

# PERSPECTIVE PLANNING MODEL OF A STEEL PLANT BASED ON SYSTEM DYNAMICS PRINCIPLES

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## ABSTRACT

Using the principles of System Dynamics a software package of an integrated Steel Plant has been designed for computing its possible futures states, carrying out 'What if' experiments, policy design and testing. The package includes a set of models to estimate general Indian economic conditions, all India demand of flat and tubular steel products, availability of coking coal and power, and the performance of Steel Plant both in tonnes of output and financial indicators. The software package has been used to identify would-be bottlenecks in the next ten years and for evaluation of rationalisation, debottlenecking and modernisation projects already contemplated by the management.

## 1. INTRODUCTION

### 1.1

For simulation of Industrial Management problems the father of System Dynamics, J.W. Forrester<sup>1</sup> suggested that causes underlying the dynamic behaviour exhibited by all systems lie in the presence of casual loops of interdependence of various variables in a system. The subsequent applications of System Dynamics concept for modeling Industrial Systems have further paved the way for its application in modeling and simulating the behaviour of a total company as part of a national economic environment<sup>2,3,4</sup>. This paper presents the case of an integrated Steel Plant model based on System Dynamics principles for the purpose of perspective planning.

### 1.2

This Computer Based Perspective Planning System has been designed during 1980 for the use of management of a public sector Steel Plant located in India. The software package has been designed using the DYNAMO language<sup>5</sup> and runs into nearly 3500 statements. During design and validation the DEC 20 System available at Regional Computer Centre, Chandigarh, India was used. Finally the software package has been implemented on Burroughs System. It is estimated that 12 manyears have been spent in design, development and testing of the package by an inter-disciplinary team of Planners, Technologists, Economists, Financial Experts, Marketing Specialists, Systems Engineers and Electronic Data Processing Specialists.

### 1.3

The package is constituted of a number of models which have been designed for the purpose of computing the probable future states of the following target variables:

- Inflation
- Demand of Steel products e.g., plates, sheets, pipes
- Supply of Coking Coal and Power
- Production of 9 finished goods and 8 semi-finished goods

- Inventories of
  - o Raw Materials
  - o Work in Process
  - o Finished Goods
- Sales, Expenses & Assets
- Profit and Return on Assets

To compute the probable states of these target variables the following models have been designed:

- Indian Economy Model
- Steel Demand Model
- Production Model
- Supply Models
  - o Coking Coal
  - o Power Supply
- Inventory Models
- Financial Models

The output of some models are inputs to others as shown in Exhibit I.

The various models have been separately programmed, tested and validated, with the exception of the Financial Model which does not have a separate identity but has to be run in conjunction with Production and Inventory Models.

Therefore, a package combining all the three i.e. Production, Inventory and Financial models has been prepared. Together these three models represent the Steel Plant where as other three models of Economy, Demand & Supply represent the environment of the plant. The three models representing

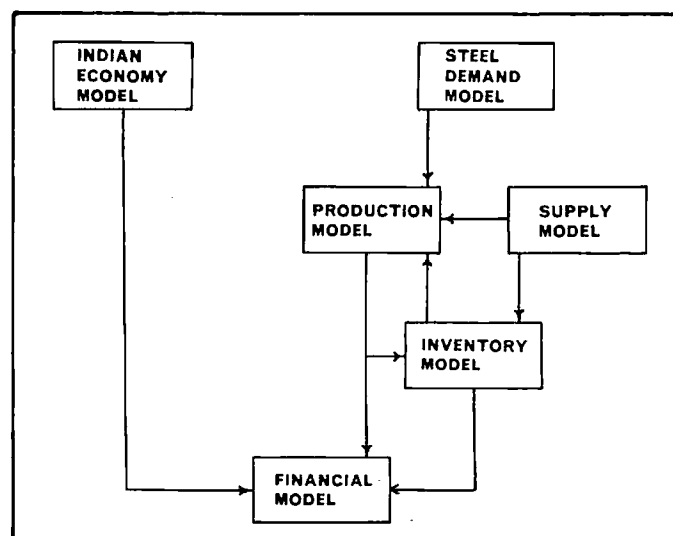


Exhibit I: Perspective Planning System of Steel Plant

the Steel Plant are designed programmed for the monthly results and those of the Economy, Demand & Supply for the annual results.

#### 1.4

The software package is being managed, maintained, updated and altered to suit changing management needs by a perspective planning department of the steel plant. The department is headed by a manager who reports to Deputy General Manager (Management Services). The various Deputy General Managers report to the General Superintendent who in turn reports to the Managing Director. The top management team constituted of all Deputy General Managers, General Superintendent and the Managing Director makes use of this package. The Deputy General Manager (Management Services) identifies those information needs of the top management team which can be satisfied by the use of package. These are then translated in terms of specific tasks for the perspective planning department. The executives working in this department do their home work and return their models if necessary with different scenarios of parameters. The computer outputs are studied by the group and analysed. The results of this analysis are presented to the management. This package has been used in the past to find answers to some of the 'what if' questions e.g.

- \* How does Steel demand respond to various assumptions about e.g., monsoon behaviour, saving rate, government fund allocation policy etc. etc.?
- \* How does investment programme change in response to change in demand/product mix scenarios?
- \* What happens to the long term profitability and return when one and more of the envisaged or ongoing modernisation projects, debottlenecking schemes are implemented, rescheduled etc. etc.

For further details about this package including programme listing the readers may approach Manager, perspective Planning Department, Rourkela Steel Plant, Rourkela. The various models are briefly discussed in following sections.

