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MUHAMMAD ASAF KHAN  
DEPUTY CHIEF (STATISTICS)

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SIGNIFICANCE OF DATA

The need for collecting data is as old as the world itself. In the earlier days there was need to count the family members, the total inhabitants of a country etc. On small scale, in the family there was an imperative but unconscious counting of the family income, expenditure, ages, and other such characteristics which were basic to run the affairs of the house hold. The state gradually started collecting information in respect of its assets such as number of persons, agricultural produce, cattle and other sources of wealth. The inherent instinct of human being to expand his domain also compelled the earlier rulers to keep an up-to-date inventory of its combatant resources to assess their capabilities of defensive as well as offensive position.

With the development of knowledge and gradual increase of the population, it became imperative for any state administration to have complete and up-to-date information on each and every aspect of its resources. The internal and external trade was a direct result of assessment of the national/regional surpluses and short-ages of various commodities and services.

With the development of industrial technology the pace of production was accelerated manifold, which necessitated the assessment of the internal demand and as well as exploration of external markets. In order to make such a complex exercise it became necessary to

that the data are not an end in themselves but are means  
statistical services. However, it may be clearly understood  
made great efforts to develop and improve their national  
data produced in all parts of the world. Governments have  
development in the quantity and quality of the statistical  
In response to the demand there has been a rapid  
and control of the operation of society.  
fact, have become essential to the understanding, assessment  
solving national and international problems. Statistics, in  
for precise and timely statistical information as an aid in  
within and beyond national frontiers, has stimulated a demand  
dependence of economic, social and political factors, both  
tics in almost all human activities. The increasing inter-  
there has come about a steady growth in the need for statis-  
states and of the scientific approach to their problems,  
ments has been collected. With the development of modern  
of quantitative information on matters of concern to govern-  
In short, from a very early date, certain amount  
effectively.  
receipts, expenditures, liabilities etc. to run its affairs  
this, the state also started collecting information on its  
income during the particular period of production. Beside  
the sale of its produce to have an idea of its profit or  
diture incurred, raw material used, and the income through  
employees, machinery, production, man-hours worked, expen-  
own system of collection of information regarding their  
The producing and consuming establishments evolved their  
production, demand and purchasing power of the masses.  
collect elaborate information in respect of consumption,

to an end. Data have to be organized, manipulated and presented in some meaningful manner to the decision makers, to take decision for efficient working of their affairs. This manipulation of data has given birth to the science known as statistics. Thus we speak of employment statistics, accident statistics, road statistics, vehicle statistics, passenger miles statistics, etc. Statistics plays an increasingly important role in the nearly all phases of the State the sphere of statistics has now spread to agriculture, biology, business, communications, transport, economics, education, chemistry, electronics, medicine, physics, political science, and engineering. The statistics serve as base for the formulation of various development and other plans for the country. The government cannot make their plans objectively unless it has all the relevant data on various sectors of economy such as agriculture, mining and quarrying, manufacturing, construction, energy, transport and communications, whole sale and retail trade, banking and insurance, public administration and defence services.

The benefits which generally accrue by utilization of data in decision making are broadly summarized as under:

1) Statistics help in presenting an unwieldy mass of information in simple, definite and classified form. If wage-sheets of all the two thousand workers in a mill are given, it is impossible to form a correct idea about them from these sheets. But if they are tabulated and summarized, definite information will be easily available. It has, therefore, been said, "By the use of statistics we obtain from millions of facts the grand average of the world".

Statistics furnish us with methods of comparison such as different forms of averages, graphs, coefficients and become very easy to compare, weight and judge them in the right perspectives. Income per capita in different countries, ages at deaths, incidence of taxation, literacy and unemployment etc. can be compared with advantage.

(i)

Statistics also help in ascertaining conditions of relationship e.g. there are some factor such as rainfall and yield, supply and prices which bear relation between such factors. Once the normal difference of correlation is ascertained, the effect of statistics, efforts can be made to establish correlation in one can be easily seen in the other.

(ii)

And lastly, statistics endeavour to give material for planners as well as administrators to serve as guide in planning as well as in shaping policies for the future.

(iv)

### Role of Statistics

With the increasing demand for minute details of information on various aspects of economy, various techniques such as Simulation, PERT (Project Evaluation and Review Technique), CPM (Critical Path Method), System Analysis, Operation Research and other Decision making theories have been developed in statistics which have made possible to analyze even the minor effects of various inputs in the process of production and consumption. In earlier days it was very difficult to make detailed analysis owing to the lack of computing machinery but with the invention of computer a revolution has come in the field of data processing. Computer has made possible to calculate details to any extent required. Data can be stored for a longer time and can be updated, deleted and substituted with simple procedures.

In view of the developments, both in techniques and in machinery, every aspect of social, economic and human life is being planned on the basis of the pattern exhibited in the past.

The importance of statistics can not be over-emphasised but some of its significant features are given below:

- i) Statistics simplifies great bodies of numerical data by constructing out of them some representative quantities such as mean, standard deviation, correlation co-efficient, etc.
- ii) It permits the most exact kind of description, thus bringing the matter within easy comprehension.
- iii) It enables us to draw general conclusions, and to make prediction for future under given conditions.
- iv) Statistics are an unavoidable necessity for an efficient running of governmental machinery.
- v) Planning without statistics is impossible.
- vi) Statistics reveal the nature and pattern of the variations of a phenomenon through numerical measurement. In short, statistical method is one of the devices by which man tries to understand the generality of life.

### ROLE OF STATISTICS IN PLANNING:

PLANNING is a process through which priorities of various sectors are fixed keeping in view the available resources. Planning in Developing Countries is a very difficult process. On one hand, the financial as well as human resources are very scarce and on the other precise information regarding the actual resources is not available. Since the developing countries cannot afford to base their development plans on incomplete, vague, and imprecise



Also mere collection of data is not and should not be treated as statistics. It is the application of mind using the statistical methods to data which converts raw information into statistical information. For instance, the preparation of land revenues records has been a major data collection activity but has never been subjected to evaluation and statistical analysis. The same could be said about many other fields.

The science of statistics is very useful but the value and uses of statistics do not lie in figures themselves, but in the conclusions to be obtained from them. Misuse of statistics by interested parties to serve their ends, has brought considerably bad name to this useful science. But it must be remembered that statistics cannot bear, on their face, the stamp of their quality. The statistics are only as good as the integrity of the person who compiles them.

#### LIMITATIONS OF STATISTICS:

Information, the need to collect information of each sector in depth and to make the decisions on the basis of the data so collected is imperative.

TRANSPORT PLANNING IS AN INTERNAL PART OF THE  
WHOLE PROCESS OF PLANNING AND IT IS IMPORTANT THAT IT IS  
UNDERTAKEN ON A BROAD SCALE, ENCOMPASSING WHOLE AREAS.  
DEVELOPMENT OF TRANSPORT IS A CONTINUING PROCESS AND  
THEREFORE THERE IS A CONTINUING NEED FOR TRANSPORT PLANNERS TO  
PLAN AND MONITOR THE RESULTS.  
TRANSPORT IS A MAJOR PART OF THE PRODUCTIVE  
INFRASTRUCTURE OF THE COUNTRY. THERE IS NO OTHER SECTOR  
OF THE ECONOMY WHICH HAS SUCH BROAD AND SO MANY INTER-  
RELATIONS AND LINKS. BY INTEGRATING SEPARATE SECTORS OF  
THE ECONOMY AND LINKING ECONOMIC REGIONS, IT CREATES THE  
POTENTIAL FOR BROAD SPECIAL AND PRODUCTIVE DIVISION OF  
LABOUR. THE SOCIO-ECONOMIC DEVELOPMENT OF A NATION CAN  
BE MEASURED IN TERMS OF ITS MOBILITY. ALSO THE GROWTH OF  
PRODUCTION, INCREASE IN PER CAPITA INCOME AND THE BROAD-  
ENING OF FOREIGN TRADE RELATIONS ALONG WITH SPECIALIZATION  
AND CONCENTRATION OF PRODUCTION AND CONSUMPTION CENTRE.  
LEAD TO A STEADY INCREASE IN THE OVERALL TRANSPORTATION.  
TRANSPORT CAN NOT BE DEVELOPED WITHOUT A PROPER STATISTICAL  
BASE.  
TO ACHIEVE THIS OBJECTIVES, DETAILED STATISTICAL  
INFORMATION HAS TO BE COLLECTED AND UTILIZED FOR MAKING ANY  
DECISION. UNFORTUNATELY AT PRESENT, THE SIGNIFICANCE OF  
STATISTICAL DATA HAS NOT BEEN REALISED BY THE ORGANIZATIONS  
AND INSTITUTIONS CONCERNED WITH THE OPERATION AND PLANNING  
OF THE TRANSPORT SECTOR.

1. ROLE OF TRANSPORT IN THE NATIONAL ECONOMY:

TRANSPORTATION

1. Total mileage of roads by category and classification under Federal/Provincial Government.
2. Inventory of road making machinery and information on various characteristics thereof.
3. No. of vehicles by type registered/on road.

ROADS AND ROAD TRANSPORT.

The requirements of data in the field of Transportation may be summarised as below:

behind. data presentation, but unfortunately we are lagging far behind. progress in the areas of data collection, data processing and constant and conflicting. Other countries have made lot of in isolation from each other and therefore, are often in- most cases the data is being collected by some organizations rendered it almost un-useable in the planning process. In lacks coordination and uniformity of standards, which has ation. Whatever data is available with some organizations, reliable statistics particularly in the area of transport the desired objectives. At present we lack upto date and considerable amount of effort needs to be put in to achieve both from manpower point of view and money. Therefore Data collection is time-consuming and expensive

the objectives of a particular situation or need. the detail in which it is presented varies according to amount of data. The amount of basic data collected and planning involves the accumulation of a considerable The transportation planning like any other

REQUIREMENTS OF TRANSPORT DATA.

1. Total rolling stock by category in fleet.
2. Total rolling stock by category on line.
3. Number of passengers carried and passengers kilometers travelled.
4. Freight carried in tonnes & tonne kilometers.
5. Average turn-around time.
6. Average kilometer per wagon per day.
7. Average load carried per wagon.
8. Average trip length i.e. average distance travelled per passenger per journey.
9. Peak month traffic - both passenger and freight.
10. Vehicle kilometers per vehicle on the line per day.
11. Locomotive kilometers per day for locomotive by category and type.
12. Average number of passenger/freight coaches per train.
13. Average number of passengers per passenger coach.
14. Average tonnage hauled per freight train.

RAILWAYS:

- i) No. of vehicles in fleet by make/model
- ii) No. of vehicles on road by make/model
- iii) Kilometers operated-urban/intercity.
- iv) Passengers carried and passenger kilometers travelled.
- v) No. of serviceable vehicles
- vi) No. of vehicles scrapped.
- vii) No. of vehicles added to the fleet.
- viii) Operating costs per seat kilometer.
- ix) Fuels, Tyre/Tubes, Maintenance cost, etc.
- x) Wages and Salaries.
4. No. of vehicle by type by Tax paying/not Tax paying.
5. Import/sale of vehicles by type.
6. Taxes and duties realized by type of vehicles.
7. Road Transport Corporation.

- 3. Total no. of ships in the fleet by type and DWT.
- 2. Total capacity and % avg. utilized by category.
- 1. Total no. of freight by type carried.

SHIPPING:

- 8. In-coming and outgoing passengers handled.
- 7. Gross revenue earned and expenditure.
- 6. Number turn around time of ships.
- 5. Average turn around time of ships.
- 4. Average number of ships in queue, with maximum and minimum length of queue.
- 3. Average waiting time of ships.
- 2. Number of ships entering/leaving the ports.
- 1. Cargo handled by type.

PORTS:

- 1) Rehabilitation and improvement of track.
- 11) Construction of New Lines.
- 111) Repair and reconditioning of lines.
- 1V) Manufacture/Acquisition of lines.
- V) Re-stocking and repair of rolling stock.
- VI) Construction of terminals, building and other facilities.
- VII) Capital at charge.

- 15. Average speed per train.
- 16. Number of employees by category.
- 17. Gross revenue.
- 18. Operating and maintenance expenditure on rolling stock:-
  - 1) Fuel consumed
  - 11) Maintenance cost.
- 19. Wages and salaries of staff.
- 20. Total expenditure.
- 21. Developmental expenditure and physical achievements of:-

1. Number of Civil Aircrafts by type in the Country.
2. International and domestic passengers carried and number of passenger kilometers.
3. International and domestic freight carried and number of tonne kilometers.
4. Imports and exports of freight by all airlines.
5. Movement of International Passengers by PIA Vs Others, to and from Pakistan.
6. Operating costs of PIA:
  - i) Fuel
  - ii) Chartering
  - iii) Repairs and sundries
  - iv) Landing fees, etc.
7. No. of employees of PIA by category/occupation.
8. Total wages paid.
9. Gross revenue.
10. Number of airports (International, Jet, Non Jet, Landing strips).
11. Landing fee charged.
12. Revenue from Landing fee etc.
13. No. of Civil Air Craft: Over-flying Pakistan without Landing.

CIVIL AVIATION:

6. Number of employees by category of Pakistan Shipping companies.
7. Total wages paid.
8. Gross revenue earned.
4. Imports and exports by type of cargo carried by all international carriers to and from Pakistan.
  - By foreign ships
  - By Pakistan flag carriers
5. Operating costs of national ships:
  - i) Fuel costs
  - ii) Repairs and sundries
  - iii) Port expenses.

working under the Planning and Development Departments for the collection, and compilation of data in various At provincial level, Bureaux of Statistics are

#### II) BUREAUX OF STATISTICS:

the field of transportation is very inadequate. transportation as well but at present supply of data in and if properly coordinated it can be used in the field of large field organization to collect data at national level not been adequately covered. Statistics Division has a etc. but there are many areas including transport which have in the field of trade, prices, national accounts, labour Statistics. Although they are producing lot of statistics agency at the federal level assigned the character of In Pakistan, Statistics Division is the main

#### I) STATISTICS DIVISION

in brief as follows:  
concerned with specialized transport sectors are described in the past without sound foundation. Certain organizations of data the plans in these sectors had mainly been prepared collection of the above required data. Due to the paucity Transport sector has lacked till today in the dated in the transport research organization. variables are required to be collected, organized and up- agricultural commodities, and other social and Economic with urban/rural breakup, production of agricultural/non- statistics on population by administrative levels of areas, Apart from the above listed data requirements, the

sectors. There are also statistical/research cells in

various organizations/departments which produce statistics in their own area of interest as a part of their administrative activity.

