 mt. The Steel Authority of India Limited approved (February 1989) a scheme for augmenting capacity of Bolani Iron Ore Mine from 22 lakh MT to 34.40 lakh MT run of mined ore (ROM) per year at a cost of Rs. 59.37 crore. The work (excluding tailing dam and slime pipeline) was completed through Hindustan Steelworks Construction Limited. Total lease area is 1321.450 Ha. Reserve Forest 1181.66 Ha. Forest Unclassified 44.12 Ha. Total Forest 1225.78 ha. The machineries used in the mines are: BE-1000 Hyd. Backhoe, 210 M 50 Te dumpers, D-355A dozers-3 dozers, RECP-650 drill diesel-160mm, Hyd. Shovel BE-1600, HD 785 komastu 100 T.

3.3 CALCULATION OF OPERATING COST OF SHOVEL:

Depreciation cost = 12% (of investment cost = 3.00 crore)

Avg. per year = 30000000 * 0.12 = Rs. 36.00 lakh per year i.e. 3600000/300 = Rs. 12000/ day = Rs. 1200/- per hour.

Fuel cost (HSD Oil) 75 liters per hour @ Rs. 40/- per lit. = Rs 3000/- per hour.

Maintenance & spare parts cost =15% of depreciation cost =Rs. 180/-per hour.

Operators & helpers wages = Rs. 120/- (Approx.) per hour.

So, total operating cost for shovel = a) + b) + c) + d)

= Rs.(1200 + 3000 + 180 + 120) = Rs. 4500/- per hour.

3.4 CALCULATION OF OPERATING COST OF DUMPER:

Depreciation cost = 12% (of investment cost = 2.00 crore)

Avg. per year = 20000000 * 0.12 = Rs. 24.00 lakh per year i.e. Rs. 800/- per hour.

Fuel cost 30 liters per hour @ Rs. 40/- per lit. = Rs 1200/- per hour.

Maintenance & spare parts cost = 25% of depreciation cost =Rs. 200/-per hr.

Operators & helpers wages = Rs. 70/- (Approx.) per hr.

So, total operating cost for shovel = a) + b) + c) + d) = Rs.(800 + 1200 + 200 + 70) = Rs. 2270/- per hour.

Now haul pack dumpers are loaded with coal for Coal Handling Plant(C.H.P) with a shovel, which has the following characteristics:

Table 3.1: Arrival and Loading Distribution

Time(minutes)	Arrival(probability)	Loading(probability)
1 – 2	0.10	0.15
2 – 3	0.15	0.20
3 – 4	0.25	0.25
4 – 5	0.40	0.30
5 – 6	0.05	0.10
6 – 7	0.05	--

At 7 AM queuing process starts and the calculation is done up to 8.00 AM. i.e for 1 hour interval only. If the shovel is idle dumper immediately moves to spot for availing the loading facility. On the other hand, if the shovel is busy the dumper will wait on the queue. Dumpers are loaded on the first come first serve basis.

Using Monte-Carlo simulation technique from the given frequency distribution of arrival and loading times, the probabilities and cumulative probabilities are first worked out as shown below. These, then become the basis for generating arrival and loading times in conjunction with a table of random numbers:

TABLE 3: CUMULATIVE PROBABILITY

Time between arrival (minutes)	Cumulative probability
1-2	**0.10**
2-3	**0.25**
3-4	**0.50**
4-5	**0.90**
5-6	**0.95**
6-7	**1.00**

TABLE 4: CUMULATIVE PROBABILITY

Time between arrival (minutes)	Cumulative probability
1-2	**0.15**
2-3	**0.35**
3-4	**0.60**
4-5	**0.90**
5-6	**1.00**
6-7	**1.00**

Table 3.2: Random number coding for inter arrival time

Inter arrival time(minute)	Probability	RN allotted
1-2	0.10	00-09
2-3	0.15	10-24
3-4	0.25	25-49
4-5	0.40	50-89
5-6	0.05	90-94
6-7	0.05	95-99

Table 3.3: Random number coding for loading time

Loading time(minutes)	Probability	RN allotted
1-2	0.15	00-14
2-3	0.20	15-34
3-4	0.25	35-59
4-5	0.30	60-89
5-6	0.10	90-99
6-7	0.00	--

Table 3.4: The following information can be obtained from the above simulation work-sheet based on the period of one hour only