## 2. ECONOMY MODEL

The economy model has been designed to generate behaviour of INFLATION in the Indian Economy. Only five Sectors of Indian Economy have been modeled. They are:

- o Investment Good Sector
- o Consumer Goods Sector
- o Employment Sector
- o Consumption Sector
- o Savings Sector

The imbalances between purchasing power and goods available have been understood as the global cause of inflation. During any simulation period there could be either a demand deficit (i.e. purchasing power is less than goods) or goods deficit (i.e. goods are less than purchasing power). The extent of goods deficit defines the extent of inflation. The model embraces economic indicators such as net domestic product, employment, wages, demand, purchasing power, consumption, savings, etc. etc.

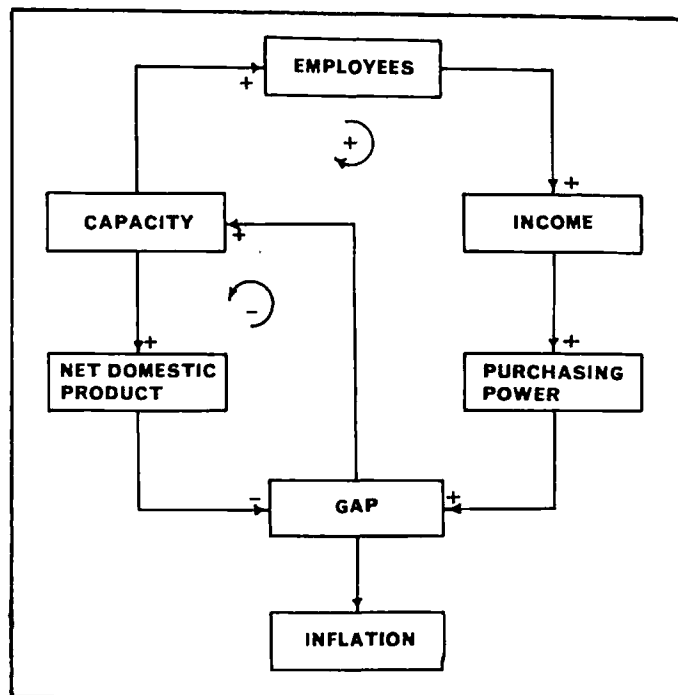


Exhibit 2: Feed-Back Structure Economy Model

### 2.1 Feed Back Loops

Two principal casual loops governing this model are shown in Exhibit 2. When purchasing power exceeds annual production in the economy the gap decides the extent of inflation. This gap together with the production capacity and Net Domestic Product (NDP) constitutes a negative loop which implies that investments are always chasing this gap. This gap also lies on a positive loop along with capacity, employees, income and purchasing power. It implies that this gap which results in enhanced capacity creates also more opportunities for employment, thereby providing additional income to people. As a result of this, people have some additional purchasing power which enhances the gap further, thereby pushing the process of economic growth further. This loop can also explain economic disaster and collapse, in case, it starts operating unchecked in recessionary conditions when supply of goods is in excess of demand.

### 2.2 Inputs

Some of the inputs in the Economy Model are:

- o Capital output ratios i.e. production capability per rupee of investment for the two sectors of Investment Goods production and Consumer Goods production.
- o Capital Intensity for employment in the two sectors i.e., number of jobs created per rupee of capital investment in a sector.
- o Life of the capital in two sectors.
- o Monsoon Forecast.
- o Delays for capital Investment to become productive in both sectors.
- o Income fraction saved or saving rate.
- o Fraction for wage rate increase on an average per annum.

#### RUN - ECONOMY MODEL

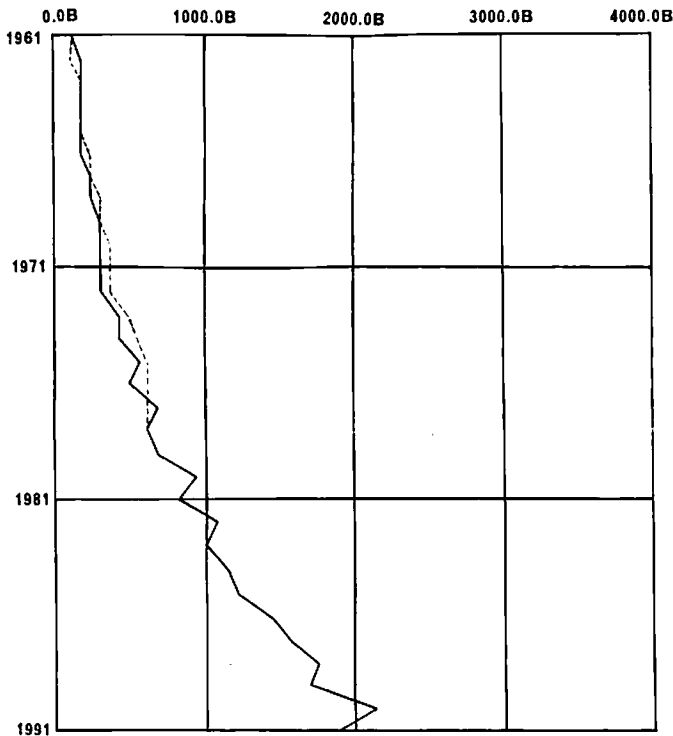


Exhibit 3: Validation Plot of Net National Product (NNP) at Factor Cost and Current Prices