### III) CENTRAL ROADS ORGANIZATION

Central Roads Organization (CRO) of Ministry of

Communications collect some data from various departments on roads, vehicles and accidents, but this is not comprehensive. The CRO bases its compilation on the reports received from the provincial departments of Highways, Excise and Taxation, and the Traffic Police. Two separate forms (Annexure: 1 and 2) are used for the collection of data by the Highway Department, District Councils, and Municipal Committees and Town Committees. The data is collected on various characteristics like name and location of roads, type of surface, width of surface, total length, name of the District in which located. Data is also collected on roads constructed during the year; roads under construction; and improvements including widening, reconstruction, resurfacing, etc. carried out during the year. Moreover inter-agency transfer of roads and data on road expenditure (construction and maintenance is also collected. CRO has been collecting this data since 1967. However, there are a no. of discrepancies and gaps in the data collected so far. The information thus collected is inadequate to meet the transport planning needs.

The data regarding road and road transport as

compiled by the CRO suffers from the following:-

1) Inventory of roads has not been prepared with detailed information on various characteristics.



11) The provinces do not supply the information about all roads or regularly inform about the changes occurring during a year.

Similarly the data on motor vehicles registration and motor vehicles on roads are compiled from the information supplied by the provincial transport authorities. All provinces do not supply the information according to any standard format. The Punjab authorities compile detailed classification but other provinces do not tabulate the information in such a manner.

The data on accidents are compiled by CRD from the reports received from the directorate of the Police in the provinces. The variables for collection of data are fatal, non-fatal and other accidents; No. of persons killed and number of persons injured.

RAILWAYS:

Railways has been a very important mode of transport in Pakistan. It came into existence in May, 1961, when Karachi was linked with Kotri. Over the subsequent years the network expanded quite rapidly. The present track kilometer and route kilometer totals 12514 and 8815, respectively.

Pakistan Railways is doing its job in respect of statistical reporting better than any other transport agency. They publish year book which contains sizeable information. But this information needs to be re-organized for various analytical purposes. More performance indicators such as operating cost per seat-kilometer,

number of employees per 100,000 passengers carried etc. need to be collected for comparison with other modes of transport for planning purposes.

CIVIL AVIATION

The planning directorate of Civil Aviation has also made one time effort of publishing data on a few variables for the period of 1970 to 1976. They collect information for PIA and for the airport authorities in the country. The PIA collect a lot of information on passenger kilometers route kilometers flown, freight handled etc. but it is not published in a systematic manner. There is need for collecting, compiling and analysing the data on all aspect of Civil Aviation on continuing basis.

PORTS:

Ports in Pakistan have lot of activity but do not publish the amount of data being produced by them as part of their operational activities. They put forward data on a few indicators like freight handled, gross revenues earned and expenditure; incoming and out going passengers handled, etc.

SHIPPING:

Statistical reporting in the area of shipping is even in worse shape than the ports in Pakistan. Shipping authorities have lot of statistical information on freight

There are a number of methods of collecting information: mail questionnaire, personal interview, direct observation or laboratory test. The decision as to which method is the best will be governed by the nature of information sought and the population under survey. A brief discussion of these methods is given below:

#### METHODS OF COLLECTING DATA:

data. the sake of collecting and disseminating authentic and valid and uniform concepts and definitions will be deployed for be developed in collaboration with transport organizations all modes of transport. Standardised reporting forms would existing in almost all the statistical series in data for NTRC by doing so would bridge the gap presently in the country and other organizations related with Transport. collected by NTRC with the help of the Transport Agencies the transport agencies to plan objectively. The data will be lishing a Data Bank with common data base in order to help N.T.R.C. has assumed the responsibility of estab-

#### NATIONAL TRANSPORT RESEARCH CENTRE:

reports which can be used as input to planning efforts, etc. but about nothing is published in the form of and receipts), their employees by occupational categories turn around time of ships, break-up of revenue (expenditure carried by type of freight, capacity utilization of fleet;

MAIL QUESTIONNAIRES:

A questionnaire is prepared on the subject matter of the survey and mailed to the respondents. The respondents are required to record the necessary items of information. This method is generally cheaper and quicker as regards the collection of information than the direct observation or the interview method, provided that the rate of response is adequate and the recording documents are returned within a reasonable time. The major cost is postage stamps, which should be quite small. If the respondents have the information and are interested in the purpose of the survey, the response can be quick. This method is particularly useful when you want to reach the members of an association who are usually spread over an entire country. And since the respondent provides information unaided by the interviewer, the well known biases of the interviewers and their whimsical interpretation of the questions do not enter into the results obtained. Furthermore, there are situations in which a considered answer is needed, for example, when an establishment is asked the value of inventory or the cost of raw materials used. In this case the respondent needs time to consult documents to give an acceptable answer. A mailed questionnaire provides the opportunity for such consultations. And then there are questions which one is prepared to answer through the mail. In all these cases the mailed questionnaire appears to be a convenient vehicle for collecting the information. On the debit side, one cannot ask all sorts of questions through the mail. Unless the question is simple

introduces systematic errors in the results.

often differ from the respondents in many respects. Their exclusion will  
Experience of data collection in several fields shows that the non-respondents  
which are 40 percent and base the results on the respondents alone.  
rate up to 60 percent. One cannot simply ignore the non-respondents  
be barely 40 percent, and repeated reminders may push this  
care to complete and return it. The initial response rate may  
When a questionnaire is mailed, many of the respondents may not  
technique in the amount of non-response present in such surveys.  
The greatest drawback in the mailed questionnaire

errors without divulging the truth.

can read through the completed questionnaire and correct any  
erently in different parts of the questionnaire. The respondent  
to cross check the response by putting the same question diff-  
this in a mailed questionnaire, and then you may not be able  
own view one is interested in. There are no means of ensuring  
friends and report the consensus of opinion. It is the person's  
individual to discuss the subject with members of his family or  
times, as in opinion survey, you do not want the selected  
into regular correspondence with you on the subject. Some  
final since ordinarily the respondent will not want to enter  
respondent. In a mail survey the response has to be taken as  
again and again, thereby arriving at the final response of the  
confusing. In an interview you have a chance to explain yourself  
ionnaire, but this may not be noticed or may be found to be  
to explain the technical terms used at the back of the quest-  
stand the question and that brings about errors. You may try  
and straight forward, the respondent is likely to misunder-

The manner of asking the questions and the probes to be used  
But the exact questions to be asked are not standardized.  
schedule and information is to be collected on these items.  
In the other method a list of items is recorded on the  
put the questions to the respondent in questionnaire method.  
and the interviewer is required to follow the same wording,  
one method, a standard set of questions has been prepared  
from the units in the sample by the method of interview. In  
There are two ways to collecting the information  
of the interviewer in eliciting worthwhile response.  
less. The success of the survey depends heavily on the skill  
collected without the help of the interviewer is probably worth-  
and many people cannot think in numerical terms. Any data  
population is illiterate, very few records are kept of any kind  
oping countries. In these countries a sizeable proportion of the  
of measurement in household surveys, particularly in the devel-  
or direct interrogation method. This is the most common method  
from selected individuals is known as the personal interview  
and well trained interviewers call upon and solicit information  
The method of direct investigation in which skilled

#### INTERVIEWING:

samples are combined suitably.  
from the 40 percent that had not cooperated, and the two  
through the interview method are treated as random sample  
their command to obtain a response. The responses obtained  
the information. The interviewers use all the persuasion at  
take a small sample of them and send interviewers to collect  
One method of handling the non respondents is to

it is worthwhile to resort to the record schedule system. meaning, it is advisable to use standard questions; when not, are familiar to ordinary people and convey some standard Nothing could be further from the truth. When the questions the recording schedule will be free of interviewer bias.

This does not mean that the data collected through used to obtain something worth-while. to work; it is the recording schedule which will have to be In such a situation the questionnaire method is not expected be presented to him to place him in the proper age group.

is desired to be measured. A calendar of events may have to at variance with what is meant by such terms, and with what meant by such terms. His understanding may be completely

that the respondent may have no clear-cut idea of what is conditions prevailing in the developing countries are such holding find a place on the list. The social and economic

ment, gainfull activity, and operation of an agricultural plans for national development. Thus, items such as un-employ- is quite sophisticated; such information is needed for making

The kind of information usually collected these days to decide. This may be called the recording schedule method. for eliciting acceptable response are left to the investigator

## DESIGN OF FORMS:

The problem of the design of forms, questionnaires or recording schedules should be discussed as soon as the planning of the survey starts. This is one of the most important aspects of the survey. The layout will depend upon the type of form. If it is a questionnaire to be answered by the respondent unaided, the form should be attractive looking. The questions should be simple and clear. The number of questions should be reduced to the barest minimum. There should be proper space for recording the answers, especially when the "other" category is to be specified. In a recording schedule, attractiveness is not a major consideration: field handling is more important. In either case there should be proper space for entering the codes, say on the right-hand corner, for facilitating the job of the punch operators. If different parts of the form are to be answered by different categories of the population, this should be spelled out very clearly. Experience shows that it is very helpful to divide the form into three parts; one giving identification particulars of the respondent, the other giving classificatory information, and the third the topics of the survey.

## QUESTION ORDER

Careful consideration should be given to the problem of the order in which the questions should appear on the form. In order to guard against confusion and misunderstanding questions should be arranged logically; one question leading to the next. Specific question should follow general one. The opening question should be very interesting; this



of his production last year. But can he answer this question  
whether they are sufficiently informed on the subject of invest-  
ment in a developing country the value  
The study director must make sure whether respondents  
are in a position to answer the questions being considered,  
about birth control measures.

by the President was helpful or what the respondent think  
opinions or attitudes such as whether yesterday's radio talk  
expenditure for food last week. Other questions may relate to  
factual such as the number of persons in the household or the  
the information to be collected. Some of the questions will be  
the questionnaire keeping in mind the needs of the survey and  
The next step is to decide what should go into

QUESTION CONTENT

in the field.  
of the interviewer who has to bear the main brunt of the job  
questions should be determined keeping in view the convenience  
certain subject can be asked. By and large the sequence of the  
such as the income of the respondent or his knowledge of a  
this has been done, other questions of a more intimate nature  
interviewer can establish a rapport with the respondent. When  
the end. The first few questions should be so designed that the  
response on the succeeding questions, it should be relegated to  
is any question which is likely to affect adversely the res-  
should admit of simple answers of the Yes or No type. If there  
dull and difficult question. As far as possible the questions  
respondent is likely to be put off if you start badly with a  
will ensure that the respondent cooperates in the survey. The

Labour force. The result is that the data obtained by asking this question can be considerably biased. Furthermore, it is difficult to interpret the classification obtained thereby because each respondent will have a different concept of what is meant by "employment".

The basic principle in good question wording is to use the simplest words that will convey the exact meaning. The meaning of the question becomes clear when the words used are well known and mean the same thing to every-one. The question "Do you operate land?" used in some agricultural surveys is poor. It is not clear whether the person is supposed to be cultivator or an owner of the land. The question "At what time do you go to bed?" should be preferred to the question "At what time do you consign your limbs to sleep?" Again, consider the question "What kind of a house do you have?" The answer may be, beautiful or three-storied or cement painted or commodious and so on.

Leading or loaded questions should be avoided. Such questions are slanted toward a particular kind of answer and therefore can mislead the respondent. If you ask a person, "Do you not work for a living?" the obvious implication is that normally everyone is supposed to work for a living and that the respondent is not expected to be an exception. The answer is very likely to be "Yes, of course. I work for a living" although the respondent may be a housewife looking after the children. The same type of remarks apply to the question, "What brand of cigarettes do you smoke?" This question assumes that the respondent is a smoker and that the only further information needed is the brand of cigarettes. Similarly, questions of a hypothetical nature should be

automatically coded, and the answers are given in a frame of

questions, the responses are easy to analyse since they are

In the case of the closed or fixed alternative

Do you think the present government is doing a  
good job?

What is the total area of this holding?

responses as it given. Examples, of this type of question are:

should take. The job of the interviewer is to write down the

which the respondent is free to decide the form the answer

type of question. On the other hand, an open question is one in

The box actually checked is the answer to the closed

/4/

/3/

/2/

/1/

Single Married Widowed Divorced

What is the marital status of this person?

No /2/

Yes /1/

Do you own a car?

alternatives:

question is one in which the responses are limited to stated

may be divided into two categories. A closed or fixed-response

With respect to the form of response, the question

QUESTION TYPES:

question to produce better results.

whether to ask a more personalized or less personalized

Furthermore, the investigator will have to decide

will say "Yes".

by tabulating an answer to such questions. Almost everyone

offered one?" is obvious. No useful purpose will be served

avoided. The answer to "Would you accept a better job, if

reference that is relevant to the purpose of the inquiry. This form should be preferred when the range of possible answers can be adequately visualized. But care must be taken to ensure that the list of alternatives is exhaustive. The usual practice is to make the list of alternatives and with the "other" category to make it exhaustive. The main disadvantage of this system is that answers may be forced into a category to which they do not properly belong. This happens when the respondent does not know the answer to the question and is forced by the interviewer to fall in line with one of the alternatives. The interviewer may not like to put the respondent in the "do not know" class. When the respondent wants to give a qualified answer, the interviewer may not accept it since there is no room on the questionnaire to record such an answer. Another disadvantage is that the respondents tend to follow the middle course when they are given a choice between a number of answers.

With the open-ended questions the respondent is given the opportunity to answer in his own terms and in his own frame of reference without being encumbered by a list of alternatives. The coding of these answers can be done later in the office in a standardized manner. Experience, however, shows that it is not always easy to code such answers. Sometimes a reference may have to be made to the respondent to find out the exact code to be used.

To summarize, closed questions should be preferred when the possible alternatives are limited, known, and clear-cut. This is so when you are dealing with factual information

such as age, marital status, or level of education. When the issue is complex or the relevant dimensions are unknown (as with many questions relating to opinions or attitudes), the open type of question may be used with advantage. Indeed, one may begin with an open type of questionnaire and gradually develop a closed type of questionnaire when greater information is available regarding the form of response.