RN	Inter arrival time	Arrival time(AM)	Loading begins (AM)	RN	Loading		Waiting time (min)		
					Time (min)	Ends (AM)	Shovel	Dumper	Line length
35	3	8:03	8:03	29	3	8:06	3	-	-
22	3	8:06	8:06	72	4	8:10	-	-	-
48	4	8:10	8:10	84	5	8:15	-	-	-
30	3	8:13	8:15	65	4	8:19	-	2	-
90	5	8:18	8:19	23	2	8:21	-	1	1
10	2	8:20	8:21	13	2	8:23	-	1	1
53	4	8:24	8:24	43	3	8:27	1	-	-
80	5	8:29	8:29	53	4	8:33	2	-	-
40	3	8:32	8:33	22	2	8:35	-	1	1
60	4	8:36	8:36	19	2	8:38	1	-	-
23	3	8:39	8:39	17	2	8:41	1	-	-
52	4	8:43	8:43	23	2	8:45	2	-	-
70	4	8:47	8:47	59	4	8:51	2	-	-
90	5	8:52	8:52	77	5	8:57	1	-	-
32	3	8:55	8:57	11	1	8:58	-	2	1
02	1	8:56	8:58	19	2	9:00	-	2	1
	56				47		13	9	6

The random number developed is related to the cumulative probability distribution of arrival and loading time where the first random number of arrival time is 35. This number lies between 25 and 49 and indicates a simulated arrival time of 3 minutes. All simulated arrival and loading times have been done in a similar manner.

After generating the arrival and loading times from a table of random numbers, the next step is to list the arrival time in the appropriate column. The first arrival comes in 3 minutes after the starting time. This means the shovel waited for 3 minutes firstly. It has been shown under the column-waiting time: shovel. The initial random number of loading time is 29. This number lies between 15 and 34. So, the simulated loading time for the first arrival is 3 minutes which result in the loading begins at 8:03 AM and completed in 8:06 AM. And the next arrival comes at 8:06.