#### RUN - ECONOMY MODEL

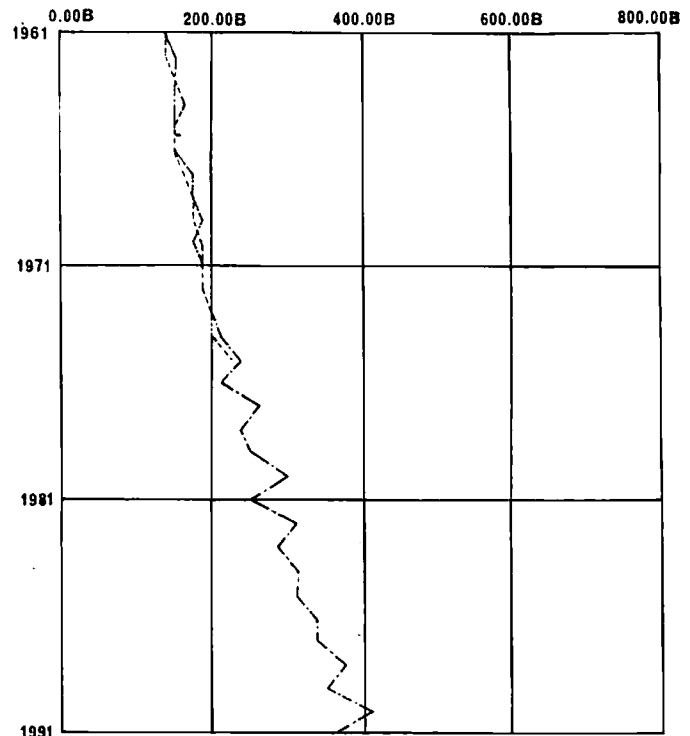


Exhibit 4: Validation Plot of Net National Product at Factor Cost and Constant Prices of 1961

### 2.3 Outputs

The model computes the following variables of the economy at the end of each year.

- o Capital Investment, Outlay, Inventory of
  - Investment Goods Sector
  - Consumer Goods Sector
- o Savings of Entrepreneurs
- o Savings of People
- o Purchasing Power of Entrepreneurs
- o NDP at constant prices
- o NDP at Market prices
- o Inflation

### 2.4 Model Validation

Inflation is explained by the difference in values of:

- o NDP at factor cost and constant prices and
- o NDP at factor cost and current prices

Plots of both these NDP values are given along with the real development in Exhibit-3 and Exhibit-4. The model starts at 1961 and has been run up to 1991. From 1961 to 1975 the real NDP values were readily available and have been plotted for validation purposes.

### 3. STEEL DEMAND MODEL

The Steel demand model has been designed to simulate the demand of the various products of the Steel Plant. Steel demand has been directly related to demand of consumer goods, capital goods and government expenditure. Represented in the model are the 15 major Primary, Secondary and Tertiary economic sectors. Also included are 9 sectors of consumption and 7 sectors of government expenditure. Together these 31 sectors decide the demand of steel. In addition there is a population sector of the model. Since the demand for steel has been computed from the whole Indian economy classified into 31 sectors, the steel demand model can be used to study a large number of gross economic indicators like Gross Domestic Product, Net Domestic Product, Consumption, Savings, Income, etc. etc.

#### 3.1 Feed Back Loops

The principal feed back loops are shown in Exhibit-5. Increase in Gross Domestic Product (GDP) results in an increase in consumption as well as savings. These savings are now used for recapitalisation so as to further increase GDP in future. This positive loop explains growth/decline of an economy. The other loop which is negative in character has been built between GDP, consumption, savings and capital employed. Steel demand moves up when capital and/or consumption goes up. The third loop is between capital and depreciation. This is also negative in character and implies, that if not replenished the capital continuously gets depreciated.

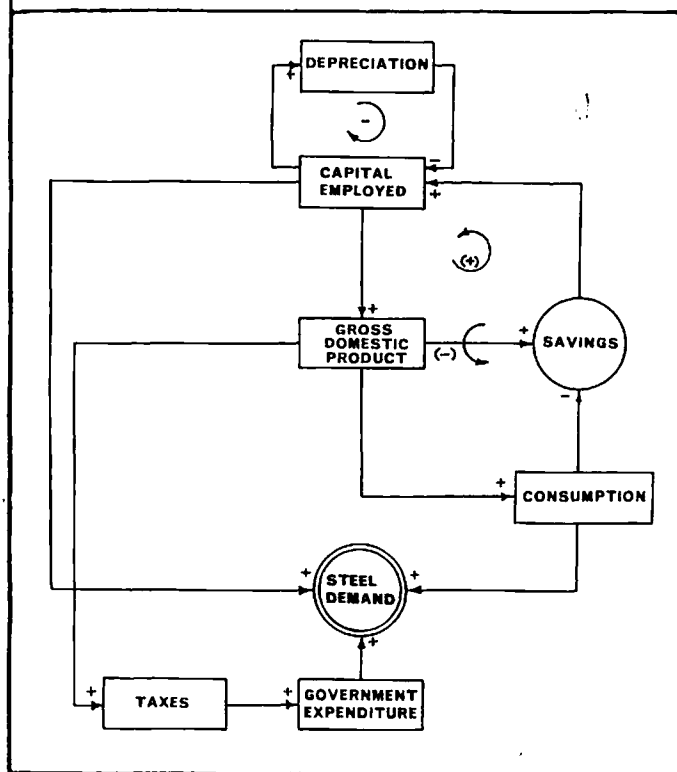


Exhibit 5: Feed-Back Structure of Steel Demand Model

### 3.2 Inputs

The steel demand model runs based on following inputs:

- o Capital allocation policy for 15 capital sectors
- o Allocation factors for government expenditure allocation to 7 sectors
- o Consumption factors for allocation of income to 9 sectors of consumption
- o Demand factors which relate steel demand for various categories of steel to 31 sectors of capital consumption and government expenditure.
- o Monsoon behaviour
- o Output to capital ratio for each of the 15 capital sectors
- o Agricultural productivity factor
- o Substitution factor

### 3.3 Outputs

Demand model has been designed to simulate the demand of 9 different varieties of Steel. These are Tin Plates, Electric Resistance Welded Pipes, Spiral Welded Pipes, Galvanised Iron Sheets, Electric Steel Sheets, Heavy Plates, Dividing Plates, Hot Rolled Sheets, and Cold Rolled Sheets.