METHODS OF COLLECTING DATA  
FOR TRANSPORT PLANNING

Transport Planning process involves the accumulation of considerable amount of data. In addition, to the earlier

described data needs on roads, vehicles, railways, shipping, ports, civil aviation, data on present day travel pattern in the areas to be studied must be collected. Data on future land use, population, existing trip facilities need to be collected. Different surveys necessary to collect the basic data are time consuming and expensive. Therefore, careful programming of the collection of data is required to assemble the data quickly and efficiently.

The study areas need to be defined. For effective processing of the surveys the entire country would be needed to be divided into zones, for which a coding scheme is required. This coding scheme should define all areas precisely from highest to the lowest tier, which is essential in view of the usage of the computer for analysing the results and preparing cross tabulations. It would facilitate the collection and use of basic traffic data for research purposes.

TRAVEL PATTERN DATA:

Travel pattern data is required for four basic movements.

- a. External - Internal movements
- b. External - External movements
- c. Internal - Movements
- d. Internal - External movements

All these types of movements can be made by different

modes and depending upon the purpose of the study this movement data shall be collected for private motor vehicles, public transport, commercial vehicles, etc.

The only satisfactory method of determining the origin and destination of through movements, and external - internal movements across the external cordon, is to question the persons actually making the movement. In transportation studies this is normally done by direct interview, or issuing pre-paid

GORDON SURVEYS - EXTERNAL:

trips passing through or into the area. Interviews are carried out on the external cordon line to cover to determine movements originating within the area. Roadside interviews, commercial vehicle and public transport surveys defined by the external cordon. The survey includes home for all trips on a typical day within the town or urban region collection of basic facts relating to present day movements. The home-interview study is concerned with the

THE HOME INTERVIEW STUDY:

interview and external cordon surveys. Times carried out as a check against the results of the home-interview study, an internal cordon or screen line survey is some- addition, external cordon are surveyed in the home-interview study. In movements occurring within the area defined by the picked up on the internal and external cordon surveys. home-interview study, if this is carried out, and are also Internal - External movements are surveyed in the

external cordon. External - Internal movements are invariably surveyed at the Data relating to these different types of movements is collected in a variety of ways. Through movements, and

identified and entered on the form its code, as is the number the interviewer. The class of vehicle being interviewed is time, location of the survey point and the identification of information recorded includes general information about the date, records the answers on specially prepared forms. The information recorded includes general information about the date, survey point, and questioned by an interviewer, who sample of road users are stopped at the external cordon

(b) Direct Interview: In the direct interview method, a transportation studies. viewing. They can also be successfully utilized in major and where they are used in conjunction with some direct interviews, pilot surveys, fully utilized in heavy traffic conditions, pilot surveys, Nevertheless, postcard surveys can be reasonably successful. ranges from 10 to 50% of those issued with the postcards. the response rate to such surveys is variable, and usually survey, as they are distributed to the road users. However, of travel are entered on the cards by the staff operating the trips, and type of vehicle. The time, location and direction ation, the location of origin and destination, purpose of point. They are usually accompanied by a request for cooperation, the road user, are distributed at the external cordon survey cards, with return address and questionnaire to be filled by (a) Postcard Surveys: Pre-paid business reply post-

ROAD TRAFFIC MOVEMENT:

sometimes used. identification of each movement across the cordon line, are other methods, relying on the observation and business reply postcards at the roadside.



of occupants in the vehicle. This information is normally

recorded as the vehicle approaches the survey point.

questions are then put to the driver of the vehicle

about the origin and destination of his journey. Because the

study area is divided into zones for the purposes of a trans-

portation study all origins and destinations within the exter-

nal cordon must be recorded in detail. For points outside the

study area, the name of the town or village and the district

is normally sufficient. The origin and destination of a trip

must never be recorded at the same point. For round trips the

farthest point reached from one end of the journey should be

recorded as either the origin or destination of the trip.

The driver is next questioned about the purposes of

his journey and what he was doing before starting the trip

(e.g. going home from work; going shopping from home).

While the interviewers at the survey point are question-

ing the sample selected for interview, a continuous record

of all vehicles passing through the point is kept by enumera-

tors.

Both interviews and the total vehicle enumeration are

carried out for a set time interval-usually one hour. As soon

as the chosen period of time elapses a fresh count for the next

time period is commenced, regardless of the number of entries

recorded.

It is standard practice to have a police constable on

duty to direct traffic and select the vehicles for interview

on the instruction of the site supervisor. The size of sample

the vehicles chosen. No definite guidance is available about the area, and interview the owner or driver responsible for to take a sample of all the commercial vehicles garaged within trips taking place within the external cordon, it is necessary To obtain full information about commercial vehicle

#### COMMERCIAL VEHICLE SURVEY:

travel to be adopted on leaving the bus or train. travel adopted prior to boarding bus or train, and mode of way, and (depending on the purpose of the study) mode of view namely place of origin and destination, purpose of journey, passengers is similar to that required at the roadside interview. The information required from both bus and rail

card to the survey headquarters. requested to complete the questionnaire and return the post-passengers as they board either bus or train and they are od is the pre-paid business reply postcard. This is issued to interviewing on a crowded bus or train the most favoured method. this information. Because of the problems associated with A variety of techniques can be adopted to assemble ance to warrant the collection of full information about them. under study. However, they are usually of sufficient importance to form a small proportion of the total travel in the area outside the external cordon, but have destination within it, Public transport trips by bus or rail which originate

#### PUBLIC TRANSPORT TRIPS:

and the volume of traffic on a particular route. interviewed varies with the accuracy required in grossing up,

any bottlenecks on the network will also be revealed. In addition, location and extent of at less than capacity. In addition, location and extent of data will highlight those parts of the road network operating critical points, are also important. Analysis of this survey conditions, junction spacing and capacities specially at Carriageway widths, traffic regulations, visibility traffic assignment procedures to be adopted. The existing road classification, and the requirements of the network is based on the volume and nature of traffic carried, main or primary network. The destination of this primary characteristics of the road network being restricted to the of work involved, normally result in the survey of the physical The limited capacity of the computer, and the amount

MAIN ROAD INVENTORY:

assignment stage of the transportation planning process. This data is required for use in the trip distribution and works, and the present day traffic volumes and travel times. a stock taking of the major highway and public transport network is the survey of existing transport facilities; It is, in fact An important element of the collection of basic data

SURVEY OF EXISTING TRANSPORT FACILITIES:

would be considered satisfactory. that for a small town a sample approaching 100% could be necessary, whereas in a larger area a sample of less than 30% the size of sample to be selected, but is generally accepted

PUBLIC TRANSPORT INVENTORY:

The designation of public transport network is slightly more complicated than the designation of road networks. In the large urban areas both rail and bus facilities will be available for internal movements, but for the smaller built up areas only bus transport will be of interest.

The identification of the railway network is a comparatively straightforward matter, which can be done from a route map and timetable.

It is usual for the public transport operators to participate in the transportation planning process, and in addition to current passenger volumes carried, they can also provide details about fare structure and future proposals.

A similar procedure is adopted in identifying a bus network. Principal routes, stopping places, and travel times can be derived from route maps and the operators timetable. However, buses are invariably delayed by traffic congestion, especially during the peak periods, and to obtain the actual rather than the scheduled running time of the services, a check is made in the field. In addition, links must be added into the public transport network to represent time spent and waiting at the terminal and interchange points.

TRAFFIC VOLUME CENSUS:

Traffic volume counts are made at the external cordon, the internal cordon if operated, the internal screen lines, and any other position considered necessary. The purpose

TRAVEL - TIME SURVEY:

of the counts is to establish typical patterns of hourly, daily and seasonal variations in the traffic flow.

Travel times, and speed-flow relationships for both

peak and off-peak periods are used as a basis for determining

the present level of service performed by the system, and in

the distribution and assignment stages of the transportation

planning process. The moving-observer method, devised by the

Road Research Laboratory, London is considered to be the most

efficient and reliable way of collecting this information for

motor vehicles. Basically the procedure involves an observer

1. Making a trip in a motor vehicle over a specified length

of the road network, both with and against the traffic stream

he is surveying.

2. Counting the number of on-coming vehicles when travelling

against the stream of traffic being surveyed.

3. Counting the number of vehicles overtaking the test car,

and the number of moving vehicles overtaking by the test car.

4. Measuring the times taken for the journey with, and

against, the stream being surveyed.

From the formula

$$(1) q = \frac{(x + y)(t_a + t_w)}{(x + y)}$$

(Flow)

t = mean journey time

q = Flow vehicles per minute

x = Vehicles met when travelling

against the stream.

y = Vehicles met when travelling

with the stream.

therefore traffic can be said to be the function of buildings, or places such as markets, depots, docks and stations. In towns activities in towns take place in buildings and are concentrated there. It is characteristic of activities and traffic is concentrated in town because (the people) are engaged in. Traffic is therefore a function want them to move in connection with activities which they mysterious reasons of their own. They move only because people Vehicles do not of course move about the roads for

of land use. It has been demonstrated that the movement of goods and people by either public transport or private motor vehicle is inextricably linked with the distribution and intensity

PLANNING AND ECONOMIC DATA:

es of vehicles. Mean journey times can be obtained for different classes of vehicles if x and y are counted for the different classes. Values for the total number of runs. The run over each leg is repeated for minimum of six times and x, y, t<sub>a</sub>, and t<sub>w</sub> are replaced by the average

The flow of vehicles in the stream (in vehicles per minute) and the mean journey time can be calculated.

Y = Vehicles overtaking test car minus vehicles overtaken by test car.

t<sub>a</sub> = time against stream

t<sub>w</sub> = time with stream.

$$(11) t = t_w - \frac{q}{Y} \text{ (Mean Journey time)}$$

different household sizes.  
households, or can be sub-divided into categories based on  
be given in an unsophisticated way such as the total number of  
satisfactory. The household structure of a zone can similarly  
although a fewer number of categories would probably be more

groups 0-4 years, 5-14 yr, 15-24 yr, 25-44 yr, 45-59 yr, and 60 and over,  
age structure can be given in considerable detail covering the  
of persons of five years of age and above. In other cases, the

ces this can take the form of a simple indication of the number  
structure of the zonal population is required. In some instan-

In addition, some indication of the age/sex, and household  
lution is a significant factor in estimating trip generation.

essential. Experience has shown that the total zonal popu-  
each internal traffic zone, basic population statistics are  
However, certain elements are fundamental to all studies. For  
size, purpose and organization of the study being carried out.

The type of planning data collected varies with the  
POPULATION AND EMPLOYMENT DATA:

data.  
present-day relationship between trip generation and planning  
rates estimated using the predicted planning data, the  
predicted for the target date, and future trip generation  
economic characteristics. These planning factors are then  
rates are established for different land-use, population and  
transportation planning, whereby present day trip generation  
It is this relationship which forms the basis of

generally adopted indicators.  
occupation by socio-economic group are all popular and  
the main economic supporter-derived from an analysis of  
from Local Authority records, the socio-economic group of  
owner - occupied dwellings in the zone or rented houses derived  
records kept by the Local Authorities - the proportion of  
available. Levels of car ownership derived from the Excise  
which reflect income and for which information is more readily  
therefore derived indirectly from an analysis of those factors  
An indication of levels of income in each zone is

way.  
there is a strong possibility that they will be incorrect any  
to answer such personal questions and if answers are given  
study. However, the population at large is generally reluctant  
question about household income as part of the home-interview  
One method of obtaining this information is by asking a direct  
data is required about the income levels in each traffic zone.  
Consequently, as part of the transportation planning process,  
number, frequency and mode of trips made by the residents.  
The level of income in a household affects the

#### INCOME

to derive the required information.  
It is usual practice to carry out a special survey  
breaking it down into significant groupings by age and sex.  
are in employment, or it can be presented in more detail by  
This data can be simply the crude total of residents who  
the labour force is also required for each internal zone.  
Information relating to the size and structure of



ATTENDANCE AT SCHOOLS, COLLEGES AND OTHER EDUCATIONAL ESTABLISHMENT

Information about the location, and number of attendances at Primary and Secondary Schools and further educational establishments is required for each internal zone. This data is obtained from Local Authority records. If necessary, the home-interview study results can be used as a check.

OTHER LAND-USE DATA:

It has been found that both the amount and the characteristics of travel are influenced by the intensity of development of land. For residential areas - the areas from which the bulk of travel is generated - this intensity of use is measured in terms of residential density. Net residential density is the measure most typically used.

EVALUATION OF SURVEY ACCURACY:

It is desirable to check the accuracy of the survey data before the process of analysis is completely under-way. This is done by comparing it with facts that are either already known, or obtained as part of the survey process.

HOME INTERVIEW - DWELLING UNIT SAMPLE:

The accuracy of the dwelling-unit sample selection can be estimated by comparing the population of each Enumeration District or traffic zone, as determined from the expanded home-interview data, with the population derived from census data. The census data, however, must be adjusted to take account of changes which may have occurred since that information was compiled.

The accuracy of travel-pattern data recorded in the home-interview study and the roadside interviews, can be

ACCURACY OF TRAVEL - PATTERN DATA:

If necessary, a modified sample chosen. the procedure of sample selection should be re-examined and poorly chosen sample is the cause of poor comparison, then If the spot checks indicate that an inadequate or comparisons should be re-interviewed.

necessary, parts of all of the zones showing unsatisfactory or they should be replaced by other trained interviewers. If either be given further instruction on interviewing procedure this shows the interviewers to be at fault then they should checks at sample dwellings previously interviewed, and if The cause can be determined by carrying out spot

1. an inadequate or poorly selected sample
2. unsatisfactory work on the part of the interviewers

causes are:

atisfactory comparison does result then the two possible more than  $\pm 15\%$  of the adjusted census data. If an unsat- Expanded home-interview data should not vary by

situation before the work is too advanced. can be determined immediately and steps taken to rectify the If the comparison is not satisfactory the source of the trouble the interviewing is completed in each zone or area, so that punched. If at all possible it should be carried out as should be done manually before the tabulating cards are To avoid unnecessary expense a preliminary check

checked in a variety of ways each of which involves preparatory work before the survey commences. Perhaps the most satisfactory methods of checking motor vehicle trip data is the use of a screen line. The object of a screen line is to divide the area bounded by the external cordon into two, and to compare the actual traffic flows across the line with those reported in the home-interview study. The screen line chosen should preferably be a natural barrier, such as a river or railway, with comparatively few crossing points. It should be straight to avoid vehicles crossing in more than once on the same trip; it should not pass through the central area where the complexity of vehicle trip is almost certain to involve vehicles crossing and recrossing it on the same trip; and it should not pass too close to the external cordon. An alternative to the use of a screen line is the use of two or three control points, preferably in different parts of the study area. Viaducts, bridges, under-passes or other well-known points through which large volumes of traffic pass, are most suitable locations for these control points, and the objective is to compare the actual vehicle trips passing through the control point with the number of trips reported in the home and road side interviews which should pass through the same control points.

