PART I
CHAPTER I

INTRODUCTION
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1.1 DEVELOPMENT OF AUTOMATIC DATA PROCESSING.

1.11 Traditionally, the famous British Mathematician Charles Babbage may be said to be the father of the present day computer. Though his analytical engine conceived in 1833, was not a computer in the modern sense, it was to have an internally stored program and was to be capable of executing and transferring data program steps. Due to limitation of technology of the day and unreliability of the mechanical devices, however, it was not practicable to develop a full working model of the engine at that time. The credit for developing the first working computer of a substantial size however goes to the Harvard University. It is here that Howard Aiken was able to develop an Automatic Sequence Controlled Calculator, Mark I in 1944. In 1947 the IBM Engineers built an advanced version, the Selective Sequence Electronic Calculator. Completion of Electronic Discrete Variable Automatic Computer designed by Eckert and Mauchly and another computer based on the design of Von Neumann and others completed by the Institute for Advanced Study at Princeton opened new vistas in the field of computers.

1.12 With the growth of information explosion occurring along with the growth of industrial activity in the post world war era, the limitations of human organs in manipulating large scale information at a fast pace, was being increasingly felt. The simultaneous development of computers provided a solution to this growing problem. By 1954 IBM had started commercial production of IBM 650 and thus opened a field for automatic data processing in the business world.
1.13 The impact of automatic data processing in developed countries has been noticeable in every field of human activity. Its impact has been particularly pronounced in the economic field leading to the development of multinational corporations and world market. The industrial environment of the modern world had taken a completely new look due to the impact of automatic data processing with the help of electronic computers.

1.14 Firms having electronic data processing capabilities have been able to increase their profitability considerably, making an edge over their rivals and competitors. With the help of this additional tool, the decision making process of the management has undergone substantial change. It is much easier for the management to simulate years of operation and notice the effect by running simulation programmes on computers in minutes. With this process, management can notice the effect of its alternative plans in minutes and select the optimum plan for actual operation without incurring the cost and delay of actual trials. Thus the automatic data processing capability enables the modern manager to see the effect of his decision without incurring the cost and risk of actual implementation. Thus it saves the firms from costly errors due to implementation of wrong management decisions producing less than optimum results.

1.15 In fact the automatic data processing capability is considered to be the most astounding scientific achievements of the present century. The widespread use of electronic computer in business and management field is hardly two decades old. In this short period it has contributed to a technological progress, according to some people, equal to that of about two centuries since the development of steam engine in 1769. In
The computer has provided us the answer to our biggest problem enumerated by the great efficiency expert Dr. Gilberth, "So much to do, so few to do it". This problem is the child of great information explosion created by each discipline and the necessity to digest this data. There is an exponential increase of this information but our capacity to absorb it remains constant. We could get out of this chaos only through an effective interaction of man machine relationship, established through the interaction of human brain with the electronic computer. This has been amply demonstrated by the example of industrial revolution of the developed countries, which have resorted to large scale computerisation of their business and administrative activities during the last two decades.

1.2 MACRO ASPECTS OF ADP DEVELOPMENT IN INDIAN ENVIRONMENT

1.2.1 Computers in Data Processing

The electronic data processing capability was a gift of 2nd World War to the business world of the west. During the first decade of its development from 1944 to 1954, USA itself had only 12 computers installed for business data processing. The development of computerised data processing for business purposes during subsequent years grew at a phenomenal pace and by turn of the next decade till 1969, USA had over 76000 computers installed and over 23000 computers were on order by 1970. The pace of computerisation in other developed countries during this decade was also quite fast (refer table 1.31). In Indian environment, however, computerised data processing made its first appearance only when developed countries had already girdled up for large scale expansion. The first computer in
Table 1.21

Growth of computer installation in some foreign countries

<table>
<thead>
<tr>
<th>Country</th>
<th>1957</th>
<th>1957</th>
<th>1969</th>
</tr>
</thead>
<tbody>
<tr>
<td>U.S.A.</td>
<td>75</td>
<td>2206</td>
<td>7882</td>
</tr>
<tr>
<td>U.K.</td>
<td>52</td>
<td>2108</td>
<td>5000</td>
</tr>
<tr>
<td>West Germany</td>
<td>20</td>
<td>3563</td>
<td>6400</td>
</tr>
<tr>
<td>France</td>
<td>15</td>
<td>891</td>
<td>4903</td>
</tr>
<tr>
<td>Japan</td>
<td>-</td>
<td>2411</td>
<td>4977</td>
</tr>
<tr>
<td>Italy</td>
<td>10</td>
<td>1780</td>
<td>2300</td>
</tr>
</tbody>
</table>