It can also be used to study the behaviour of the following Economic Indicators and Indian Economy.

- o Gross Domestic Product and Gross National Product
- o Per Capita Income
- o Government Tax Revenue

- o Consumption and Savings
- o Capital Employed Sectorwise
- o Government Expenditure
- o Population

### 3.4 Validation

The demand model has been validated by running it from 1971 onwards. The results are given in Exhibit-6 and found satisfactory. The demand plotted is All India Demand but only of flat products and pipes produced by the Steel Plant. The real demand is not known, therefore, it has been estimated from sales in the past.

## 4. COKING COAL SUPPLY MODEL

This model has been designed to simulate the coking coal shortages in India by estimating both demand and supply of these in future. The model has two sectors

- Demand Sector &
- Supply Sector

There are no feed back loops in it.

The demand of Coking Coal is modeled as a function of All India demand of steel. This steel demand is roughly estimated from the growth rate of Gross National Product simulated in economy Model as shown in Exhibit-7. The steel demand referred here includes all the varieties of the steel and is not limited by only the nine varieties covered in steel demand model. Coking Coal production has been modeled as a function of installed capacity and fresh capital allocation of government to this sector in the Sixth Five Year Plan and the 10 year investment plans prepared by Coal India Ltd. To estimate production in future, in addition to Capital Output ratio utilisation factor is also taken into consideration. The coking coal shortages are fed to production model.

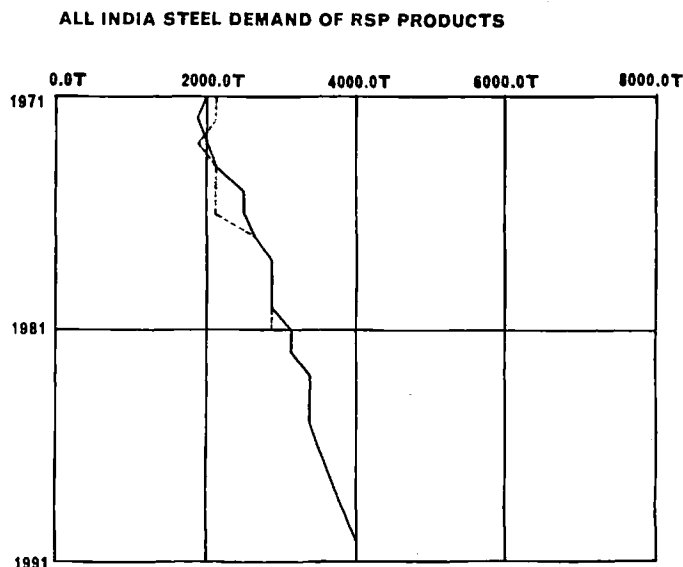


Exhibit 6: Validation Plot Steel Demand Model

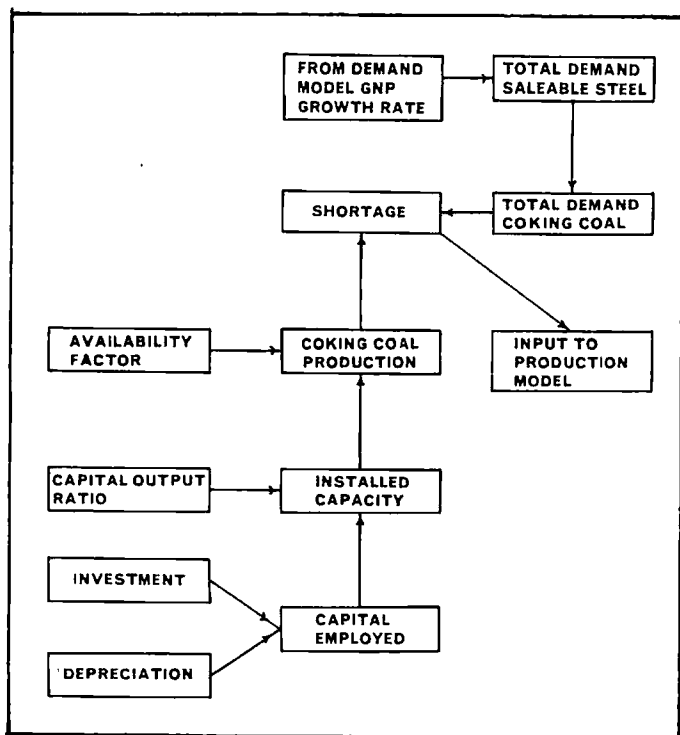


Exhibit 7: Flow Chart Coking-Coal Supply Model

## 5. POWER SUPPLY MODEL

Three sectors of this model are:

- Thermal generation by State Electricity Board
- Hydel Generation by State Electricity Board
- Power Generation by Captive Power Plant of the Steel Plant.

In addition to the power received from captive power station, the Steel Plant also gets power from the state grid. The total power available to the steel plant is constituted of two parts. One part is supplied from the state grid and the other from its own generation. The model structure is designed on the lines adopted for the design of Coking Coal supply model. The demand for power is computed from the production model. The capital employed in these three sectors gives installed generation capacity. The utilised capacity depends upon operational efficiency as well as availability of inputs. Monsoon behaviour influences the Hydel Generation Capacity. Capital employed in each sector depletes through usage and grows based on investments planned by the government in the sector of power generation.