The traffic counts carried out at both the screen line and the control points are similar, and include the use of automatic vehicle counters, recording total traffic flows in one hourly periods, supplemented by classified manual counts.

In addition to the checks provided by the screen line or control points, data collected at the external cordon roadside interviews can be used to assess the accuracy of the trips across the external cordon reported in the home-interviews study by residents and commercial vehicle operators within the external cordon.

A comparison of the reported public transport trips with the total public transport movements for an average day, derived from the public transport operators, will reveal any discrepancies in this particular field. The accuracy with which journeys to and from work have been reported can be assessed by comparing the number of persons employed in a particular zone, with the work trips into the zone as derived from the expanded-interview data. Allowance must be made for absenteeism and persons walking to work.

ANALYSIS:

1. Coding and punching.

Before the data collected by the interviewers can be processed it must be coded into a predetermined series of number forms. This coded information is then punched on to punched cards for mechanical sorting and processing.

Occasionally the interview forms used in the field are so arranged that the results are entered on the form in the appropriate code, as the interview takes place. This process, however, places additional strain on the interviewer, and in practice it has been found that it is safer to use special staff to code the data in the office.

The coding operation is repetitive and tedious, and in an attempt to eliminate confusion and errors the process is usually broken down into a series of operations, each performed by an individual member of the coding staff, e.g. one person codes the origins and destinations only, another codes mode of travel and so on. Once the data has been coded it is transferred to punched cards by specially trained operators, and is used in this form as the computer input.

2. Expansion factors:

Data collected at the different types of field survey, which utilise a sampling procedure, must be expanded to represent the whole population, and to account for missed interviews. This is achieved through the use of expansion

factors and ordinarily they are calculated for each zone

used in the survey; The expansion factor used for the home-

interview study is basically the total universe, i.e. the

total number of households in the survey area divided by

the total number of successful interviews. This is calculated

from the following formula, for each traffic zone:

$$\text{Expansion Factor} = \frac{A - \frac{B}{C} (C + \frac{B}{C} \times D)}{B - C - D}$$

Where A = total number of addresses on original list

B = total number of addresses selected as original

sample

C = number of sample addresses that are ineligible

(e.g. demolished, non-residential)

D = number of sample addresses where no response is

made (e.g. refusal to answer, no reply)

The external cordon survey expansion factor is usually

derived for each class of vehicle, time interval and direction

of flow used at the survey point. It is calculated from the

following formula:

$$\text{Expansion Factor} = \frac{A}{B}$$

Where A = the number of vehicles of the specified class counted passing through the survey point for the relevant time interval.

B = the number of vehicles interviewed, of the same class and for the same time interval.

In addition, 24-hour factors are required to bring to a

24-hour basis the information collected at the external

cordon stations operated for a 16-hour period only. This

is achieved from the following formula:

$$\text{24-hour expansion factor} = R \times \frac{B}{A}$$

ation study is comprehensive, and can be presented in many  
 Data collected in the various stages of transport-

4. TABULATIONS:

trips can be divided by two.

Alternatively the processed tabulated values for through

a 0.5 expansion factor in all 'through' trips records.  
 standard method of eliminating this duplication is to punch

cordon twice, and will therefore be interviewed twice. The

In theory 'through' trips will cross the external

3. THROUGH TRIPS:

zone.

A separate factor is usually calculated for each traffic

D = number of vehicles for which refusals are recorded

C = unlicensed.

B = number of vehicles in the sample disposed of or

Where A = total number of registrations chosen as the sample  
 B = Number of registrations in the sample disposed of or

$$\text{Expansion Factor} = \frac{A}{C} \left( \frac{B}{C} + \frac{D}{B} \times D \right)$$

expansion factor; from the formula:

derived in the same way as the home interview survey

The Commercial Vehicle Survey expansion factor is

B = Average count for 's' days for vehicles of  
 appropriate class passing through survey point  
 during the period of time interviews are made.

A = Average count for 's' days for vehicles of  
 appropriate class passing through survey point  
 in 24 hours.

R = Average expansion factor for time interval

caution. The results that any conclusion derived must be treated with have to be made in the transportation planning process, with to estimate the future course of events numerous assumptions standards demanded by the population generally. In an attempt pattern of industrial growth, and the requirements and ahead, while economic advances have led to changes in the accurately population trends for more than five to ten years graphic spheres ensure that it is impossible to predict tremendous rate. Changes in the technological, and demographic spheres ensure that it is impossible to predict In the last half century change has been occurring at a with the projection of the same data to the target data. significant when - compared with the problems associated the existing situation poses many problems, but these are The collection of this basic data relating to

CONCLUSIONS:

tabulations that may later be required. as so arranged as to facilitate the processing of any ded data in its punched state, or converted to magnetic the same time care should be taken to ensure that the standard tabulations required for all transportation studies. Different forms. It is usual to prepare, in the initial stages.



AUTOMATIC DATA PROCESSING:

If we analyze the needs of an organization for

obtaining accurate and adequate information, we find several

areas of business activity that must be controlled. Just

as an early shepherd had to keep track of the sheep in

his flock, the organization must keep track of the things

it owns. This is known as keeping an inventory. When

inventory falls below of safe minimum, it must know how

many units to re-order and how long it will take to re-

place its stock so that it may continue to carry on its

activities without interruption.

Large or small, an organization needs records.

An automobile is equipped with an oil pressure gauge to

indicate whether or not the engine is receiving proper

lubrication. Without this device, it is unlikely that the

driver would be aware of a lubrication failure until serious

trouble developed. Likewise, a business firm needs "gauge"

to determine its operating performance. These "gauges" of

business are its accounting records.

Pay roll must be prepared regularly. This involves

the preparation of a pay-check for each employee, as well

as the maintenance of information regarding his earnings

and deductions for the year. The organization must have

ready cash to pay creditors such as suppliers, the landlord

or the mort-gage holders, and the advertising agency, etc.

All accounts receivable and accounts payable

Information must be recorded. Provincial and Federal governments require more records and reports from various organizations each year. These reports and others of a similar nature must be prepared, and numerous workers often are required to get the job done.

In relation to the total number of real production workers in an industry, the number of clerical employees is quite high. Clerical requirements have continued to grow each year creating higher costs. A higher and higher percentage of industry's working capital and personnel are required for recording, classifying, summarizing, and filling masses of vital data. If it were possible to total the annual cost of creating and maintaining records, the sum would be staggering.

At present, it is estimated that one out of every three employees is engaged in clerical work. This ratio seems high, considering the fact that it is the production and sale of goods which sustains the industry and provides the revenues. The salaries of clerical help are direct overhead. To keep these costs down, organizations are always looking for better and cheaper methods of keeping their records.

Economy is not the only factor but speed is equally important. Timing is critical in decision-making, and to aid the administration in arriving at a better decision, data must be available as soon as possible. Management may speed up the processing of data by increasing the clerical force, of course but this would mean increased clerical costs.

Most airlines have turned to the computer to aid them

1) AUTOMATED FLIGHT RESERVATION:

not be achieved earlier e.g.

been possible to perform many important functions which could

With the availability of electronic computer, it has

ted to management a month after that.

nearly passed for action data processed quarterly and presen-

Frequent intervals and in timely and useful form. The day has

and forecasting their consequences. Data must be available at

describing the situation offering alternative types of action,

ses to changing conditions. Thus management must have data

the ability of management to make accurate and rapid respon-

rated over the years. This acceleration puts a premium upon

The pace of life for most organizations has accelera-

accurately, and economically.

processing equipment is to process information quickly,

processing is to aid management, the aim of using the data

value to him. Since the chief objective of automatic data

does not reach the manager when he needs it, it is of little

mation in time to effect important decisions. If information

Effective management control requires the "feed-back" infor-

that this information be accurate and on time to be of use.

based on "Second hand" information. It is important, then,

the basis of personal knowledge and experience now must be

from operations, decisions which previously could be made on

also is increasing. When the manager becomes further removed

distance between a manager and the activity he is to control

data increasing but as businesses become more complex, the

Not only is the volume of data and the need for

such problems have been known for some time. Before the advent  
their forecasting is a very complex one, methods for solving  
than they were in the past. While the problem of accurate wea-  
Weather predictions today are far more reliable

#### IV) COMPUTER AND THE WEATHER:

now in operation keeps track of air-traffic.  
One of the most complicated computer applications

#### III) AIR TRAFFIC CONTROL:

branch for the (booked-up) period.  
The computer is instructed to refuse confirmations for that  
hotel is booked to capacity for a given day or period of time.  
room again. The same approach is used when a certain branch  
computer by any branch and the branch can start 'selling' the  
his room reservation, the necessary information is fed to the  
name and address, is mailed to the hotel. If the guest cancels  
ting branch and a duplicate, complete with the guest's  
in a matter of seconds. Confirmation is made to the request-  
some major hotel chains are now able to confirm reservations  
confirming these reservations. Through the use of computers,  
many locations and to speed up the task of requesting and  
the problems of coordinating advance reservations involving  
The hotel industry has been trying to reduce

#### II) HOTEL RESERVATIONS:

space on any flight in seconds.  
ticket agents scattered across the country, to confirm  
airline's system makes it possible for any one of its  
in the vital job of ticket reservations. One major

of computers and rapid data collection, however, the means were not available to put this knowledge to use. Computer has made it possible in the U.S. to use this knowledge to plot weather predictions for the entire Northern Hemisphere in 40 minutes.

Similarly data on population, census, agriculture, census, consumer price indexes, Foreign Trade Classified as commodity by country and country by commodity etc. and many other cross classifications have been made possible through the use of computer. Previously the Statistics Division, the major statistical organization in the country was scared of employing statistical analysis techniques to the data of their surveys because it was not feasible manually. But now with the use of the computer, it has been possible to produce many cross classified tabulations and analytical parameters for use by the Planners.





In a basic sense an automatic computer is a machine for transforming one set of information into another; it is a data transforming device. One of the leading definitions of automatic computer is "any device which can accept information, apply definite reasonable processes to the information and supply the results of these processes". Reasonable processes are in turn defined as operations which are correct logically and mathematically such as addition, subtraction, comparing, control over these data. The function of accepting data, or putting data into the automatic computer, is referred to as the input function.

(1) It must be able to receive or accept the data that it is to process, and its user must be able to specify or have control over these data. The function of accepting data, or putting data into the automatic computer, is referred to as the input function.

(2) The automatic computer must be able to transform the input data it accepts, into the output data it is to produce. This is the processing of the input data to obtain the output data. The processing may be complex or may be simple, but same data transformation capability is a must, otherwise there would be scant reason to use the computer. This transformation capability is referred to as the processing function.

(3) There must be some way of obtaining data from the computer - a way of getting results of the computer once it is finished with the data. This is referred to as the output function.

Functions:

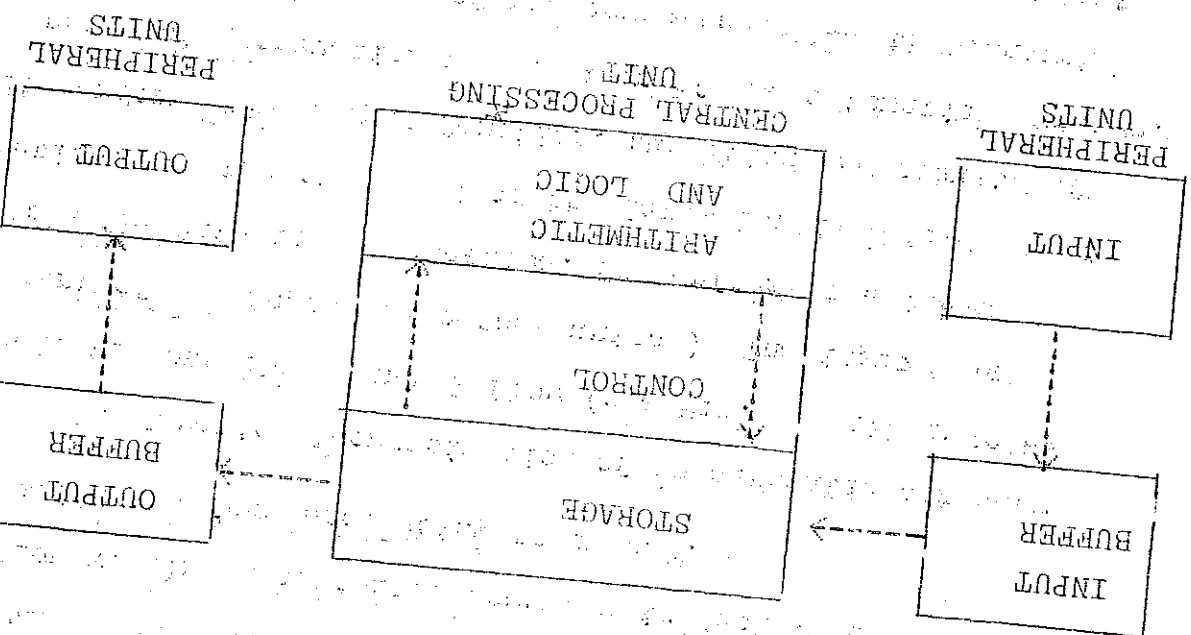
An automatic computer has the following three basic FUNCTIONS OF A COMPUTER:

and mathematically such as addition, subtraction, comparing.

are in turn defined as operations which are correct logically supply the results of these processes". Reasonable processes apply definite reasonable processes to the information and automatic computer is "any device which can accept information, a data transforming device. One of the leading definitions of for transforming one set of information into another; it is In a basic sense an automatic computer is a machine



The functional organization of an automatic computer is shown in the diagram below. The computer is divided into three main units: Peripheral Units, Central Processing Unit, and another Peripheral Unit. The Central Processing Unit is further divided into three sub-units: Storage, Control, and Arithmetic and Logic. Data flow is indicated by arrows: from the Input Peripheral Unit to the Storage sub-unit, from Storage to Control, from Control to Arithmetic and Logic, from Arithmetic and Logic to the Output Peripheral Unit, and from the Buffer Input Peripheral Unit to the Storage sub-unit.