(Source: Report of the Committee on Automation
Govt. of India, Ministry of Labour & Rehabilitation
p. 23)
India was installed in 1956 by Indian Statistical Institute at Calcutta. This was used mainly for educational and research purposes. For business data processing, the first computer appeared on the scene as late as 1961. This one was installed by Baco Standard Eastern Inc, Bombay.

1.22 Transfer of Technology.

1.221 The late entry of computerised data processing in the Indian environment was responsible to an extent for the sluggish growth of computer capability in India. The 1960 was a period of growing foreign exchange stringency in India. Import of computer hardware was therefore, as difficult as import of any other capital equipment. Further, the successful computer manufacturers abroad were quite heavily booked for their home market and that of other developed countries. They were thus not particularly interested in entering the Indian market. On the other hand the business houses in India itself were not quite sure whether they had reached a stage where they could derive the full benefits from the use of electronic data processing. They were thus not very enthusiastic in pursuing the plans for acquiring such facilities during early sixties.

1.222 The example of the developed countries however, had left no doubt in the mind of the intelligentsia and the authorities in Government regarding the potentialities of computers to act as a catalytic agent for hastening the pace of economic growth. While the private business was still vacillating with the plans of computer till 1964 computers entered in India only for Government and R & D purposes. For business purposes the
electronic data processing picked up both in private and public sector only from 1965. By 1970, however, the country had more than 100 computers installed in various sectors (refer Table 1.23).

1.23 Choices open and indigenous production.

1.231 Entry of computers in the business field created an awareness in the mind of business executives in India, who were by now seriously engaged in exploring the possibility of acquiring such facilities. They were now seriously concerned that their competitors should not get away with undue benefits, simply because they had introduced electronic data processing. This awakening in the Indian Industry was responsible for a steady growth of computerization during the later half of the sixties. Though this growth was slightly arrested during 1970 but it picked up again during 1971. During the first decade of its introduction in the country itself, computers had covered a wide field of Indian industry. A detailed distribution of computers installed in India industrywise till 1971 is given in Table 1.231.

1.232 The growing application of computerized data processing in the Indian environment and the limitations of dependence on foreign knowhow and technology however, soon forced the Indian Government to formulate a comprehensive policy for achieving self sufficiency in the field of computers in India. In keeping with this aim, the Government of India laid down a detailed guide line for the growth of computer industry in the country.

The main features of these guide line were as under:

Table 1.23

Computers in India (Aug. 1971)
(Yearwise and sectorwise distribution)

<table>
<thead>
<tr>
<th>Year of Installation</th>
<th>Govt. Depths</th>
<th>Public Sector</th>
<th>Private Sector</th>
<th>&amp; Undertakings</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1961</td>
<td>-</td>
<td>1</td>
<td>1</td>
<td>-</td>
<td>2</td>
</tr>
<tr>
<td>1962</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>1963</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>1964</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>8</td>
<td>9</td>
</tr>
<tr>
<td>1965</td>
<td>1</td>
<td>3</td>
<td>5</td>
<td>5</td>
<td>14</td>
</tr>
<tr>
<td>1966</td>
<td>1</td>
<td>6</td>
<td>5</td>
<td>4</td>
<td>15</td>
</tr>
<tr>
<td>1967</td>
<td>3</td>
<td>6</td>
<td>11</td>
<td>3</td>
<td>22</td>
</tr>
<tr>
<td>1968</td>
<td>-</td>
<td>9</td>
<td>9</td>
<td>8</td>
<td>20</td>
</tr>
<tr>
<td>1969</td>
<td>2</td>
<td>5</td>
<td>10</td>
<td>2</td>
<td>19</td>
</tr>
<tr>
<td>1970</td>
<td>1</td>
<td>5</td>
<td>4</td>
<td>-</td>
<td>10</td>
</tr>
<tr>
<td>1971 (partial)</td>
<td></td>
<td>4</td>
<td>11</td>
<td>7</td>
<td>23</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td>10</td>
<td>39</td>
<td>55</td>
<td>36</td>
</tr>
</tbody>
</table>