## 6. PRODUCTION MODEL

The purpose of this model is to understand the state of capacity development and its utilisation in each of 26 production sectors. From production point of view, the Steel Plant has been divided into two main sectors:

- Physical Production Sector; and
- Information Production Sector

Sixteen sectors of physical production and ten sectors of information production have been included in the model.

The physical production sectors are Coke ovens, Sinter Plant, Blast Furnace, Steel Melting Shops and all the rolling mills. The various information production sectors are e.g. Production Planning and Control, Finance, Design, Personnel, Maintenance Planning, etc.

This production model design is based on the following important assumptions:-

- the flow is unidirectional commencing with the production of the Coke Ovens and finishing with the Rolling Mills.
- when the output of a shop needs to be distributed to more than one shop at the next stage of production, the distribution is in the ratio of the amount of input, which can be processed by the each shop in the next stage. For example, Blast Furnace supply hot metal to open Hearth Furnaces and L.D. Convertors. The amount of Hot Metal produced in any planning period is distributed amongst the Open Hearths and L.D. Convertors in the ratio of the minimum of their available capacity and work load during that period. However, in case of Finishing Mills the criterion for distribution of products of Hot Strip Mills to the Finishing Mills is based on their respective demands for the products of the Finishing Mills.
- the Ingots produced by the Steel Melting shops are fit for distribution to any of the subsequent Rolling Mills i.e., no distinction is made between the Ingots produced by Open Hearth Furnaces and L.D. Convertors, based on any quality criterion.

### 6.1 Production Flow Model

The production of Steel Plant during any planning period depends upon the coordinated performance of 16 shops. As shown in Exhibit-8, demand directly identifies work load of the finishing mills, which depending upon their capacity availability decide work load for semi-finishing mills.

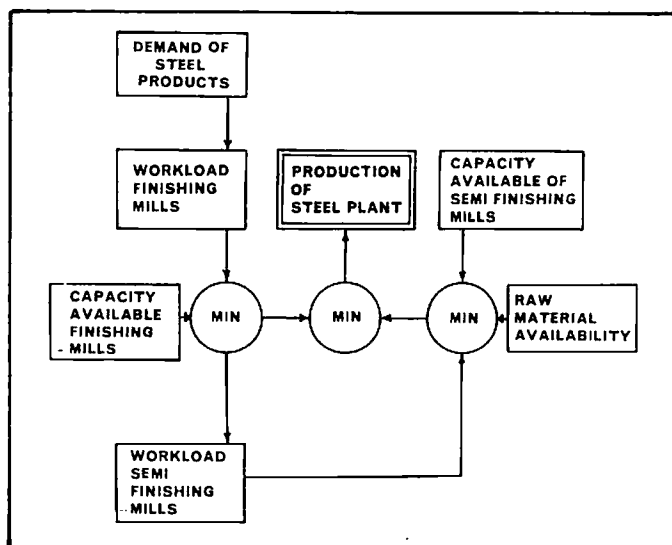


Exhibit 8: Flow Chart Production Model

The output of the semi-finishing mills is minimum of

- o Capacity availability
- o Material availability
- o Work load availability

The production of Steel Plant is minimum of

- o the minimum calculated above
- o work load of finishing mills &
- o capacity availability of finishing mills

During computation of work load one is required to proceed from finishing mills backwards and then proceed the other way to compute production of each shop based on availability of capacity, material and workload. Capacity has been further analysed and modeled using the following relationships.

Capacity = Output/job \* No. of jobs

No. of Jobs = Time Available/Time per job

Time Available = Minimum (Time Available of men, Time Available of machines)

Time Available of Machines = Total Time Available – Down Time

Total Time Available = No. of Machines \* No. of Shifts/day \* Working days \* Hours/Shift

Down Time = Breakdown Time + Preventive Repair Time

Breakdown Time = Mechanical + Electrical + Delays

Preventive Repair Time = Capital Repair + Minor Repair

Minor Repair Time = No. of Repairs \* Down Time/Repair

No. of Repairs =  $\Sigma$  Hrs. Run/Time between failures

#### 6.1.1 Coke Flow Model

Let us take up the example of Coke Flow. How have the production rate and consumption rate of Coke been modeled?