FUNCTIONAL ORGANIZATION OF AN AUTOMATIC COMPUTER

Input data into output data requires arithmetic and logic  
With the input data in storage, to transform the  
of the term "storage".

"storage" are interchangeable, but the trend is in favour  
part of the central processing unit. The terms "memory" and  
normally equipped with a storage or memory unit which is  
of holding, memory, or storage function; and computers are  
processing operations are complete. This requires some sort

First, they must be saved temporarily until the  
from input, and before they are provided as output?  
What is to be done with the data after they are received?  
processing unit (CPU) that perform the processing functions?  
But what about the parts of the computer called the central

the processing operation to the user of the automatic computer.  
unit performs the output function, supplying the results of  
function. At the other end of the data-flow line the output  
recepts the data to be processed. It performs the input  
re part of the input and output units.) The input unit  
the buffers

The functional organization of an automatic computer  
closely follows this general flow (see Fig. 1).  
processing and from processing to output.  
e flow within an automatic computer is from input to  
puter, flow from the computer as output. In simple terms

operations. The resulting data, produced by the automatic  
Data go through an automatic computer in a definite  
w pattern. The flow starts at the input where data are  
received into the machine. They go through the processing  
by

The usual units of time are the millisecond (one thousandth of a second) and the microsecond (one millionth of a second). Long for measuring conveniently the speed of automatic computers the speed of human beings and desk calculators are much too slow to do it. The minutes and seconds commonly used for measuring note-worthy is the very great speed at which automatic computers can add and subtract numbers. The ability to add and subtract is not unusual; what is unusual is the ability to add and subtract numbers.

#### WHAT AUTOMATIC COMPUTERS CAN DO:

storage unit to the output unit. Once the processing is complete, the flow of data is from the storage unit and the arithmetic and logic unit; circular flow is possible (which may be repeated many times) computer is from the input unit to the storage unit. Then a Thus in summary the flow of data within an automatic

#### THE FUNCTIONAL ORGANIZATION OF AUTOMATIC COMPUTER:

of its processing to the storage unit. receives data from the storage unit and supplies the results arithmetic and logic unit is circular. The arithmetic and logic unit The data flow between the storage unit and the arithmetic and logic unit is circular. The arithmetic and logic unit receives data from the storage unit and supplies the results of its processing to the storage unit.

plish the job. be applied in any sequence and as often as needed to accomplish the job. arithmetic and logic operations are not uncommon. They can its design. From as few as three to as many as forty types of such operations, that a computer can perform depends upon which is also part of the central processing unit. The variety of these operations is called the arithmetic and logic unit, operations: The part of the automatic computer that performs

a second, abbreviated "ms"), the microsecond (one-millionth of a second, abbreviated "us", and the nanosecond (one-billionth of a second, abbreviated "ns").

2. Automatic computers can multiply and divide numbers.
3. Automatic computers can do some logic operations. In a fundamental sense, automatic computers are logic machines for the processing of information. The logic system employed in most computers is derived from Boolean logic, which is a variety of mathematical logic.
4. Automatic computers can choose among alternatives in a manner that amounts to making a decision. This ability is an extension of the logic capability stated above and is usually restricted to simple judgments, such as larger than "or" equal to".
5. Automatic computers can "remember" and "recall". The ability of automatic computers to remember (that is, to store information) is virtually unlimited.
6. Automatic computers can communicate with their operators and with other machines. For example, computers can accept from their human operators the information they are to process and the instructions they are to follow in doing the processing (the input). They can tell their operators the results of their processing as through a printing operation. Computer can accept input data directly from machines, and in turn use the output data directly to control machines.

science applications.

engineering and scientific applications, and in management programmed to compute the mathematical functions needed in some application in business statistics. Computers can be itself, or to take a square root - an operation which has or programmed so as to keep track of the decimal point For example, an automatic computer can be either constructed operations, some of them important for data processing.

10. Automatic computers can perform some special

efficiency.

9. Automatic computers sort (for instance, put symbols in an alphabetical or numerical order) with a high degree of

in several ways.

8. Automatic computers can check on their own accuracy

guidance or assistance.

self directing in that it follows the program without human predetermination mentioned above. The automatic computer is as it executes it. The program constitutes most of the

directions that enable the computer to modify its own program is to do it, and how it is to do it. The program may include each major part of the automatic computer is to do, when it and partly because of the program. The program lists what

because of the way the components have been linked together, further human intervention. It has this ability partly

ted what to do, it can process the information without provided with the information to be processed and instructed in a predetermined manner. Once an automatic computer has been 7. Automatic computers can direct themselves in a

WHAT AUTOMATIC COMPUTERS CANNOT DO:

1. Automatic computers cannot process the data of an application for which they have not been programmed. That is, for every application of an automatic computer, one must first program the computer. After this has been done, it can process the information. Without it the automatic computer is of as much help as a sleeping white elephant.
2. Automatic computers cannot make a non-predetermined decision; that is, automatic computers can make only the decisions for which the alternatives have been delineated and provided in advance.
3. Automatic computers, unaided by human beings, cannot construct all of their own programs.
4. Automatic computers cannot completely avoid making errors. This is hardly surprising. An automatic computer is a man-made device; and what man-made thing is not subject to occasional failure?
5. Automatic computers cannot efficiently do non-recurring tasks. This is basically a problem of programming, for with non-recurring tasks the ratio of programming time to computer operating time is very high.

CRITERIA FOR COMPUTER APPLICATION:

Judging by the foregoing list of capabilities and limitations, one might suppose that the areas of application for automatic computers are extremely broad, and so they are. In practice, there are only four prime requirements for the application of an automatic computer: (1) the application must consist of information handling only; (2) the exact goal or object of the data handling must be known; (3) the exact nature of the available information must be determinable; and (4) the ways of processing the information must be sufficiently well understood that at least one procedure for doing it can be accurately described by a listing in sequence of finite number of steps (that is a program). These four requirements must be met before an automatic computer can be applied; and where ever they are met, an automatic computer application is possible, although it may or may not be desirable for other reasons.

DATA STORAGE:

The function of Data Storage consists of Input

data preparation, data storage and file organization. Lot of developments have taken place in the above fields and a brief description of these is given below:

DATA PREPARATION MEDIA:

units

The input/accept data and transfer the same.

to the computer. The questionnaires or printed reports are not acceptable to the computer unless the information is converted into a medium which is understandable by the computer.

This data conversion was first started in 1890's when Dr. Hollerith invented a device named card punching machine.

After that lot of improvements have taken place in card punching machine.

but still card punching has a key role in the art of data processing. Different data preparation devices are briefly described below. All of them have their merits and demerits and it is upto the System Designer to use the right machine at the right occasion. Some of the media used for data preparation are listed below:

1. Punch Card.
2. Paper Tape
3. Magnetic Tape
4. Disk.
5. Console Typewriters.



PUNCH CARD

1234567.....

9	
8	
7	
6	
5	
4	
3	
2	
1	
0	

pattern of holes down the length of the tape. Each character

The data on paper tape are recorded usually as a

feet in length.

feet in length or in short strips of less than about twenty

handled either in reels of about twenty to a few hundred

board, very light in weight and flexible. Paper tape is

newsprint to high quality plastic-impregnated opaque card-

tape is made ranges from something that looks like a heavy

5/8 inch to 1 inch wide. The paper base out of which the

Paper tape is a strip of paper of indefinite length, and

computational rather than data processing applications.

paper tape has been used with computer oriented towards

and is not very durable, but it is inexpensive. Typically,

output with computers, is bulky and inconvenient to store

Paper tape which is also used for both input and

#### PAPER TAPE:

is very slow as compared to the magnetic media.

electrical contact or photo-electric device. The card reader

movement of the card past a sensing mechanism usually either

computer through a punch card reader based on the physical

data in the coded form. The punched cards are read by the

in a standard card. The holes cut in the cards represent

long and 0.007" thickness. Upto 80 columns can be punched

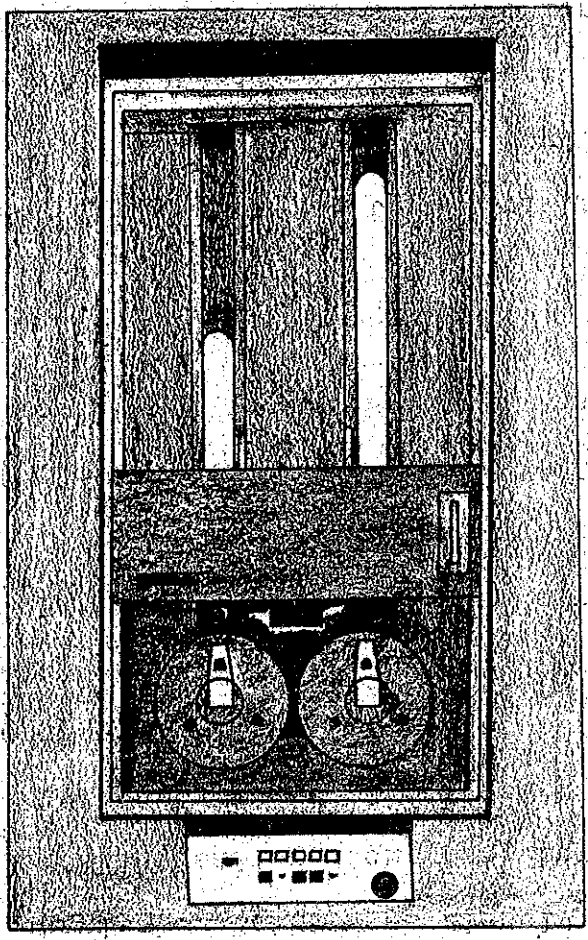
controlled dimensions and thickness, usually  $3\frac{1}{4}$ " wide,  $7\frac{3}{8}$ "

computers. Punched cards are pieces of cardboard of strictly

Punched cards are common for input and output on

#### PUNCHED CARD:

MAGNETIC TAPE UNIT



standards of temperature and humidity are met. Dust can  
The tape itself is durable as long as the usual computer  
operation (through flaking or scoring of the magnetic surface).  
fore wear begins to affect the accuracy of the reading  
usually delivering more than 10,000 readings or writings be-  
tape reels are compact, and the tape record is durable,  
reels can be used at a very modest incremental cost. Magnetic  
than can be put on one reel of magnetic tape, two or more  
expandable amounts. When more data are to be stored  
provides permanent but erasable storage in convenient and  
currently in use. Magnetic tape is popular because it  
handle them are among the most popular storage devices  
Magnetic tapes and the magnetic tape "drives" to

#### MAGNETIC TAPE:

second,  
a hundred characters to several thousand characters per  
second. The speed of photoelectric readers range from about  
range from less than fifty to few hundred characters per  
The speed of electromechanical paper tape readers  
eighty columns in twelve rows.  
handled and only five to eight channels need to be read, not  
are simpler because only continuous strips of tape need be  
punched card readers in their reading mechanism, but they  
electric or electromechanical. Both types closely resemble  
Most punched paper tape readers are either photo-  
across the width of the tape.  
on paper tape is recorded as pattern of holes in a row

is a serious problem. The magnetic tape used as a storage device for an automatic computer is similar in operation and in form to that found in home tape recorders. It comes in reels, sometimes as long as 3600 feet, although 1200 to 2400 feet is more common. The words of information are recorded on the tape (written on the tape) by special electromagnets (heads). To write (to record) the recording heads make small, invisible spots of magnetization on the magnetic tape as it passes across them at a constant rate of speed. The erasing of whatever was previously recorded is automatic in order to make room for the new data being written. To read (playback) the tape, passing over the reading heads at a constant rate of speed, induces in the reading heads small voltages which when amplified are a reproduction of the stored word. The same heads are often used for both reading and writing.

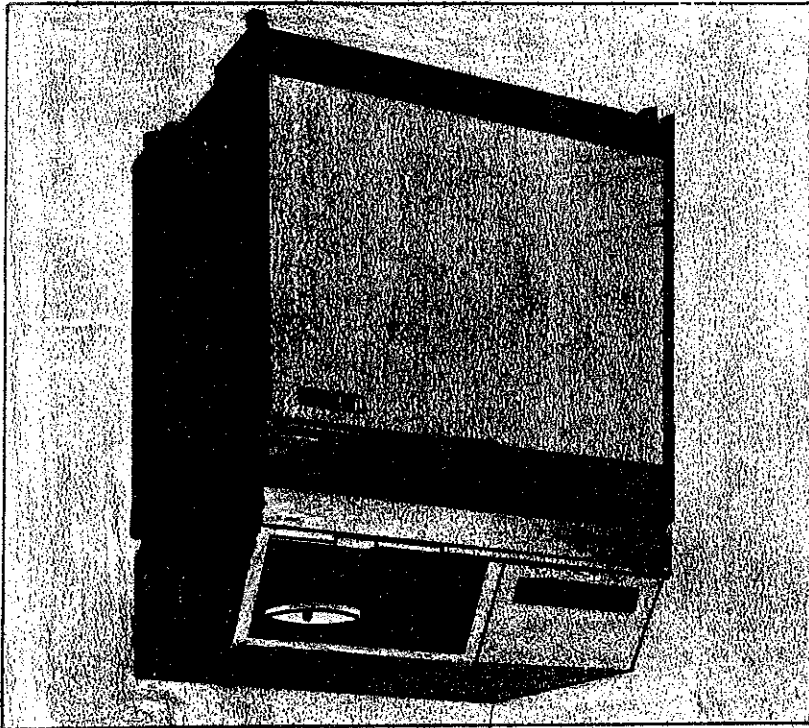
For convenience, a magnetic tape can be thought of as if it were marked into a number of channels which run the length of the tape and in which spots are recorded. Five to eight channels across the tape are typically in computer use. A block is a group of words recorded serially without any intervening blank spaces. Each block may be thought of as being composed of one or more records. Most blocks are ten or more words in length, are separated by enough blank space (unwritten-on tape) i.e. the interblock gap to allow the magnetic tape to stop and start moving accurately before reading or writing is attempted.

that may have been recorded at the troublesome place. Flaking  
spliced neatly; but this does not prevent the loss of data  
or become kinked, a section must be cut out and the ends  
Magnetic tape has its drawbacks. If the tape breaks  
not.