(Source: Report of the Committee on Automation, Govt. of India Ministry of Labour & Rehabilitation, pp.38)
### Table 1.231

Computers in India classified according to Industry

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Name of Industry</th>
<th>Govt. Dept.</th>
<th>Public Sector</th>
<th>Private Sector</th>
<th>R &amp; D</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Air Transport</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Automobiles</td>
<td>1</td>
<td>2</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Cement &amp; stone lime</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Chemical &amp; Chm products</td>
<td>2</td>
<td>3</td>
<td>9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Electric supply</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Engineering incl. Iron &amp; steel</td>
<td>15</td>
<td>9</td>
<td>24</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Banking and Ins.</td>
<td>4</td>
<td>-</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Petroleum</td>
<td>1</td>
<td>4</td>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Railways</td>
<td>11</td>
<td>11</td>
<td>11</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Others</td>
<td>10</td>
<td>3</td>
<td>8</td>
<td>38</td>
<td>2297</td>
</tr>
<tr>
<td>11</td>
<td>Textiles</td>
<td>13</td>
<td>13</td>
<td>13</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Service Burea</td>
<td>7</td>
<td>7</td>
<td>7</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(Source: Report of the Committee on Automation, Govt. of India Ministry of Labour & Rehabilitation, pp 157)
a) All manufacturing programmes for computer system in future were to be based on terms and conditions as generally applicable to all other manufacturing programmes in the country.
b) Manufacturing programmes with majority foreign collaboration were generally to be accepted on 100% export basis.
c) All users should first attempt to meet their in house requirements through computers available in the Indian Market and additionally draw on the facilities offered by Regional Computer Centre.
d) Computers other than those available in the Indian market through Indian Manufacturing programmes will be considered as expensive items of Import. Accordingly requirement of in house computers for import were to be considered in merit in terms of relevance to national development programme and related priorities.

In keeping with these guide lines and the manufacturing licenses were granted to indigenous manufacturers. The current programmers of computer system manufacturing and ancillary equipment within the country were as follows:

1) **International Business Machine World Trade Corporation.**

(IBM) started manufacturing in India in 1969. They had a factory at Bangalore manufacturing punch cards and at Kurla, Bombay, manufacturing 029 key punch unit record equipment and reconditioning and assembly of 1401 control processing unit.

They were granted industrial license as under:

a) To recondition 68 computers of 1401 series over a 3 year period, 22 each in 1969 and 1970 and 24 in 1971.
b) To manufacture 8029 key punches upto a maximum of 4000 units.
(ii) The International Computers India Manufacturing Co., Ltd.

ICL was established in 1963 and had been engaged in manufacturing of off line card preparation equipment in its plant at Pune. With the foreign exchange earned through exports, they had been selling and maintaining their systems like 1904, 1905, 1903 etc. They were awarded manufacturing license to manufacture 40 systems in 1981 - A series in collaboration with Bharat Electronics Ltd. of Bangalore. In this venture B & L was only a sub contractor.

(iii) Electronics Corporation of India Ltd., Hyderabad.

ECIL was scheduled to produce TDC-12 real time computers developed by Electronics Division of Bhabha Atomic Research Commission in the name of TDC-12. A total of 35 systems were scheduled for production during the 4th plan period and thereafter a production capacity of 10 computers per year was envisaged. Proposal from ECIL for production of small to medium size computers TDC-15 and TDC-32 was also accepted subsequently by the Electronics Commission of India.

1.24 Problems of scale in achieving organizational goals.

1.241 The organizational goals for which the computers were introduced in India, was to achieve the following.

1) To cope up with greater volume of information processing tasks by handling complicated data with speed and accuracy.

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ii) To generate useful information from an intricate mass of evidence, to enable the management to understand and solve problems in field of production planning, sales, inventory control and accounting.

iii) Providing infinitely greater scope for complicated mathematical and statistical computations and thus help research activities.