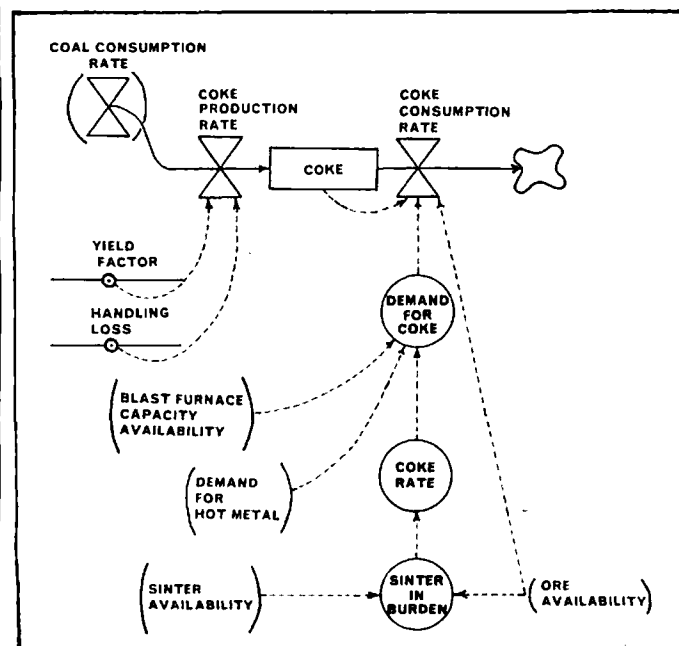


Exhibit 9: System Dynamics Flow Chart Coke Flow Model

The System Dynamics Diagram of Coke Flow is given in Exhibit-9. The Coke production rate has been modeled as a function of the Coal consumption rate, the yield factor and the handling loss factor. The Coke consumption rate formulation is comparatively a complex one. It depends upon the coke availability, the Coke requirement of blast furnaces and the amount of burden available for reduction by coke to hot metal. The coke requirement of Blast Furnaces depends upon their capacity and workload. The workload of Blast Furnaces in turn depends upon the hot metal requirement of Steel Melting Shops. The amount of burden available also limits the amount of coke that can be utilised provided other constraints permit. Coke requirement for reduction of burden not only depends upon the burden but also the percentage of Sinter available, in burden. All such relationship between flows of 9 finished goods, 4 raw materials and 7 in-process materials have been modeled on similar lines, translated into equations and programmed to constitute the Steel Plant model. Following relationships are drawn from the System Dynamics flow diagram shown in Exhibit-9.

$$L \text{ CK.K} = \text{CK.J} + (\text{DT}) (\text{CKI.JK} - \text{CKO.JK})$$

$$N \text{ CK} = \text{CKN}$$

$$R \text{ CKI.KL} = \text{CLO.JK} * \text{YFCO} * (1 - \text{HLCL})$$

$$R \text{ CKO.KL} = \text{MIN}(\text{CK.K}, \text{CKRD.K})$$

$$A \text{ CKRD.K} = \text{MIN}(\text{CKRBD.K}, \text{FMCO.K})$$

$$A \text{ WLCO.K} = \text{FMBF.K} * \text{CKRT.K} / (1 - \text{HLCO})$$

$$A \text{ CKRBD.K} = \text{BRD.K} * \text{CRBHM.K} + \text{CKRT.K} / (1 - \text{HLCO})$$

$$A \text{ BRD.K} = \text{ORE.K} + \text{SNT.K}$$

$$A \text{ CFBHM.K} = \text{TABLE}(\text{CFBHMT}, \text{PSIB.K}, \text{O}, 100, 10)$$

$$A \text{ PSIB.K} = \text{SNT.K} * 100 / \text{BRD.K}$$

$$A \text{ FMCO.K} = \text{MIN}(\text{CPCO.K}, \text{WLCO.K})$$

$$A \text{ CKRT.K} = \text{TABLE}(\text{CKRTT}, \text{PSIB.K}, \text{O}, 100, 10)$$

#### Abbreviations

BRD	=	Burden
CK	=	Coke
CKI	=	Coke in Rate
CKO	=	Coke Out Rate
CKRD	=	Coke required
CKRBD	=	Coke required for burden
CKRT	=	Coke rate
CPCO	=	Capacity Coke Ovens
CPBF	=	Conversion Factor Burden to Hot Metal
CKRTT	=	Coke Rate Table
FMCO	=	First Minimum Coke Ovens
HLCO	=	Handling Loss in Coke Oven Sector
SNT	=	Sinter
WLCO	=	Work Load Coke Oven Sector
YFCO	=	Yield Factor in Coke Oven Sector

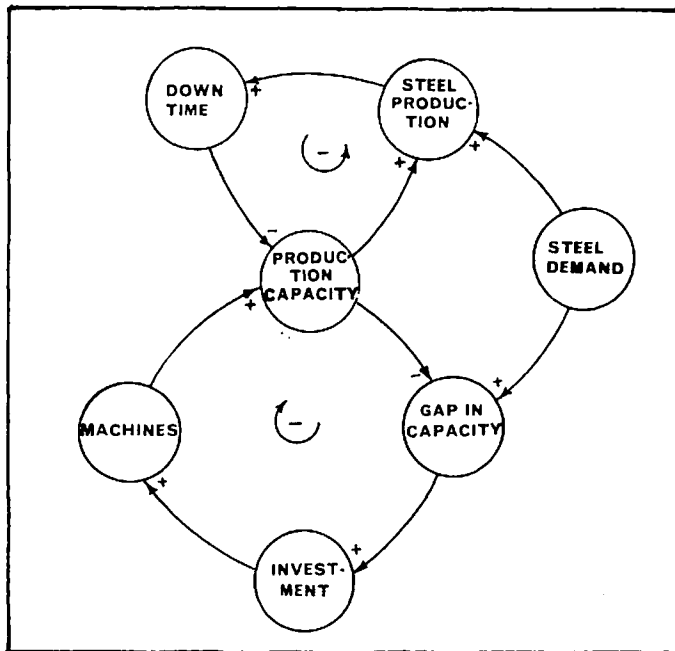


Exhibit 10: Feed-Back Structure Production Model

### 6.2 Feed Back Loops

The dynamic behaviour in any physical production sector is caused by a negative loop which connects variables like capacity availability, production and down time as shown in Exhibit-10. Production depends in addition to the capacity availability on demand and raw material availability. The other negative loop connects gap between demand and capacity to investment, installed capacity and capacity available. Higher the gap, higher is the expansion to meet the demand. This loop represents managements reaction to increasing demand for its products.

### 6.3 Inputs

Each of the 16 physical production sectors is governed by the following technical parameters.