associated addresses recorded on the tape); in most they are  
magnetic tape are addressed (that is, the blocks have  
speed. In a few computers, the blocks recorded on the  
and writing of words in blocks increases the overall operating  
1 to 15 milliseconds are common). For this reason, the reading  
moving at the correct speed (start and stop times of from  
required to read or write one word after the magnetic tape is  
it to a complete stop are many times longer than the time  
from dead rest to full reading speed and the time to decelerate  
the start and stop times, the time to accelerate the tape  
nearly all computers, asynchronous clutches are employed, and  
10 to more than 200 inches per second have been used. In  
erent for different automatic computers. Rates of from about  
rate of speed or else errors may result. This speed is diffe-  
Magnetic tape must over pass the head at a constant

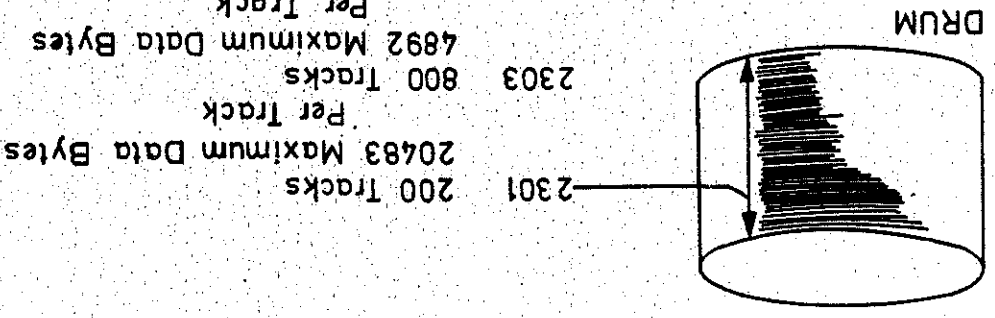
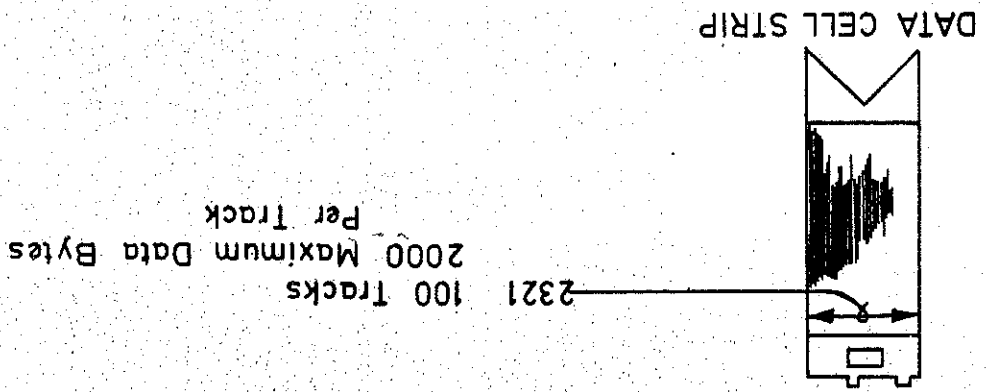
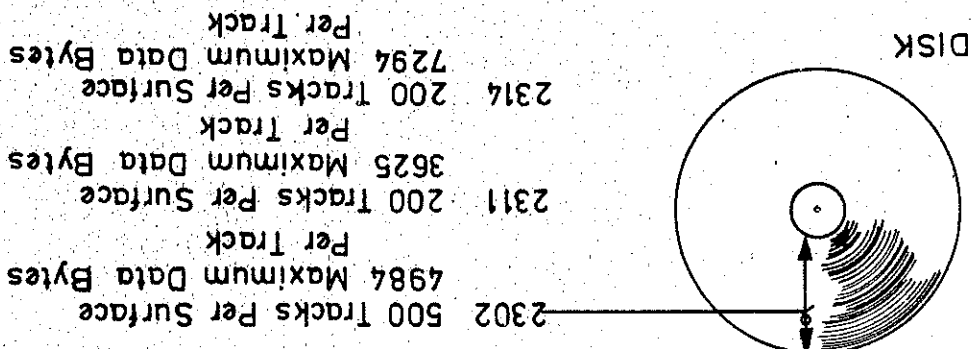
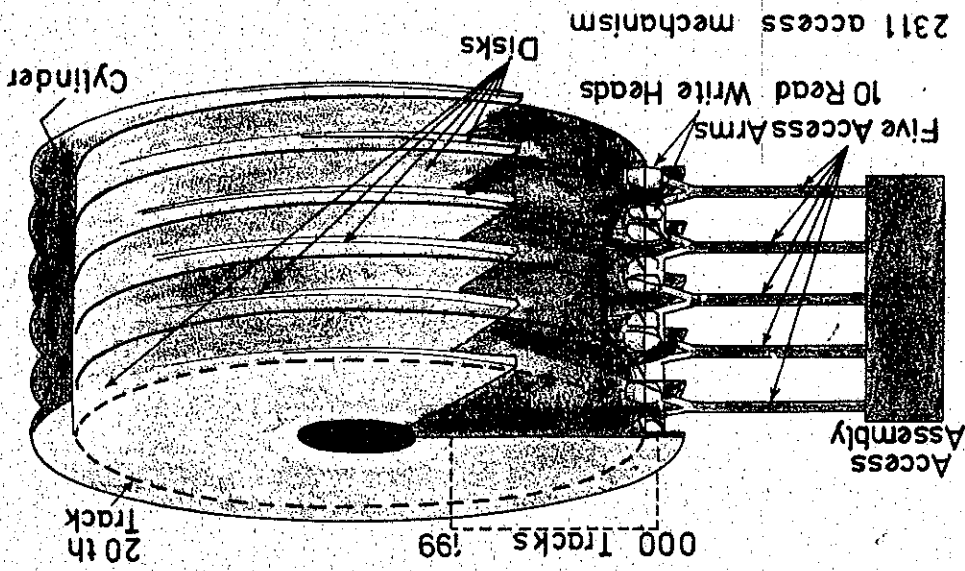
magnetic tape.  
common and useful indicator of the storage capacity of  
spaced say 200 per inch. The density of recording is a  
into a reel of magnetic tape than the spots are more widely  
over 1000 bits per inch much more data can be crowded  
per inch per channel. When a dense recording is possible  
the number of possible magnetic stops that can be recorded  
The performance of magnetic tape is affected by

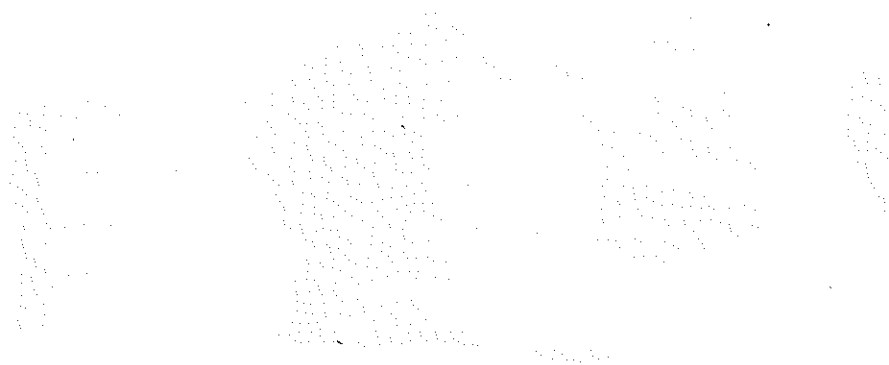
DISK STORAGE DRIVE











of almost the same type as that used on magnetic tape. The surface on both of its sides is coated with magnetic material disk is a metal disk that rotates about its centre. The flat sometimes called disk files, are in wide use. The magnetic at random access times of less than a second, magnetic disks, For external storage of large quantities of information

MAGNETIC DISKS:

tape is normally not used for internal storage. Magnetic modification and report preparation operations. Magnetic records are to be kept and handled in an ordered sequence at high speed. This is the common situation in record Magnetic tape is most useful when large number of

than usual temperature also seems to help. used for long term storage. Keeping such reels at a cooler be unwound and rewound at least once a month or so for tape problem, the reels should be rewound, slowly and loosely and in the reel, thus obscuring the recorded data. To reduce this to copy itself by magnetic attraction on the adjoining coils this, the magnetic pattern on each coil of tape tends when wound on reels is also subject of "print through". In heads to cause read or write failures. Magnetic tape they may keep the magnetic tape far enough away from the (transport) require the same treatment: If dust particles cling, oxide coating (rubbing on the heads or on other parts of the of the oxide coating from the plastic base, scratching of the

the cards or recording the data on magnetic tapes or disks.  
Data preparation can be performed through punching

#### DATA PREPARATION:

per disk file.  
The storage capacity is on the order of millions of characters

the magnetic surface sufficiently to make data unreadable.

rare while a slight misadjustment of the heads may damage

used. Though the disks themselves are durable, once in a

is moderately durable because the disks are ruggedly constr-

erasable storage, just as does magnetic tape. The equipment

In general, magnetic disks provide permanent but

length of the block depends upon the particular equipment.

to read or write an entire block of data at a time. The

time required for this mechanical movement, it is customary

position the head over the correct address. Because of the

The access time depends on how long it takes to

question.

disk, the side of the disk, and the number of the disk in

of the distance of the recording head from the centre of the

address of data recorded on the disk is expressed in terms

its centre. Magnetic disks are normally used in stacks. An

coatings on either side of the disk and at any distance from

positioned, or floated on a stream of air, above the magnetic

constant speed, a combination reading and writing head can be

is normally fully serial. When the disk is rotating at a

except that a simpler head can be used because the recording

very much like reading from magnetic tape and writing on it,

Data-recorders offer the most practical method of speeding up and cleaning up input preparation. They make it possible to transcribe raw data, from source documents, direct to computer-compatible magnetic tape and to verify the transcribed data on the same machine.

#### PUNCH CARDS VS. MAGNETIC TAPE:

In many large EDP installations, costs of punched card input preparation exceed computer processing costs.

Even the fastest card punch operator is limited by the operational speed of the punch. Card punch equipment is noisy contributes to operator fatigue, and errors. Error correction with cards is a time-consuming, expensive process and generally calls for a complete re-punch of all the data in the card.

Lost cards and accidentally mixed batches are

common occurrences. Card storage frequently is a heavy cost burden. Scheduling becomes complicated, with two unique

machines needed for the card punching job. Stand by equipment for peak loads results in rentals for equipment used only

part time.

And once a batch of cards is punched and verified, the punched data still must be converted to computer-compatible language on magnetic tape.

DATA-RECORDER uses point to substantial operator productivity increases. Former card punch operators handle more

work on Data-Recorders.

Single and Dual stations so that the numbers of data entry Station) and the 3747 Data Converter. The System is based on data stations (the 3741 Data Station and the 3742 Dual Data The IBM 3740 System consists of two types of

with traditional unbuffered key punches. accuracy and ease of handling large data volumes compared data entry environment as well as increased productivity, machines that can offer true flexibility in the choice of The key to Disk Data entry System is a family of

KEY TO DISK:

pass and under one programme control. The operator can capture all the data from a document in one the Data-Recorder. Logical record of any size can be recorded. The users are not bound to 80-column records with efficiently, and more profitably.

errors reach the computer, allowing it to operate more in verification also are easily corrected. Thus, fewer in the memory, before they reach the tape. Any errors found der's memory. Sensed errors can be corrected immediately Key-entered data is first stored in the Data-Recorder-

noise-induced fatigue. make fewer errors, because they are not overpowered by pleasantly silent compared to the card punch. Operators maintain an even keying cadence. The data-recorder is Key board operation is effortless. Operators can

stations can be tailored to the installation's specific needs. Each unit can be operated completely independently making this one of the most flexible, advanced data entry systems available today. It can meet the needs of both the centralized data entry area and a decentralized operation, or any combination of the two.

Data stations used as direct replacements for present card punch units in the centralized, high-productivity key entry environment can improve efficiency, reduce errors and eliminate much of the noise so often associated with key entry operations. No changes in established document flow procedures are required when implementing the 3740 System.

Each data entry station is equipped with a screen which displays the data as it is recorded. This gives immediate error recognition and correction. The display screen also shows the machine status at any given time providing more effective operations control.

The diskette measures eight inches square and weighs less than two ounces with its protective envelope. It is easy to handle, store and mail.

The low-cost, re-usable diskette can store almost 1900 data records. In many cases, this represents two days' operator output. The diskette provides direct access to recorded information. Retrieval of required data or end of job is easily accomplished. Any record on the diskette can be deleted, altered or substituted.

processing system.

remote locations as back-up for data already sent to the storage and valuable back-up. Diskettes can be retained at The diskette medium provides virtually unlimited times.

data for entry on the same diskette is received at different This is a particular advantage when a variety of related There is no need to convert immediately after recording.

compatible tape can be accomplished whenever convenient. or 3742 station equipped with verify. Conversion to computer verification can be done at any time on any 3741 environment.

can be entered on any 3740 station to suit special operating data can be transferred from one diskette to another. Data same data entry station or at any 3740 station. If required, information can be recorded on the same diskette at the until the next batch or related data is received. The on to a diskette. The diskette can then be removed and stored one diskette, or as information arrives it can be entered An operator can enter a complete batch of data on



THE PROGRAM:

The program in the stored program computer has

a vital control function—the role of directing and organiz-  
ing the data-handling capability of the computer. The

computer can be directed to do a number of different ele-

mental operations. The program provides for performing

these elemental operations in a sequence selected to meet the

requirements of the data processing or computational task at

hand. The program in effect makes a stored-program general-

purpose computer into a machine specifically adapted to the

carrying out of a certain data-processing or computational

task. By means of different programs, the user of an automa-

tic computer can adapt a single machine to fit successively

the requirements of a variety of tasks. Such changes of

program give the automatic computer a major part of its

general-purpose capability.

An automatic computer can be thought of as having

certain elementary capabilities built in by the designers and

called by various names — functions, orders, codes, commands.

Examples are addition, multiplication, comparison, moving of

data from one place in storage to another, movement of data

from the arithmetic and logic unit to storage, the output of

data to magnetic tape — and dozens more are possible. The

commands specify the basic data manipulation operations which

the automatic computer can perform, but they do not specify

the sequence in which they are to be used, nor do they identify

the data to be manipulated. The commands by themselves, in

other words, are only latent capabilities until brought into

play by some specification of the sequence of the operations and of the items of data.