In most cases of computerisation of process, there was little redundancy or displacement of electrical staff. In any case anticipated redundancy of electrical staff in the short as well as long run could be warded off in most cases by absorbing the surplus staff in future expansion of business or by stopping further recruitment. Computerisation of process in Indian environment invariably resulted into increased expansion of business activities and it was easy to take the employees into confidence by assuring them of continued employment. Where trade unionism amongst clerks was weak or absent, the computer installation could progress without significant protest from workers.

Labour resistance,

Problems of computerisation were taken up by the trade unions late in 1964, at the national level. The fear that the use of computer might catch on with passage of time resulting into aggravation of the problems of labour displacement and thus retard the growth of unemployment, prompted a joint convention of trade unions at Delhi during December 1965. During this convention, the major trade union bodies like AITUC, UTUC, HMS, BMP, EES, Federation of P & T employees demanded a total ban
on the use of computers in the country. As there was no response to this demand by the Government, another convention was held in December 1967 by the trade unions to reiterate their demand, ultimately Govt. decided to take up the issue for discussion by the Standing labour committee in 1968. After a discussion in this committee during July 1968, a committee on automation was appointed to work out the details and submit their recommendations to the Government.

1.252 Deliberations during these conventions revealed that the Trade Unions in India felt that computers were an uneconomic tool for administrative and commercial use in the Indian environment as it involved a sizeable amount of capital expenditure including foreign exchange. In a situations of scarce capital and labour plenty, it was wrong and unnecessary to spend huge sums on computers while depriving clerical workers of job opportunities. On the other hand, the management felt that the increased efficiency resulting from computerisation, ultimately lead to economic growth. As most employers offered assurance of job continuity to their workers while introducing automatic data processing, redundancy of workers was really not a problem. The Government, however, felt that it was not possible to achieve real advance in the standard of living of workers without increased productivity. In the larger interest of the workers and the country, if automation brought in increased productivity, it was thing to be accepted rather resisted.

1.25 Spread of Datamation to various sectors.

1.261 Indian Railways were one of the first major Public Sector
undertaking to introduce computerisation of data processing in their industrial activity. Its three major production units namely Chitraban locomotive works, Integral coach factory of Madras and Diesel locomotive works at Varanasi had switched over to computerised data processing during 1966 in the field of accounting, inventory control and production control activities. All these units together employed over 26,000 workers and the switch over to datamation was achieved without any labour trouble through proper motivation and education of the worker. It was realised all around amongst the workers that manual effort could never achieve instantaneous readjustment to changing situations where data regarding materials and output of machines and men was enormous. These men seemed to have realised that the computers had not only done them no harm but had actually worked to their advantage.

1.252 Achievements of the Indian Railways in introducing computers without any labour resistance could be attributed to three basic assurances offered by the management. These were:

1) No staff would be retrenched.

2) Present emoluments and even their prospects of future promotion would not be affected adversely.

3) No staff would be transferred from one station to the other on this account without their consent.

1.263 With the experience of the railways, other Public undertakings followed suit. By 1970, most of major Public bodies had introduced electronic data processing (Refer table 1.231). Major business houses were even faster in developing their computer capabilities. As computerisation of activities was the concern
of the top management, in most organisations, a major premium was placed on their understanding of scientific language and methodology for taking this decision. The issues which the top management were called upon to decide while taking a decision regarding various aspects of the management uses of the computer in his organisation, were:

1) Where would the computer be first used?
2) Who all will be involved?
3) How widely was it to be used?
4) How will the use be assessed?
5) How fast was its use to be extended?
6) In general, how could it be made most effective in the organisation?

1.27 Activities affected.

1.27.1 For examining the aforesaid aspects, the management had to draw extensively from past experience of Indian environment as well as of abroad. This required research into the existing information, one had to even study several modes to clearly understand the flaws in one's assumptions or arguments.

1.27.2 Two decades later now, we have the benefit of such experience and the top management of to-day can study this in consultation with the experts on the subject within their organisation and outside to spell out further details of policy which can help achieve the standards required. The gas policies for datamation laid down by Proctor and Gamble way back in 1964 are still quite relevant in to-days context. To quote from the above:

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Mr Lowry says:
"I shall begin my story with a touch of history. P & G created a Data Processing Systems Department in 1954. We had no particular knowledge or deep conviction at that time about the subject. However, some guidelines were laid down early by top management."