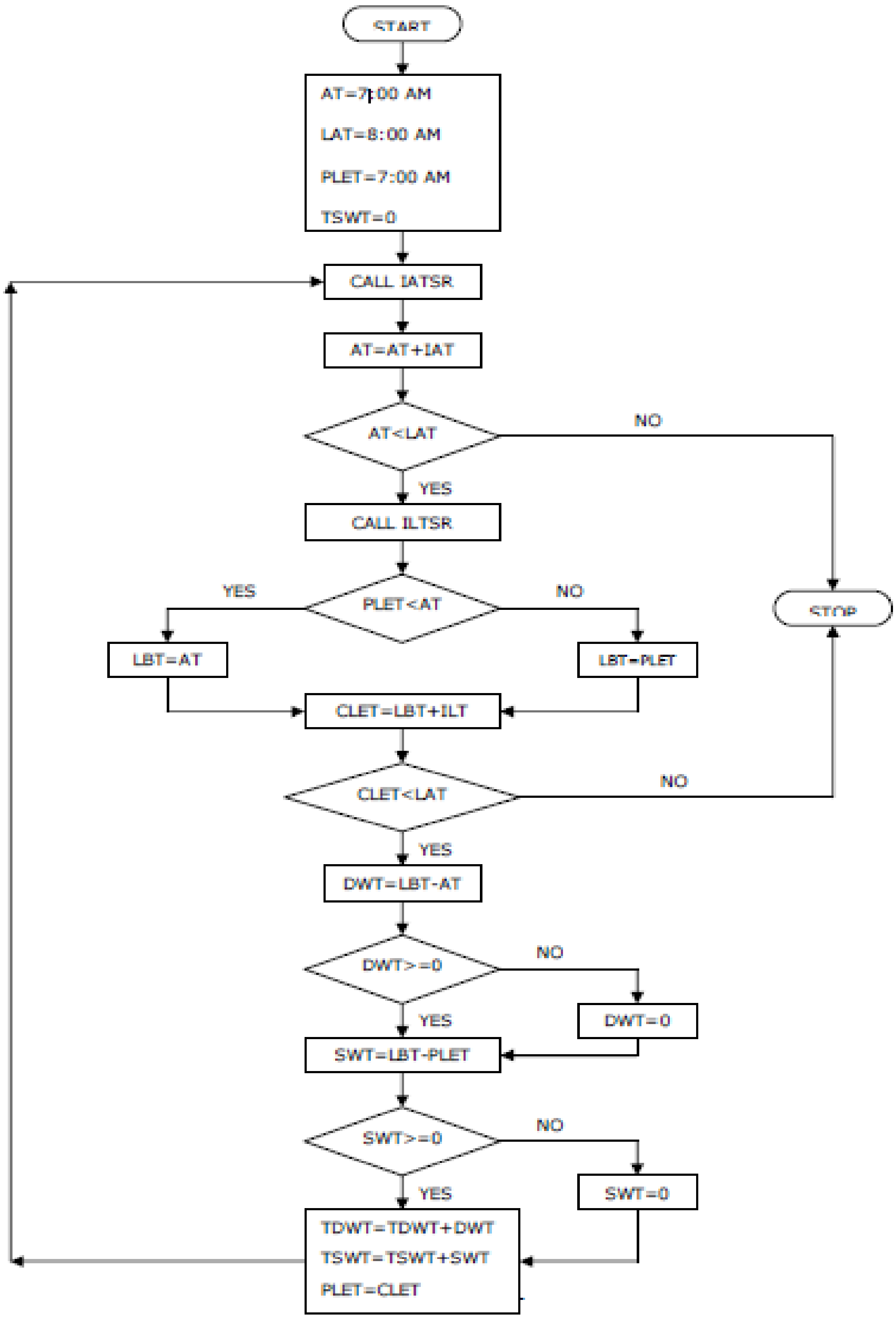

Fig. 1: Flow Chart Showing Simulation Work-sheet

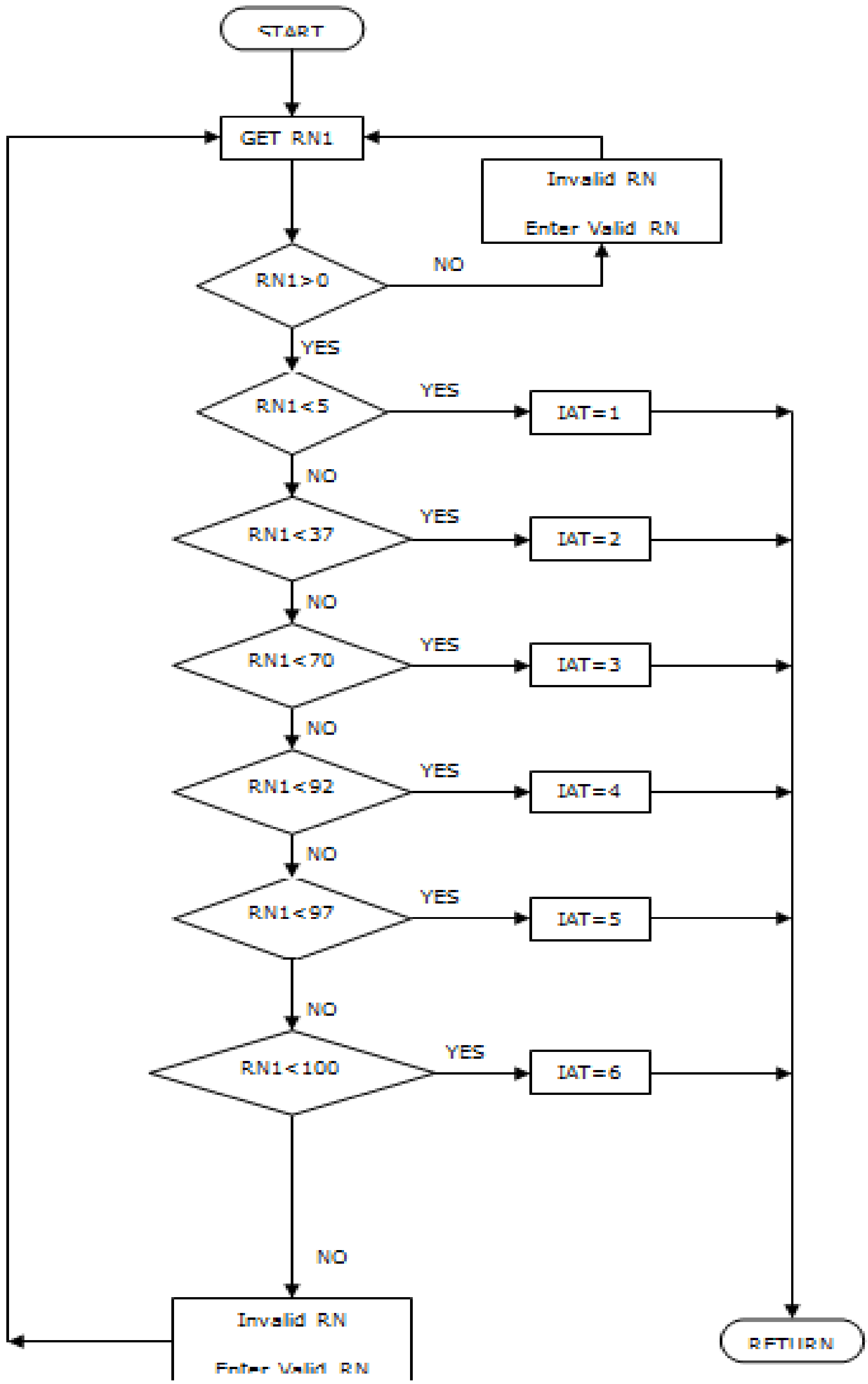

Fig. 2: Flow Chart Showing Sub-Routine Inter Arrival Time

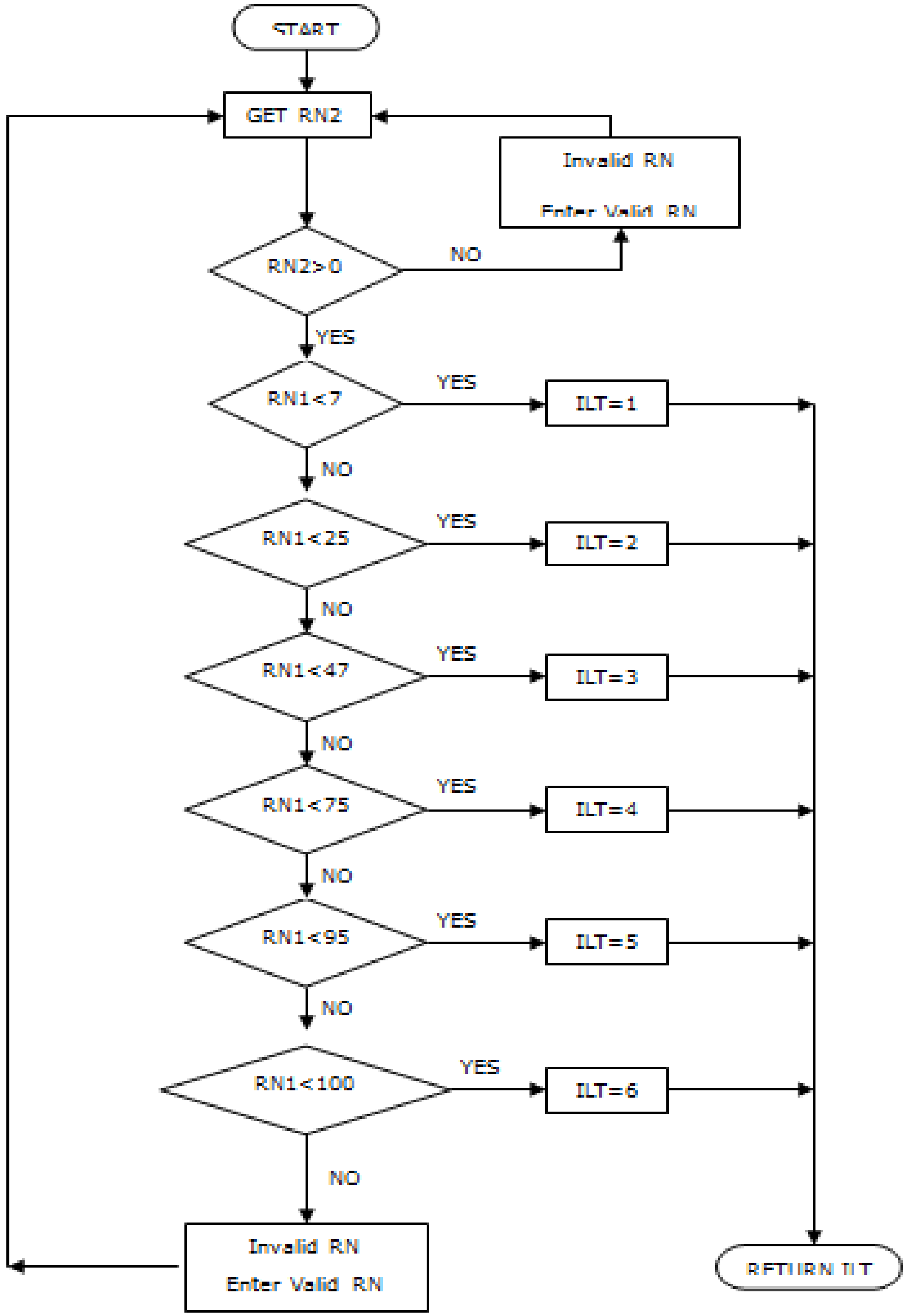

Fig. 3: Flow Chart Showing Sub-Routine Inter Loading Time

The informations are obtained from the above simulation work sheet based on the period one hour only.

a) Average Queue Length = No of dumpers in the waiting line /No. of arrivals = 6/16 = 0.375
b) Average Waiting Time for the Dumper before Loading = Dumper waiting time / No of Arrivals = 13/16 = 0.8125
c) Average Loading Time = Total Loading Time/No of Arrival =47/16
= 2.9375 minutes
d) Time a Dumper Spend in the System = Average Loading Time + Average Waiting Time before Loading = 2.9375 + 0.8125 = 3.75 minutes

3.5 CONCLUSION:

Simulation Work-Sheet established in this problem also states that if one or more dumper is added in the system. There is no necessity for a dumper to wait in the queue. But, before implementation, the cost of having an additional shovel has to relate with the cost due to dumper waiting time and this can be worked out as follows:

Table 3.5: Cost Comparison of with one Shovel and with two Shovels

One hour period	Cost with one shovel	Cost with two shovels
Dumper waiting time 9 minutes * Rs 38/- per minutes	Rs 342/-	Nil
Shovel cost	Rs 4500/-	Rs 9000/-
Total cost for one hour period	Rs 4842/-	Rs 9000/-

So, we see clearly that for one hour period dumper loss 39 minutes for which provide of one additional shovel will not be a wise decision. The same way we can calculate the cost of one additional dumper which is to be compared with time loss due shovel waiting time.

Table 3.6: Cost Comparison of with existing dumper and one additional dumper.

One hour period	Cost with existing dumper	Cost with one additional dumper
Shovel waiting time (13 minutes *Rs 75/-)	Rs 975/-	Nil
Dumper's cost	N	N + 2270/-
Total cost of one hour period	N + 975/-	N + 2270/-

Also adding of one more dumper is expensive than the no of existing dumper with shovel loss due to waiting time. Therefore the selection of equipment is optimal with this simulation work sheet. Now, it will be determined by on management's philosophy that if they want to calculate maximum loss due to shovel and dumper is practicable but at the same time the primary crusher will be idle, and the entire transporting system will be idle, etc. these will cost extreme production loss. So, one more shovel or dumper or both are to be added in the system whichever is less though it is not economic, but in greater sense it will help to continue the whole system and much economical.

3.6 PERFORMANCE APPRAISAL OF MINING MACHINARIES

The 7 events which were identified from the mine data analyzed were:

Event 1 : Breakdown of shovel
Event 2 : Breakdown of Dumper,
Event 3 : Breakdown of drilling machineries,
Event 4 : Breakdown of Dozer,
Event 5 : Breakdown of Primary crusher
Event 6 : General maintenance,
Event 7 : Power Failure

The list of subsequent tables shows the break-down data analysis of different machineries.