The basic unit of a program is known as the instruction consisting of one command, and one or more operands, each with an associated control character. Thus, an instruction specifies (1) the data that the automatic computer is to operate upon and (2) the operation the computer is to perform. A program is a set or list of instructions in such an order (sequence) that the computer can execute the instructions automatically.

### PROGRAMMING LANGUAGES:

Various programming languages can be used for pre-

paring programs, but there are three major types. The oldest are known as machine or absolute languages. They were followed shortly by the symbolic languages, which in turn served as a base for automatic coding and programming languages ("problem oriented" languages). The characteristics of these types of languages can be seen in the way that commands and operands are expressed in each.

Because of the difficulty of remembering and using such arbitrary alphanumeric designations, symbolic programming languages were developed, using mnemonic combinations of letters and numbers. Thus, in a symbolic programming language, the command ADD might be represented by the letters ADD, and the command MULTIPLY by the letters MPY. Operands are typically represented by the symbolic language address of the data to be operated upon, as for example, HRSOFT might be the address whose contents are the number of hours a man was absent

popular automatic coding languages have been ALGOL AND  
process. In the area of computational applications, the most  
errors during programming and they speed up the programming  
Automatic coding languages aid in reducing clerical

Typically each language subroutine.  
be applicable to a number of models of automatic computers.  
the machine languages, and one automatic coding language may  
the automatic coding languages are much more distant from  
in the machine language for the same computer. In contrast,  
available in a symbolic language have corresponding commands  
have symbolic languages. Usually most of the commands  
specifically for use with it. Many automatic computers also  
Every automatic computer has a machine language

even by someone having little knowledge of programming.  
WAGE-RATE GIVING GROSS-EARNINGS, can be understood easily  
notation to be used. For example, MULTIPLY HOURS WORKED BY  
but rigorous variety of ordinary English or mathematical  
automatic coding languages, which allow the use of simple  
Even more convenient for the human being are the

program.  
itself under the control of a compiler or interpreter  
language program. This is in practice done by the computer  
program must be translated into an equivalent machine

To be utilized by an automatic computer a symbolic language  
use of absolute (machine language) addresses and commands.  
last week. Many symbolic languages allow the selective

processed and the results of the processing.

For holding not only the program but also the data to be internal storage of the computer is limited and must be used. In practice this is one of the most bothersome. The

A third objective of programming is economy of storage of operating a computer are primarily fixed costs. made to operate rapidly to be economical, because the costs second objective of programming is speed. The computer must be required by the nature of the task, in the format required. A programmer must have the automatic computer produce the data important of the objectives of programming is accuracy. The each in partial conflict with the others. The first and most A programmer must keep in mind four major objectives, programming language.

prepare a set of specific directions for the computer in advance must plan how the computer is to do it, and then must prepare must have a good grasp of what the computer is to accomplish, performance. In writing the instructions the programmer which will later be given to the computer to guide its programs the programmer writes a series of instructions prepares such programs is known as a programmer. To prepare the of instructions for an automatic computer. A person who prepares Programming is the process of preparing sequences of instructions.

OBJECTIVES OF PROGRAMMING:

Language).

most popular has been COBOL (Common Business Oriented FORTRAN. In the area of data-processing application, the

should be only one exit arrow from each box, unless the box

should be only one entrance arrow to each box; and there  
matic computer is to maintain control. This means that there  
diagrams, it is good practice to show clearly how the auto-  
each alternative is set down fully. In making detailed flow  
letely and that what the computer is to do in the event of  
mmmer must see that all the alternatives are specified comp-  
(2) He prepares detailed flow diagrams. The progra-

which the programmer has not foreseen and provided for.  
the computer cannot by itself take care of eventualities  
change. All aspects of the task must be considered, because  
statement of the task should leave nothing to guess or to  
ment of exactly what the computer is expected to do. The  
(1) He sets down a clear, complete, detailed state-

through five steps.  
what instructions to write, the programmer usually must go  
write these instructions in the proper sequence, and to know  
computer telling it how to perform a job. To be able to  
is attempted is the building of a set of instructions for the  
become logically complex and very detailed. Basically what  
Though programing is not difficult, it can

PROGRAMMING PROCEDURE:

fanciness is usually the best approach.  
simple straightforward logical approach without frills or  
stand, it is easier to use, and it is easier to revise. The  
A simple program is easier to write, it is easier to under-  
A fourth objective of programming is simplicity.

specifies some transfer of control. All boxes showing

control operations - tally changes, tests, etc., can be specially marked. Such boxes should contain only control

operations.

(3) He writes the instructions in the programming

languages selected. This really is a process of translating

the flow diagram into a sequence of written instructions, the

number depending upon the level of detail in the flow diagram.

To facilitate the translating process, instructions are usually

written in three functional groups: one group for "set-up",

one group for "do", and one group for "clean-up". In addition

to this grouping, a three fold division of the available

storage capacity is usually established - one for the program,

one for the program constants, and one for working storage (for

input, output, and intermediate results).

(4) He codes the instruction, re-expressing them in

machine language. During this step absolute addresses are

usually assigned. If the programmer did the third step with a

symbolic or automatic coding language, then step 4 is usually

carried out instead by the automatic computer by means of

translating programs, as stated earlier.

(5) He must debug the program i.e., correct the

mistakes made in prior steps.

RETRIEVAL THROUGH COMPUTER:

Retrieval of data in a computer system is accom-

plished through SOFTWARE, which is needed for storing and

retrieving records in a data base system. The role of SOFT-

WARE is broader than just storing and retrieving information

though it must also insert, delete and modify records. It

must guard data against errors and system malfunctions and

must also provide recovery from errors. The software should

also provide clearing of the data after a period of use and

after numerous additions, deletions or changes have occurred.

The Software consists of control programs and

application programs. The various operating systems used by

various makes of computers have their own specific require-

ments. An operating system is defined as an integrated set

of a computer operation. The operating system consists of

control programs and language compilers. For IBM system/360,

a summary chart is given herewith for illustration of various

characteristics of different operating systems, and it depends

upon the requirements of the organization to select operating

system suited to its needs and requirements. The data is

handled in the computer by the user programs which are classi-

fied into various languages further defined at machine level,

low level or high level.

A stored program can be run when it is in the com-

puter's storage unit. To be executable, the program must be

in the machine form, which the computer can understand and

act on. Each computer has a language of its own. This language

S/360 OPERATING SYSTEMS SUMMARY

Min. storage Requirements	BPS	BOS	TOS	DOS	OS
System Resid- once Device	8 K Cards or Type	8 K Disk	16 K Tape	16 K Disk	64 K Disk
Languages Supported	Assembler RPG FORTRAN	Assembler RPG	Assembler RPG COBOL FORTRAN PL/I	Assembler RPG COBOL FORTRAN PL/I	Assembler RPG COBOL FORTRAN PL/I
I/O Devices Supported by All Systems	Card Reader, Card Punch, Card Reader - Punch, Printer, Magnetic Tape, Printer-Keyboard, Paper Tape Reader, Optical Character Reader				
Additional I/O Device Support by System	Magnetic Disk				
Other Capabilities	Limited Remote Processing	Limited Remote Processing	Storage Protection Multi-programming Interval Timer Tape Switching Universal Character Set	Remote Processing Storage Protection Interval Timer Tape Switching Multi- programming Universal Character Set, Device Independence	Remote Processing, Multi- programming Multi-process- ing, Storage Protection Interval Timer, Device Independence, Dynamic Storage Allocation, Universal Character Set.



designed by the engineers who designed the computer and this will be only language which the computer will react to. Since the main storage of the computer is made up of all 1's and 0's i.e. Binary Digits, therefore, the machine language is also made up of Binary Digits.

The other languages, low level or high level are

Symbolic languages like ASSEMBLER, FORTRAN or COBOL and must undergo translation into the machine language before they can be executed. These language translators are called COMPILERS. The COMPILERS act on the SOURCE PROGRAM, written by the programmer and translate all the instructions into machine language program i.e. OBJECT PROGRAM.

COBOL stands for COMMON Business oriented Language which is more widely used in commercial applications and resembles English. FORTRAN stands for Formula Translation and is a programming language widely used in coding Scientific and Engineering problems for computer and the statements/instructions resemble mathematical equations. Both the COBOL and FORTRAN are high level languages because they generate more than one machine instructions for one instruction written in it.

The control programmes include programmes such as Linkage Editor, Initial Program Loader, Supervisor, Librarian and the job control program.

All the control programs and language compilers are resident on a system residence device which is a Disk or Tape operating system. Taking IBM System as an example the sequence of functions that take place in the computer system is as follows:

File organization is the process of relating the identification number of a file record to the address of that record in the storage unit. The identification number used must be related to the addressing scheme designed into the equipment. The primary objective of file organization is to retain data in storage systematically so as to retrieve them in the fastest way possible when needed. The method used for

### FILE ORGANIZATION:

VI. The user programs then assume control of the computer and process the data to produce the desired output according to the specifications prescribed in the System designed for the job.

V. The job control program then assumes control of the computer and reads the job control cards and calls in the programs and data i.e. the Language compiler, the source program and finally the Data to act upon.

IV. The system loader is part of the supervisor and is in storage all the time. It is this routine the supervisor uses to load all other programs in the operating system, such as the job control program etc.

III. After the supervisor is loaded the control of the computer passes to it. The supervisor consists of many separate routines, each of which performs a separate function.

II. Once the IPL program is loaded, control of the computer system passes to it, that is, the computer will start executing IPL instruction. The IPL program will then locate and load another program called the supervisor from the System Residence Device.

I. The initial program loader called the IPL program is a very small program that can be loaded into machine storage only through manual operation at the console. By setting certain controls and then pressing the load key, IBM System/360 will cause the IPL program to be transferred to predetermined main storage locations. This is a machine function and not a program function. No instructions are executed during the process of loading the IPL.

a particular file varies and its final form is dependent

on the requirements of the given application.

In setting up a file for direct-access device, there are many questions to be considered. What addressing

technique will be used? How frequently will the file be

referred to? Are disk files only to be used, or will there

be a combination of other type, such as magnetic tapes? In

updating records, are all records and information for an

application consolidated, or are they kept individually? Will

there be random processing; batched sequential processing,

or both? What are the file maintenance requirements?

#### FILE COMPOSITION-RANDOM & SEQUENTIAL:

A file of records can be arranged within a storage

unit in two major ways: Randomly and Sequentially.

In a random file, each record is at an address

computed by a randomizing routine, a program that calculated

the address from the item's control number. The order of the

records within the storage unit generally is not sequential.

To find a record in such a file, its address is simply computed

from the ID by the same formula used to put it there. The

main reason for using the random approach is to eliminate

index tables.

In a sequential file, records are sorted and stored

in the disk-storage unit in control-number sequence so that

record with successively higher ID numbers will have success-

ively higher addresses. It is not necessary (or even usual)

for the ID to be the same number as the file address; the only

requirement is that the ID's be in sequence.

Each of these two methods involves techniques to

minimize the number of accesses to the file.

### SEQUENTIAL VERSUS RANDOM-FILE ORGANIZATION:

Choosing between sequential and random organizational

techniques can be simple in some cases, difficult in other.

Basically, it involves choosing either tables or direct

computation as a means of finding an address. The following

are some comparisons that can be made between the two

techniques.

1. The sequential (table) method allows denser packing and permits a higher percent of disk storage space for use.

2. The random method is faster for random processing.

3. The sequential method is more efficient for generating reports that depend on a search of the file in control number sequence. To accomplish to same thing with random organization a finder file (a list of control numbers of all the records in the file) is needed.

4. The random method more readily handles addition to and deletions from the file. With a sequential file a large number of additions and deletions forces frequent reorganization.

5. With sequential organization, sequential processing is preferable. However, when it is batched, if the input is sorted into randomized formula sequence instead of control-number sequence, the two organizations are equally efficient.

Based upon the foregoing comparisons the following

Generalizations can be made:

1. If storage capacity is very limited and files must be tightly packed, the sequential method would be preferable.

2. If random throughput and job time are the main criteria, the random organization may give better performance.

by the systems analysis. Systems design is primarily a

synthetic process, whereas systems analysis is primarily

analytic.

Systems analysis followed by systems design together

can be linked to the preparation of a detailed plan or blue-

print for action. They specify the general structure, the

relationship among the parts of the structure, and the way

in which the structure as a whole will contribute to meeting

the demands which will be placed upon it. In short, systems

analysis and systems design together set down the basic frame-

work for the application.

If the systems design indicates that an automatic

computer is to be used, then systems design is usually followed

by six additional stages. When systems analysis is the first

stage and Systems Design is the second stage, the third stage

— the first stage following systems design is Programming.

This is the process of analyzing the rules of transformation

and planning the set of instructions needed to direct the

automatic computer and the peripheral equipment in carrying

out the system. The stages from systems analysis through

programming are known as the preparation stages.

Coding is the fourth stage. In this the individual

instructions in their proper sequence are specified in detail.

Coding necessarily follows programming because coding provides

the detail needed in the program to direct the computer.

Debugging is the fifth stage. It is concerned with

finding and correcting the mistakes and errors in the systems

analysis, systems design, programming, and coding. Often it

involves redoling parts of these stages.

handling systems, and computer or communication systems. An  
main types: information systems, data-processing or data-

The systems covered by the definition are of three  
it is information.

about any aspect of an organization and its environment, but

concerned only with information. The information can be

The definition of system indicates that systems are

tion for a purpose.

material service, and equipment service for handling informa-

A system is a particular combination of human service,

#### SYSTEMS:

easier.

arranged within the record to save time or to make updating

the file. There are several ways in which information may be

the composition of the record is as important as the makeup of

When getting an overall view of a direct-access device,

#### RECORD COMPOSITION:

while others should be sequential.

that some files in an application should be in random order,

of the two techniques. After a thorough study, it may be found

thoroughly. Approaches to file organization may be combinations

valid techniques for doing a job and both should be explored

Both sequential and random-file organization are

better choice.

4. If there are many reports to be run and the control  
numbers are long, the sequential method may be the

choice.