1. The department was to be a corporate one, centralising the study and application of computers, the installation and operation of system.

2. Investment in Data Processing System was to be subjected to same company approaches as were with other investment of assets:
   - Justification procedures
   - Rate of Return Criteria
   - Audit of actual results
   - A stepwise, prove it as you go, test market approach to systems expansion.

Whether these guidelines were laid down out of inexperience in the field or profound misdirection. I will say that they have served us well. To-day 12 plus year later, we still operate under these basic policies and see no need to change them.

As you might imagine, with such a hardened cautious approach, it was a while before we were even ready to take a first step. Methodology for design and installation of systems had to be evolved, and much preliminary study of flow of data took place, looking for a solid place to begin.

The company installed its first large scale computer in 1957 (an IBM 705). We had concluded by that time that's
We did not know how to design and install any kind of workable 'total system' - it was too big and too tough a bite, certain to produce indigestion.

We should build from the bottom up with 'subsystems' that could ultimately tie together into whatever kind of total system might be justified.

Unfortunately the top management in India has not always laid down such clear cut guidelines. They fail to realise that computer offers a new way of performing any kind of complicated organised activity with its special features as under:

1. They enable huge amounts of qualitative and quantitative data to be stored in a form in which access to the data is easy and instantaneous.

2. They possess a fantastic capacity to work on this data in whatever manner we would like to examine, process or relate it.

With these capabilities, the computer offered a mechanism:

a) To evaluate or simulate all the relevant permutations and combinations of alternatives available.

b) To enlarge the span of control of traditional management.

In its capacity to produce wealth or "addvalue" the computers produced a multiplier effect within the organisation as well as in the environment. Their use could eliminate wastage of resources under the Indian environment only when
its potentiality and limitations of the environment could be fully realised by the top management and guide lines laid down for its application accordingly.

1.276 The experience of a decade with the computers indicated that the Indian users had applied the computerised data processing in furtherance of the objectives such as:

1) Covering areas where the physical volume of work was beyond human capacity.

2) Areas which were critical to the successful functioning of the individual business.

3) Areas where the use of complex problem solving methods could yield better strategic decisions, or operating decisions, which have an important bearing on strategic decisions.

1.277 These objectives lead to the development of applications in 14 different areas of business activities as detailed in table 1.277, within the first decade of introducing computerised data processing in India.

1.278 While the objectives chosen for utilization of the computer power had been quite in keeping with the needs in of the day, the policies laid down by the top management had not been always beneficial for the long term future growth of the industry of the applications. Development of soft ware and system analysts were the major bottle necks in full utilization of the computer power. Proper orientation of executives and their correct response to automatic data processing also played an important role in the success of the new system. Employees displaced by introduction of computerised information processing
Table 1.277

Statement showing important computer applications & the number of organisation which have computerised them.

<table>
<thead>
<tr>
<th>Applications</th>
<th>No. of Units</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Public sector</td>
<td>Private sector</td>
<td>Total</td>
</tr>
<tr>
<td>-------------------------------------</td>
<td>--------------</td>
<td>-------</td>
<td>-------</td>
</tr>
<tr>
<td>1 Inventory control store accounting</td>
<td>16</td>
<td>13</td>
<td>34</td>
</tr>
<tr>
<td>2 Payroll accounting</td>
<td>15</td>
<td>16</td>
<td>31</td>
</tr>
<tr>
<td>3 Finance accounting</td>
<td>5</td>
<td>18</td>
<td>23</td>
</tr>
<tr>
<td>4 Production control &amp; Planning</td>
<td>6</td>
<td>10</td>
<td>16</td>
</tr>
<tr>
<td>5 Sales Statistics</td>
<td>2</td>
<td>10</td>
<td>12</td>
</tr>
<tr>
<td>6 Costing</td>
<td>6</td>
<td>5</td>
<td>11</td>
</tr>
<tr>
<td>7 Billing/Vouching</td>
<td>2</td>
<td>7</td>
<td>9</td>
</tr>
<tr>
<td>8 Mgmt, Inform, service</td>
<td>3</td>
<td>8</td>
<td>11</td>
</tr>
<tr>
<td>9 Traffic Freight accounting</td>
<td>9</td>
<td>-</td>
<td>9</td>
</tr>
<tr>
<td>10 R &amp; D ind. PRT</td>
<td>1</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>11 Wagon Movement</td>
<td>2</td>
<td>-</td>
<td>2</td>
</tr>
<tr>
<td>12 Linear Program</td>
<td>-</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>13 Design Calculators</td>
<td>1</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>14 Reconciliation</td>
<td>1</td>
<td>-</td>
<td>1</td>
</tr>
</tbody>
</table>