Table 3.7: Frequency and period of existence of breakdown of shovel

Date	Time needed in hours	Frequency of Shovel Breakdown	Period of existence in hours
08/12/12	--	--	
10/12/12	72	1	5.232
13/12/12	72	1	4.131
20/12/12	168	1	6.633
25/12/12	120	1	13.261
10/01/13	384	1	2.472
14/01/13	96	1	11.384
16/01/13	48	1	6.519
26/01/13	240	1	15.617
31/01/13	120	1	6.982
05/02/13	120	1	14.213
16/02/13	264	1	0.763

Table 3.8: Conversion of interval between shovel break-downs to cumulative random numbers

Interval between shovel breakdown	Frequency of occurrence	Frequency of occurrence % * random nos	Cumulative random numbers
0-100	4	4000	0-4000
100-200	4	4000	4001-8000
200-300	2	2000	8001-10000
300-400	1	1000	10,001-11,000
	11	11,000	

Table 3.9: Conversion of Existence of Shovel Breakdown to cumulative random numbers

Existence of shovel breakdown	Frequency of occurrence	Frequency of occurrence % * random nos	Cumulative random nos
0-1	1	1000	1000
2-3	1	1000	1001-2000
3-4	0	0	1001-2000
4-5	1	1000	2001-3000
5-6	1	1000	3001-4000
6-7	3	3000	4001-7000
11-12	1	1000	7001-8000

13-14	1	1000	8001-9000
14-15	1	1000	9001-10000
15-16	1	1000	10001-11000
	11	11000	

Table 3.10: Frequency and period of existence of breakdown of dumper

Date	Time needed in hours	Frequency	Period of existence in hours
08/12/12	-	-	-
10/12/12	72	1	0.162
13/12/12	72	1	1.432
20/12/12	168	1	0.615
25/12/12	120	1	1.720
10/01/13	384	1	2.346
14/01/13	96	1	1.343
16/01/13	48	1	0.349
26/01/13	240	1	4.689
31/01/13	120	1	1.612
05/02/13	120	1	4.432
16/02/13	264	1	5.112
05/03/13	408	1	1.786

Table 3.11: Conversion of interval between Dumper break-downs to cumulative random numbers

Interval between dumper breakdown	Frequency of occurrence	Frequency of occurrence % * random nos	Cumulative random numbers
0-100	4	4000	0-4000
100-200	4	4000	4001-8000
200-300	2	2000	8001-10000
300-400	1	1000	10001-11000
400-500	1	1000	11001-12000
	12	12000	

Table 3.12: Conversion of Existence of Dumper breakdown to cumulative random numbers

Existence of dumper breakdown	Frequency of occurrence	Frequency of occurrence % * random nos	Cumulative random nos
0-1	3	3000	0-3000
1-2	5	5000	3001-8000
2-3	1	1000	8001-9000
4-5	2	2000	9001-11000
5-6	1	1000	11001-12000
	12	12000	

Table 3.13: Frequency and period of existence of breakdown of Drill Machine

Date	Time needed in hours	Frequency	Period of existence in hours
08/12/12	-	-	-
13/12/12	144	1	6.012
25/12/12	288	2	13.214
27/12/12	48	1	0.982
05/01/13	216	1	4.212
11/01/13	144	2	2.079
12/01/13	24	1	0.308
22/01/13	240	1	1.516
29/01/13	168	1	2.214
10/02/13	288	1	3.793
01/03/13	456	2	2.117
10/04/13	960	3	9.786
15/04/13	120	1	0.513

Table 3.14: Conversion of interval between Drill Machine break-downs to cumulative random numbers

Interval between drill machine breakdown	Frequency of occurrence	Frequency of occurrence % * random nos	Cumulative random numbers
0-100	2	2000	0 – 2000
100-200	5	5000	2001-7000
200-300	5	5000	7001-12,000
400-500	2	2000	12,001-14,000
900-1000	3	3000	14001-17000
	17	17000	

Table 3.15: Conversion of Existence of Drill Machine breakdown to cumulative random numbers

Existence of drill machine breakdown	Frequency of occurrence	Frequency of occurrence % * random nos	Cumulative random nos
0-1	3	3000	0-3000
1-2	1	1000	3001-4000
2-3	5	5000	4001-9000
3-4	1	1000	9001-10000
4-5	1	1000	10001-11000
6-7	1	1000	11001-12000
9-10	3	3000	12001-15000
13-14	2	2000	15001-17000

	17	17000	

Table 3.16: Frequency and period of existence of breakdown of Dozer

Date	Time needed in hours	Frequency	Period of existence in hours
12/09/12	72	1	7.800
22/09/12	144	1	10.100
30/09/12	264	1	14.280
25/10/12	48	1	1.040
29/10/12	96	1	0.800
10/11/12	96	1	1.440
20/11/12	24	1	7.840
25/11/12	72	1	2.400
01/12/12	144	1	8.290
25/12/12	120	1	6.260
10/01/13	360	1	12.840
25/01/13	192	1	9.220