- o Output per job
- o Time per job
- o Yield factor
- o Down Time/Mech. Breakdown
- o Down Time/Elect. Breakdown
- o Down Time/Minor Repair
- o Capital Repair duration
- o Mean Time between Mechanical Failures
- o Mean Time between Electrical Failures
- o Mean Time between Minor Repairs
- o Mean Time between Capital Repairs

In addition to these there are other parameters like Crew Strength, Shifts Operated, Average Working Life, etc. etc.

For the 10 information production sectors, the inputs are of similar type as listed above for the physical production sectors but for the exception of those which relate to an employee.

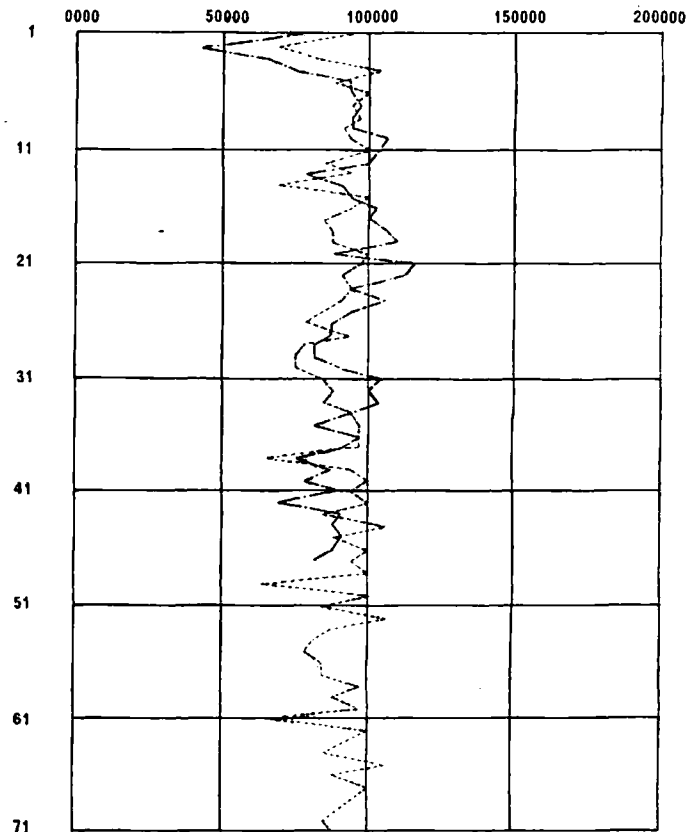


Exhibit 11: Validation Plot of Monthly LD Ingot Production

### 6.4 Outputs

The various variables which are computed by the model every period for each of the sixteen production sectors are:

- Consumption rates of materials
- Production rates of materials
- Capacity
- Manpower
- Down Time
- Inventories of work in process and finished goods
- Workload
- Machines
- No. of breakdowns

### 6.5 Validation

Outputs of all the sixteen shops and the production of scrap have been validated. In Exhibit-11, LD Ingots production is seen validated. Starting from April 1975 the model results are plotted along with the actual results achieved in the past. Comparison is made over 48 observations and the results have been found to lie within an accuracy of 3% on total production of Ingot Steel. The dynamic pattern generated are also found comparable.

## 7. INVENTORY MODELS

The Inventory Models have been designed to simulate behaviour of two categories of inventories:

- Raw Materials
- Overhead Materials

Considered are only four raw materials namely Manganese, Limestone, Dolomite and Quartzite. Two major raw materials, ore and coal are already included in the production model. While ore and coal are modeled in tonnage the other raw materials are modeled in rupees along with the various categories of overhead materials like, Spares, Consumables, Rolls, Refractories and Minor raw materials.

### 7.1 Feed Back Loops

All inventories are fluctuating in response to production requirements. There are two loops in the model as shown in Exhibit-12. Gap between standard inventory and the model inventory when goes up the ordering rate is affected which after some delay affects the goods receipts rate and finally a change in Inventory Level that is in the direction of reducing this gap. This negative loop is responsible for the fluctuating behaviour of inventories. On the other hand there is a positive loop between inventory level, consumption rate, standard inventory, ordering rate and receipt rate. This represents the manner in which the inventory levels are responding to fluctuating production rate.

### 7.2 Inputs

For each category of inventory the following inputs to the model are required.

- o Av. Lead Time of supplier
- o Internal order processing time
- o Standard Inventory in days of consumption
- o Inflation
- o Consumption rate per ton of production

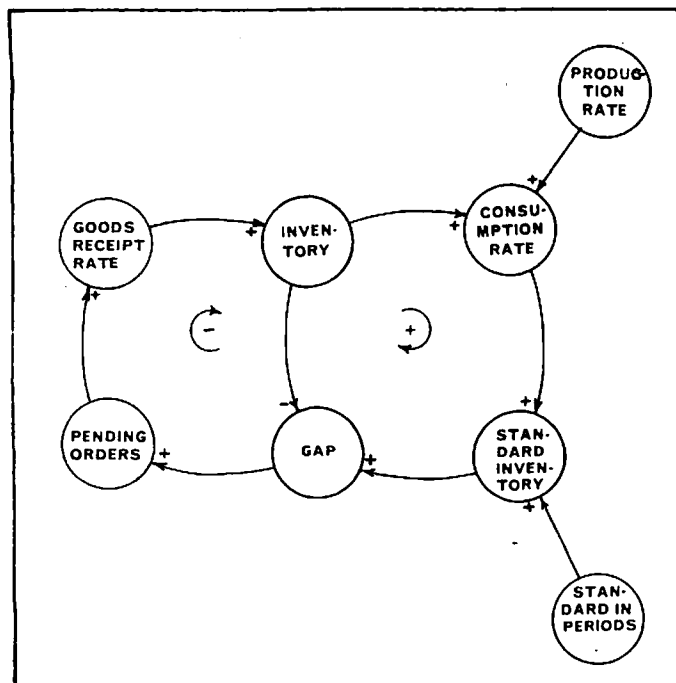


Exhibit 12: Feed-Back Structure Inventory Model

### 7.3 Outputs

Possible outputs for each category of inventory are

- o Inventory level
- o Receipts rate
- o Consumption rate
- o Ordering rate
- o Pending Orders

## 8. FINANCIAL MODEL

In addition to the normal accounting identities designed to compute Sales, Expenses, Assets and Return on Assets the model has provision for computing operating result, cash flow and long term loan requirement. To compute rupee values, all quantities generated by the production and inventory models are taken and multiplied by dynamic prices.