(Source: Report of the Committee On Automation, Govt. of India Ministry of Labour & Rehabilitation, pp. 166).
had to be absorbed in alternative jobs. Ability of the top management to lay down clear cut guidelines in their policy played an important role in the overall success or otherwise of the enterprise. All this could not be achieved without a clear understanding of the economics of datamation.

1.3 ECONOMICS OF DATAMATION.

1.31 The term ‘economics’ is the typically divided in two parts, macro and micro aspects of economy. The macro aspect deals with the large question, at the national level, what determines the gross natural product, the percentage unemployment, the overall price level or the consumer price index. This related to datamation means the effect, the computer produces on the economy of the country as a whole. In this study, no attempt is being made to examine the effect of computerisation on the national economy. Broad issues of development discussed earlier aims at focussing the attention of computerisation for the benefit of those who manage or set policies for the computer installation in a firm. The economics of datamation in this context, therefore aims at highlighting the microeconomic issues related with the process of datamation in a firm.

1.32 Resort to electronic data processing, or datamation as we might call it at micro level will amount to the design of a system application which will envolv a man machine interface, both having their own inherent characteristics. In any such design, care will have to be taken to utilise the high capacity of information handling capability of the computer and leave the conclusion drawing and decision making process to human intellect. The high cost of investment in the system, however,
implied that it was not enough to conform to the maxim only, while developing the application system. It was imperative to develop applications which also exploited economically this man-machine relationship.

1.33 A study of the marketing spectrum of the modern industrial environment might help us to assess the demand of data processing equipment in an economy. The economists' view is that the law of demand holds for virtually all goods and services. This view when applied to the demand of computer time, has its constraints. Once a particular application has been developed for computerisation one has no choice to change over to a different system on considerations of cost.

1.34 It is the combined efforts of the sales force and the technology which leads to the realisation of automatic data processing potentialities in initial stages. Obviously, it is not possible to realise the total potential of the system in stages. The portion of data that can be processed economically by machine at any time will determine the effective demand for the computer time. This effective demand will never increase the theoretical demand (which is the available computer time), though with the passage of time and experience, with datamation, the effective demand should approach the theoretical demand asymptotically. The rate of which the effective demand approaches the theoretical demand will be an indicator of the growth of the economy of the automatic data processing.

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2/Argument depends on assumption that the value of application is unaffected by its cost or that of any other application. An example can be cited of Ireland where the rise in the price of potatoes in 19th century increased its demand. Because of higher price of potatoes, peasants could purchase could purchase less meat, this in turn increased the value they assigned to potatoes, leading them to by more even at a higher price. This being an extreme case of 'income effect', could hardly prove relevant for the problems facing the computer scientists, yet drawing a parallel with this concept was not out of place as the demand for computer time once generated could not be set off only on considerations of cost.
1.4 MEASUREMENT OF WELFARE.

1.41 Economic growth of an organisation is not the only outcome of computerisation in data processing. Automation in information processing produced certain merits and demerits towards public welfare at large, while the private motive for automation could be increased profitability for owners, its impact on general public and the employees cannot be ignored. Evaluation of benefits or costs intended for the general welfare of population through the process of automation cannot be achieved through an economic analysis of the project.

1.42 While it was easy to measure the profit in monetary terms, it is difficult to measure the general welfare achieved through this process in precise terms. It is often so because at times the philosophical reason might assume greater importance than financial efficiency for incorporating the project of automation. Quite often politics, pressure groups or vociferous minorities might obscure important issues and force short sighted views at the cost of long term economy. An economic analysis could give us the degree of general welfare achieved through automation only to the extent of availability of monetary estimates. To take stock of the multipurpose public activities affected by the process of automation we have to resort to a systematic benefit cost analysis related with the rate of return of the project under study.