Table 3.17: Conversion of interval between Dozer break-downs to cumulative random numbers

Interval between dozer breakdown	Frequency of occurrence	Frequency of occurrence % * random nos	Cumulative random numbers
0-100	6	6000	0 – 6000
100-200	4	4000	6001-10000
200-300	1	1000	10001-11000
300-400	1	1000	11001-12000
	12	12000	

Table 3.18: Conversion of Existence of Dozer breakdown to cumulative random numbers

Existence of dozer breakdown	Frequency of occurrence	Frequency of occurrence % * random nos	Cumulative random nos
0-1	1	1000	0-1000
1-2	2	2000	1001-3000
2-3	1	1000	3001-4000
6-7	1	1000	4001-5000
7-8	2	2000	5001-7000
8-9	1	1000	7001-8000
9-10	1	1000	8001-9000
10-11	1	1000	9001-10000
12-13	1	1000	10001-11000

14-15	1	1000	11001-12000
	12	12000	

Table 3.19: Frequency and existence of breakdown of Primary Crusher

Date	Time needed in hours	Frequency	Period of existence in hours
16/09/12	360	1	2.480
25/09/12	48	1	6.011
29/09/12	144	1	0.680
31/10/12	96	1	1.780
10/11/12	48	1	0.480
22/11/12	168	1	14.126
05/12/12	48	1	6.600
03/01/13	48	1	4.600
26/01/13	264	1	2.600
05/02/13	24	1	1.780

Table 3.20: Conversion of interval between Primary Crusher break-downs to cumulative random number

Interval between primary crusher breakdown	Frequency of occurrence	Frequency of occurrence % * random nos	Cumulative random numbers
0-100	6	6000	0 – 6000
100-200	2	2000	6001-8000
200-300	1	1000	8001-9,000
300-400	1	1000	9001-10,000
	10	10000	

Table 3.21: Conversion of Existence of Primary Crusher breakdown to cumulative random numbers

Existence of primary crusher breakdown	Frequency of occurrence	Frequency of occurrence % * random nos	Cumulative random nos
0-1	2	2000	0-2000
1-2	2	2000	2001-4000
2-3	2	2000	4001-6000
4-5	1	1000	6001-7000
6-7	2	2000	7001-9000
14-15	1	1000	9001-10,000
	10	10000	

Table 3.22: Frequency and period of existence of breakdown of electric sub-station, transformer and other electric equipment.

Date	Time needed in hours	Frequency	Period of existence in hours
11/09/12	72	1	2.700
18/09/12	168	1	3.100
21/09/12	144	1	10.440
28/09/12	168	1	0.533
10/10/12	72	1	8.990
28/10/12	96	1	7.552
15/11/12	288	1	5.780
05/12/12	120	1	1.520
26/12/12	144	1	6.200
01/01/13	48	1	2.560
17/01/13	216	1	4.280
02/02/13	24	1	9.700

Table 3.23: Conversion of Existence of electric sub-station etc. Break down to cumulative random numbers

Existence of shovel breakdown	Frequency of occurrence	Frequency of occurrence % * random nos	Cumulative random nos
0-1	1	1000	0-1000
1-2	1	1000	1001-2000
2-3	2	2000	2001-4,000
3-4	1	1000	4001-5,000
4-5	1	1000	5001-6000
5-6	1	1000	6001-7000
6-7	1	1000	7001-8000
7-8	1	1000	8001-9000
8-9	1	1000	9001-10,000
9-10	1	1000	10,001-11,000
10-11	1	1000	11,001-12,000
	12	12000	

Table 3.24: Conversion of interval between breakdown of electric sub-station etc. Break down to cumulative random numbers

Interval between power failure	Frequency of occurrence	Frequency of occurrence % * random nos	Cumulative random numbers
0-100	5	5000	0 – 5000
100-200	5	5000	5001-10,000
200-300	2	2000	10001-12000
	12	12,000	