### 8.1 Structure

#### 8.1.1 Expenses

For each production sector there are a set of cost items.

These are:

- Personnel Expenses
- Capital Expenses
- Raw Material Expenses
- Depreciation
- Interest

All employees have been grouped into:

- Officers
- Direct Workers &
- Indirect Workers

for computing average personnel rate which is modeled as a function of inflation. The dynamic behaviour of number of employees of 26 sectors classified into three categories outlined above is generated in production model. These numbers are multiplied by respective personnel rates of various categories for computing the personnel expenses of each sector which when added together the personnel expenses of the steel plant are arrived at. The personnel rate represents on an average the cost of an employee to the company. Each of the three categories of employees has its own rate. This rate takes care of salary, dearness allowance, housing medical and all other perks. Capital Expenses are also computed for each of the 26 production sectors. For sectors having physical production this expense has been modeled as a function of production rate which when multiplied by capital rate gives capital expenses. Capital rate of each production shop represents expenses incurred towards energy, consumables, spares etc. etc. for each tonne of production. For the 10 sectors of information production the capital rate represent expenses of executives incurred towards travel, telex, telephone, stationary, etc. etc.

#### 8.1.2 Assets

Assets consist of Fixed and Current Assets. In Fixed Assets only machine assets have been included. Model computes two types of machine assets:



- Gross Machine Assets
- Written Down Machine Assets

Current assets consist of:

- Raw Material Assets
- Work in Process Assets
- Finished Good Assets
- Overhead Material Assets
- Cash Assets

#### 8.1.3 Sales

Sales are computed by multiplying despatch rates of 9 finished goods with their respective prices. Also included in scrap sale. Prices have been modeled in-flationary.

#### 8.1.4 Cash and Loans

Incoming and outgoing streams of cash have been modeled. In case of deficit the model generates the borrowing rate and in case of surplus the extent to which borrowings can be reduced. The long term loan requirements are simulated based on needs of expansion, replacement and modernisation identified in the production model. The cash inflow has two sources in the model.

- Sales &
- Borrowings (Short Term)

The cash model has the following outflows

- Expenses of 26 production sectors
- Interest payments
- Loan repayments

### 9. SIMULATION EXPERIMENTS USING THE MODELS

#### 9.1 Economic Model

Inflation behaviour has been found to be quite sensitive to model parameters like saving rate and fraction increase in wage rate. Net Domestic Product behaviour is very sensitive to capital output ratios. When the model was run by assuming repetition of any two different monsoon behaviours for the next decade selected from the last 10 decades, the long term behaviour of inflation was found to be insensitive. However, from period to period the impact of good v's bad monsoon was felt of course. It was found that over a decade the good and bad monsoon years are balancing each other as far as inflationary tendencies are concerned.

#### 9.2. Demand Model

The various optimistic assumptions about parameters like capital allocation policy, monsoon behaviour, capital output ratio, steel substitution factor, saving rate, consumption pattern, etc. etc. have limited the growth of steel demand to a maximum average of 3.5% per annum, thus implying that by the turn of the century it may touch 20 million tonnes. This scenario was too pessimistic when compared with all other scenarios produced by other agencies in India using techniques other than System Dynamics. During the last four years the actual demand development is more or

less in agreement with the one generated by this model than those of others.

#### 9.3 Steel Plant Model (Production, inventory and finance)

The model has been used to simulate the impact of various expansion, modernisation and debottlenecking projects (under implementation and proposed) on profit and return. The various project reports prepared for getting financial sanctions of these projects provided new values of parameters for these experiments. It has been found that production behaviour is quite sensitive to technical parameters defining capacity of the plant as well as its efficiency. As expected the profit and return behaviour is very sensitive to parameters defining prices and inflation. Various production programmes with varying product mix have been tried to simulate behaviour of production in tonnes and profit behaviour in rupees.

### 10. APPLICATIONS AND ADVANTAGES

The computerised perspective planning package of Steel Plant explained can be used to do the following:

- Simulate within no time as many probable future states as may be required by the sets of assumptions about environmental influences.
- Identify production bottlenecks, shortages of vital inputs, booms and recessions in demand.
- Evaluate rationalisation and modernisation projects after taking into account a large part of the enterprise and a long term view of it.
- Project resource requirements including men, materials, machines and money.
- Simulate the outcome of various policy decisions.
- Based on changes noticed in underlying assumptions up-date forecasts in no time.

The software package is modular in character where any needed additions and alterations can be easily incorporated. The programme language called 'Dynamo'<sup>5</sup> is simple to operate and can be easily learnt. The mathematics involved is also simple.

The package provides management with laboratory model of their business. Though model is highly aggregated, it still takes into account a large number of interdependancies as well as detail for simulation of future prospects under various assumptions about environmental influences. It does so in a fizzy with hairline accuracy during iterations and at such a low cost.

### ACKNOWLEDGEMENT

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