1.5 THE STUDY AND ITS RELEVANCE.

1.51 While the impact of automatic data processing on the economic growth of nations have been well established through the example of developed nations like that of Japan and West Germany during this era, quite a few apprehension have been
expressed regarding its benefits to societies where unemployment and underemployment of man power is the major problem facing the development efforts. The pessimists view in such situations emphasises that computerisation can reduce actual and potential employment in underdeveloped countries and will result in robbing the labour of its personality, creative effort and sense of achievement and will thus produce an effect to drag down the work itself to boredom. It is, however, possible to mitigate some of these evils if computerisation could bring about a rate of economic growth rapid enough to absorb the shocks and surpluses of such automation.

1.52 In a socialistic economy computerised data processing has been effectively used as an instrument of progress and has proved wholly beneficial to the people through its multiplying effect on the speed of production and distribution of social wealth, thus lowering the prices to consumers and shortening the working day causing reduced work load. Its use ultimately results in the more free time for leisure and cultural pursuits leading to a richer better and higher social order which should be the main aim of all scientific and technological evolutions.

1.53 In a capitalistic society where all production and distribution activity is dominated by profit motive, the computer power might become the tool for increased exploitation of the worker, without producing much social benefits. Where

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Computer aided automated production has helped the developed countries like USA to adopt a five work days a week and thus increase the leisure of workers.
the ownership of capital is in the hands of monopolists, larger houses alone could be in a position to install computers. The resultant advance of technology is not always geared to curbing prices but to increase profit and thus possible exploitation of the worker and the consumer.

1.54 In the mixed economy, adopting a mid course path between the two, it is not easy to assess the impact of computerisation on the society as such. While the use of computers and its resultant automation by monopolistic homes might lead to increasing unemployment, greater work load and fatigue to workers, the state control on the computer power might lead to the benefits characteristics of socialistic societies. In such situations only a proper cost benefit analysis of the individual problem could lead us to the correct evaluation of our decision models leading to the overall benefits to the community through automated data processing. Hence this study.

1.55 The relevance of this study therefore lies in developing a concept for cost-benefit evaluation of data automation which could lead to the development of a cost-benefit model for evaluation of the decision making process for automatic data processing. Through this process, one could aim at achieving operational savings, by way of improved service, reduced inventory cost, lower production cost and reduction in personnel cost.

1.6 BROAD METHODOLOGY

1.61 Study is conducted in two parts. The first part of the study relates itself to the development of the concept of cost-benefit analysis after a detailed literature survey. Importance
of technique of cost-benefit analysis over other techniques of economic analysis is examined in this part. Techniques of project development for datamation and principles of evaluation of benefits and costs of datamation are highlighted. Finally a suitable model for evaluating the investment decision policy for datamation is discussed.

2.62 Part second of the study deals with a case study applying the concepts and thoughts developed in the first part to a real life problem of datamation. Starting with a brief history of datamation in a chosen organisation, the case study examines the motivation for datamation and how the project of datamation develops replacing the old scheme and how the technique of cost-benefit analysis is applied for its evaluation to determine the most economical level of operation.

2.7 SCHEME OF CHAPTERS

2.71 The study is recorded in eight main chapters as follows. The first six chapters of the first part of the study deal with the theoretical aspects of the concept development. The case study, which forms the second part of the study, forms a single main chapter after the concept development in chronological order. For the sake of convenience of presentation, this main chapter has been further sub divided into five small chapters. These sub chapters have been assigned roman numerical numbers to give them a separate identify from main chapters. The final chapter deals with the policy implications and conclusions of the study. Detailed scheme of these chapters is as follows:
1.711 Chapter 1 introduces the subject starting with a brief 
backdrop of historical development of computers and automatic 
data processing. A macro level development of A D P in Indian 
environment has also been discussed. Relevance of the study 
has been discussed in light of the impact of computerisation 
on various economic systems. Importance of cost-benefit 
approach, for correct evaluation of decision making process 
in the field of automatic data processing has been stressed.