Table 3.25: Frequency and period of existence for General Maintenance

Date	Time needed in hours	Frequency	Period of existence in hours
14/09/12	24	1	0.890
19/09/12	360	1	10.110
05/10/12	144	1	14.210
15/10/12	120	1	3.600
24/10/12	168	1	7.261
08/11/12	48	1	3.260
14/11/12	96	1	4.260
28/12/12	24	1	0.480
05/01/13	24	1	2.230
21/01/12	120	1	3.668

27/01/13	48	1	6.640
02/02/13	144	1	4.920

Table 3.26: Conversion of interval between General Maintenances to cumulative random numbers

Interval between general maintenances	**Frequency of occurrence**	**Frequency of occurrence % * random nos**	**Cumulative random numbers**
0-100	6	6000	0 – 6000
100-200	5	5000	6001-11,000
300-400	1	1000	11,001-12,000
	12	12.000	

Table 3.27: Conversion of Existence for General Maintenance to cumulative random numbers

Existence of general maintenance	**Frequency of occurrence**	**Frequency of occurrence % * random nos**	**Cumulative random nos**
0-1	2	2000	0-2000
2-3	1	1000	2001-3000
3-4	3	3000	3000-6000
4-5	2	2000	6001-8000
6-7	1	1000	8000-9000
7-8	1	1000	9001-10,000
10-11	1	1000	10,001-11,000

14-15	1	1000	11,001-12,000
	12	12000	

Table 3.28: Different Events of Break-downs, their frequencies, and random-number distribution.

Sl No	Different Events of Breakdown	Total frequency of Breakdown	Frequency of breakdown in %	Random Number Distriution
1	Breakdown of Shovel	11	12.791	12791
2	Breakdown of Dumper	12	13.953	13953
3	Breakdown of Drill Machine	17	19.767	19767
4	Breakdown of Dozer	12	13.953	13953
5	Breakdown of Primary Crusher	10	11.628	11628
6	Power Failure	12	13.953	13953
7	General maintenance	12	13.953	13953
		86	100	100,000

From the overhead cited analysis it is observed that the random number distribution can give some indication about the occurrences of the break-down of different events like;

Table 3.29: Indicating Occurrences of break-down using random number distribution

Sl No	Events	Distribution of random number
1	Breakdown of Shovel	1 – 12791
2	Breakdown of Dumper	12792 – 26744
3	Breakdown of Drill Machine	26745 – 46511
4	Breakdown of Dozer	46512 – 60464
5	Breakdown of Primary Crusher	60465 – 72092
6	Power Failure	72093 – 86045
7	General Maintenance	86046 – 100,000

3.5 PROGRAMMING FOR RANDOM NUMBER OF DIFFERENT EVENTS

```
# include<iostrem.h>
# include<conio.h>
# include<stdlib.h>
# include<time.h>
int  UNRAND ();
int_EVENTS_IDENTIFICATION ();
void main ()
{
clrscr ();
int r;
randomized ();
r = random (100000);
cout<<"Uniform Random Number R ="<<R<</n"
cout <<"For this R The Event Generated is :/n";
if (r<12791)
cout <<"Event -1: Break-down of Shovel";
else if (r>=12792&& r<26744)
cout <<"Event -2: Break-down of Dumper";
else if (r>=26745 && r<46511)
cout <<"Event -3: Break-down of Drill Machine";
else if (r>=46512 && r<60464)
cout <<"Event -4: Break-down of Dozer";
else if (r>=60465 && r<72092)
cout <<"Event -5: Break-down of Primary Crusher";
else if (r>=72093 && r<86045)
cout <<"Event -8: Power Failure";
else if (r>=86046 && r<100,000)
cout <<"Event -9: General Maintenance";
getch ()
}
```

Chapter-4

SUMMARY AND CONCLUSION

SUMMARY AND CONCLUSION

Simulation Work-Sheet established in this problem states that if one or more dumper is added in the system, there is no necessity for a dumper to wait in the queue. But, before implementation, the cost of having an extra shovel has to compare with the cost due to dumper waiting time. This can be worked out in reference to table no 3.5 and 3.6.

The breakdown of different machineries is analyzed with random number distribution and the different event falls under definite random number distribution range. Such as if random number comes as 1 – 12791 indicates the shovel breakdown and if it comes 12792 – 26744 it will be considered as dumper break-down, etc. Therefore a clear idea can be prepared for the break-down of different machineries also precautions can be taken for preventive maintenance to minimize these break-down periods by analyzing this method and thus production can be set as Optimum and steady-state.

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