1.712 Review of literature, giving a critical appraisal of 
various applications of cost-benefit technique in previous 
works in covered in chapter 2. The importance of this tool 
of analysis in evaluation of projects, choice of projects 
under uncertainties and ranking of the alternatives available, 
has also been discussed at length. This chapter also brings 
cut a critical appraisal of the technique of cost benefit 
analysis in helping the decision making process in cases with 
multiple objectives. The relevance of applying this technique 
of analysis for decision making in a project off datamation, 
where value judgement coupled with multiplicity of objectives 
are the characteristic qualities, has been cited.

1.713 Chapter 3 of this part elaborates on the other areas 
of project analysis, and highlights the limitations of commer-
cial, social or economic profitability analysis in dealing 
with a project on datamation. Concept on structure of benefits 
and measurements of true worth of the project through the 
evaluation of net benefits, as applied to the particular 
project has also been developed.
Chapter 4 of this part carries out a study in depth, of the various aspects of developing a project for automatic data processing. Starting with the micro analytic aspects of project development, which deals with the details of the system development and engineering aspects of automatic data processing, this chapter goes into the depth of selection of equipment techniques, and design of organisational set up and its structural evaluation. Concept on structure of benefits and measurement of true worth of the project through the evaluation of net benefits, as applied to a project on datastoration has also been developed. Finally the problems faced in measurement of benefits and costs of the project and how they could be overcome are highlighted.

In application of the tools of cost-benefit analysis, the evaluation of benefits and costs plays the most important part. Chapter 5 deals with the selection of cardinal measures for evaluation of costs and benefits of datastoration, and procedures adopted for their assessment. The inherent problems of estimating the costs and benefits, particularly where the unquantifiable factors like attitude of management are involved, have also been highlighted. Finally this chapter deals, with the importance of proper selection and application of weights to the assessed benefits and costs, and how the application of this technique becomes relevant to automation.

Finally the theoretical aspects of concept development for the application of cost-benefit technique for evaluation of a project in datastoration terminates into the development of a model as discussed in chapter 6. Stressing the importance...
of allocation of scarce resources on accrued benefits, how net benefits are affected by individual preferences, this chapter goes to develop a 6-shaped model for relating the benefit accrued through datamation with the investment costs. A flow diagram of cost benefit model of datamation is also described.

1.717 The 7th chapter dealing with the case study applies to the concepts developed earlier to a real life problem at the micro level for formulation and evaluation of a project on computerisation pertaining to M/s Sharda Mills*. This case study is divided into 5 sub chapters as follows:

Sub Chapter (i) gives a brief history of development of automatic data processing in M/s Sharda Mills. The errors committed in the initial stages due to lack of proper planning and preparation are highlighted. Improper selection of equipment leads to frequent changes and uncalled for conversions. The problems encountered in preparation of input data and benefits accrued through computerisation are highlighted.

Computerisation of data processing has many motivations. The factors that lead the management to making an optimal decision for going for an inhouse computer are discussed in sub chapter (ii) of case study.

The (iii) sub chapter of the case study deals with the mechanics of developing the new system. How a planning for the future, based on well defined objectives, with clear cut assessment of resources at the disposal, could lead to a well formulated plan. The technical requirements had to be assessed before implementation of the plan; training of users, testing of the system have all been discussed at length.

* The name is hypothetical. Data collected for this study was from a commercial firm but for obvious reasons the firm did not want its name to be disclosed.
Evaluation of the project formulated earlier is the subject of the study for sub chapter (iv) in this part. Collection of data, assessment of costs, benefits and life of the project and how these have been applied to evaluate the project are discussed at length. Finally the chapter highlights the procedure adopted for the analysis using the costs yield differences of benefits and costs and the cost-benefit ratio. Impact of this analysis on the 's' shaped model developed earlier is tested.

Finally the case study closes with sub chapter (v) where the results of the analysis are discussed and findings summarised. Starting with a brief discussion of theory and assumption for analysis, applicability of the model is discussed. Justification of benefits, incremental benefits and costs and the benefit-cost ratio all go to prove that the project was a profitable one. The broad findings of this study as related to the particular case are also highlighted. 1.718 The broad conclusions and policy implications of the study are highlighted in Chapter 8.