3. If there are numerous additions to and deletions  
from the file, the random method may be a wider

existing system. The primary emphasis is not on the requirement for data in this approach; the primary emphasis of the systems analysis is the primary emphasis of the systems analysis. The documentation of the requirement for data is the primary emphasis of the systems analysis. The documentation of the requirement for data is the primary emphasis of the systems analysis. The documentation of the requirement for data is the primary emphasis of the systems analysis.

SYSTEMS APPROACH:

Another approach, and the one most important to the "systems" approach. It begins with systems analysis to ascertain what data are needed, what functions the data are to perform, how they would be used in the organization, and what relation they bear to the total information system in the organization. Thus the starting point for the systems approach is the need of the organization for data--the cataloging, description, specification, justification, and rationalization of this need. The documentation of the requirement for data is the primary emphasis of the systems analysis. The documentation of the requirement for data is the primary emphasis of the systems analysis.

EQUIPMENT APPROACH:

A second approach, popular but not as frequent as the straight conversion approach, starts with a desire to find a use for an automatic computer. In this "equipment approach", the question is "how can we use an automatic computer in this organization?" The work is oriented towards systems design, often emphasizing how to adapt existing systems to fit a given computer. This approach has been widely used for such traditional applications as payroll accounting, accounts receivable, and inventory status reporting. For this reason, very common to talk of computer application in terms of traditional clerical functions, such as billing, proving, balancing, posting, listing, etc.

analysis is simply in an analytical frame of mind. A thoughtful

The first and most important tool of systems

ANALYTICAL FRAME OF MIND:

TOOLS OF SYSTEMS ANALYSIS:

operate more efficiently.

Usually, also, the systems resulting from this approach  
the systems design comes closer to meeting management's needs.  
more time-consuming and more costly to perform. But the result-  
examines the needs for data in the organization, it is usually  
hensive than the other major approaches. Because it fully  
The systems approach is more complete and compre-

systems design.

are brought in on a comparison basis to contribute to the  
native systems designs in the light of cost, these aspects  
used already in the organization. Then, in evaluating alter-  
items of equipment or of specific systems or procedures  
than worked out from the known capabilities of specific  
usually directly synthesized from the data requirements, rather  
In the systems approach, the systems design is

process, and provide the needed data.

services of human beings, materials, and equipment to obtain,  
content of the data. The design seeks a way of combining the  
requirements usually involve time availability, format, and  
lined by the systems analysts, and do so at a low cost. These  
in some ways that will meet the general requirements out-  
systems analysts can be provided. The data must be provided  
concerned with how the data specified and documented in the  
The systems design part of the systems approach is



It is a body of techniques and an attitude of thought and approach. Among its specific techniques are the work distribution chart, the data analysis, the volume count, the statement of functions, the job description, the layout study, and the organization survey.

WORK SIMPLIFICATION:

From top to bottom to follow in time succession the flow of data-handling action and information in the system. The flow chart is read from left to right in bands is written immediately below the diagram. The form is drawn in the column of the appropriate organizational component, and a capsule description of the action that involves the documents or form in question, a diagram of the form is drawn in the column of the appropriate organizational component, and a capsule description of the action by arrows on the flow chart. Whenever some action takes place physical movement of the various documents which is indicated organizational components is normally traced by following the flow of work and of information through the amount of information about a system.

The flow chart conveys in condensed form a large

FLOW CHART:

questioning attitude is most important when one attempts to document, describe, categorize, and classify aspects of information systems. To assist themselves, analysts have found checklists of thought questions to be useful.

PROCESS CHART:

The process chart differs from the flow chart in objective, layout, and symbology. The process chart is used primarily for indicating the explicit sequence of handling operations performed on data. To assist in this graphic

portrayal the process chart is divided into two major parts, a symbol part and an explanation part. The symbol part of the process consists of a set of stylized symbols which covers the major operations performed on data. Thus, transport, delay arithmetic operation, and the like have unique symbols. For miscellaneous operations, such as sorting, the miscellaneous symbol is used with appropriate notation.

The symbols in the correct sequence for the operation at hand may be plotted on a prepared chart form or a large piece of paper, either going from top to bottom or from left to right, with appropriate branchings as may be required. The arrows show the sequence of happenings; the symbols categorize the action taken on the data (or sometime on the documents). The fitness of the detail shown depends upon the level of analysis desired - and the patience of the analyst.

PATTERNS OF SYSTEMS DESIGN:

A study of the applications that have been implemented on automatic computers reveals a great diversity. Some patterns emerge from this diversity, however, when it is studied closely. The five most important patterns are (1) file maintenance or record modification; (2) report preparation, (3) model manipulation; (3) formula evaluation, and (5) integrated operations.

THE RUN DIAGRAM :

The run diagram is an aid in devising and setting down on paper the overall sequence in which data-handling work is to be done. Its name comes from the unit of computer operation known as a run.

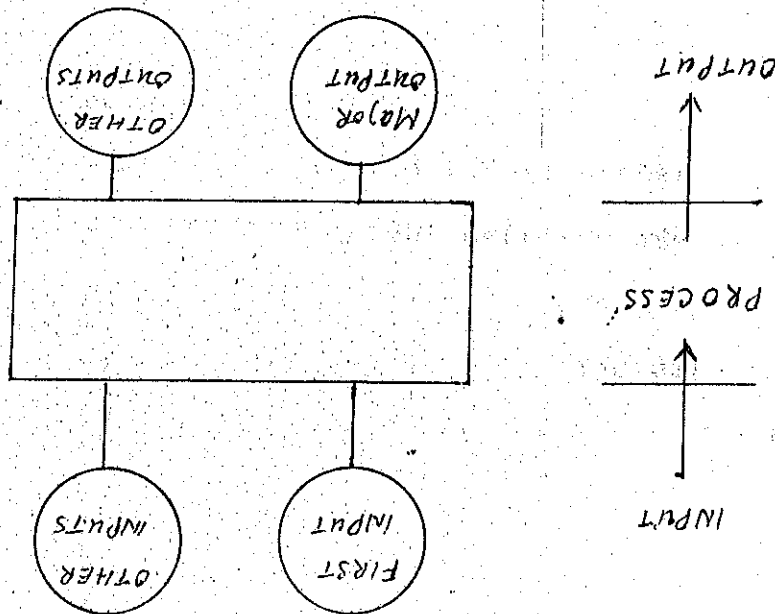
A run in computer processing is the transformation of a given amount of input data into a specified amount of output data. Thus, the updating of one master file from the changes reported in the transactions file to produce an up-dated master file can be referred to as one run. A run may

be composed of one or more passes. A pass is one movement of data from input into the automatic computer. During a given run, several passes of data may be necessary. For example

in a typical sort run (sorting records into a given order) a number of passes of the input file are required as the computer gradually moves the records from their original order to the

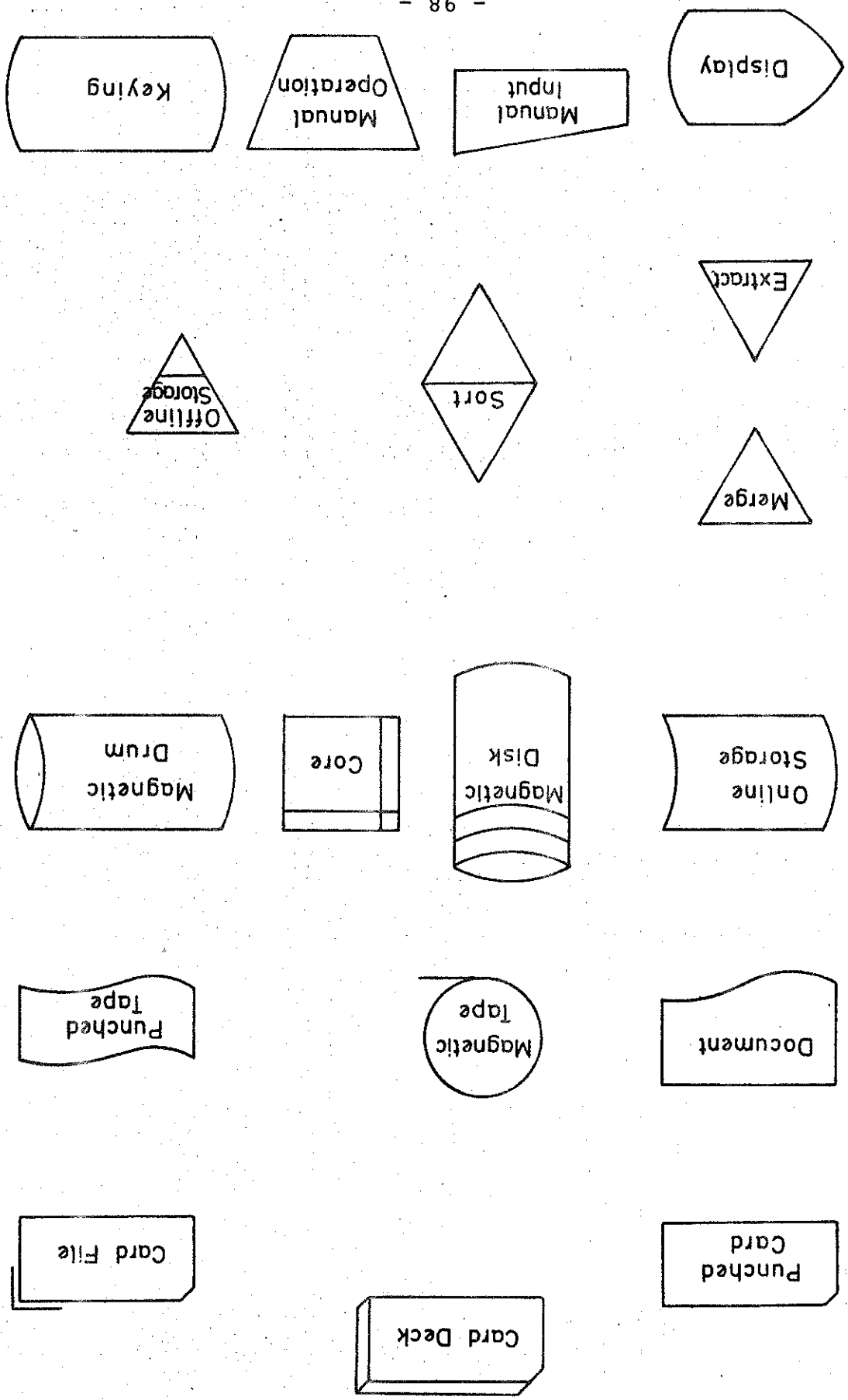
desired order.

Run Diagram





# SYMBOLS RELATED TO SYSTEMS





The run diagram is organized into three major parts. The top part represents the files used as inputs. The middle part represents the automatic computer. Either this may be labeled as such, or the nature of the processing action taken on the input may be stated briefly. The lower part of the run diagram represents the outputs produced, usually files. The outputs, like the inputs, are often represented by generalized symbols suggestive of the type of media to be used. For example, modified circles indicate that the records are to be on magnetic tape — the common case. Where a record is to be on punched cards or printed, special symbols represented these.

Several run diagrams can be combined, one below the other, when outputs of one run serve as inputs for another run. This type of run diagram is convenient where it is important to show the relationship among runs. Where only a general summary is desired, the simple run diagram is adequate and more convenient.

THE FLOW — DIAGRAM:

A second tool of systems design, the flow diagram (or block diagram as it is sometimes called) unlike the run diagram gives in detail the transformation of input data into output data. It shows a time sequence of data-transforming operations, not just a general relationship between inputs and outputs.

THE DATA SHEET:

Format or data sheets are prepared for both input and output. They describe in explicit detail each field of data

but outlines can be prepared during the systems design stage. manuals cannot be finished until the programming is completed, preparation of input and the distribution of output. The outlines and manuals are required for such operations as the relationships between them and computer operations. Procedure procedures of non-computer operations helps to clarify the are done. Setting down in either outline or manual form the directions and explanations of how such non-computer operations procedure manual is a written description in detail of in conjunction with the automatic computer operation. The broad terms of the non-computer operations which are performed The procedure outline is a written description in

#### THE PROCEDURE OUTLINE AND PROCEDURE MANUAL:

effort. systems design in order to facilitate the later programming however, as much specification as possible is made during lized until actual programming is well along. In practice, the data format have not been finalized, and will not be finalized during the systems-design stage because the details of data required in programming. Format sheets are difficult to run diagrams, provide the programmer with much of the basic Format sheets, in conjunction with flow diagrams and various fields, the position of the decimal point, etc. betic, numeric and special characters, the variations in the fields, the distinction between and position of all alpha-times the data will appear in a record, the sequence of the number of characters comprising each field, the number of that is to appear in the input or output, including the



ily in simulation, the consequences upon the entire organization  
gency or response. It may actually be an impairment. Especial-  
been reduced. The net effect may be no overall gain in effi-  
quality of the organization's response to other situations has  
the efficiency of the other parts of the organization or the  
But once the application is in operation, it may be found that  
efficiently one part of an organization in a given situation.  
It is possible to design a very good system to serve very  
— care must be taken to avoid the error of sub-optimization.  
tion — and for that matter, in doing systems design generally  
data to the output data in the application. In using stimula-  
to sketch the transformation needed in going from the input  
location, to decide upon the timing required for the runs, and  
tion can be used to select input and output data for the app-  
the various types of items of data can be approximated. Stimula-  
investigated. Then, from the simulation, the contribution of  
and complete for its responses to simulate the situation being  
constructing a model. This model must be sufficiently detail-

### SIMULATION:

Stimulation is rarely used tool because it involves  
and a readiness to explore and find out.  
that is, it includes awareness that circumstances alter case  
few guideposts can be offered, the best approach is heuristic  
can lead to improve systems design work. Where few rules are  
and on the look-out for fresh means of doing the data handling  
sensitive to relationships amount data-handling operations  
Systems design work is synthetic. An open mind,

### THE OPEN MIND:

3. The manager of an oil refinery is considering expanding the production of his plant by adding capacity at some point in the refining process. Of the many different processes involved in refining, which one should have its capacity increased so as to bring the greatest return on the capital expenditures?

2. A producer of livestock feed is required to provide certain amounts of various nutritional elements in each sack of feed. He can obtain the various elements from different grains and supplements, and he knows the cost of each. What combination of grains and supplements should he use to meet the requirements at minimum cost.

1. A manufacturer makes a number of different products. Each product uses certain production resources, each of which is available in a limited amount. The manufacturer knows how much profit he makes from each product. How much of each product should be produced in order to make the maximum total profit?

A few brief examples may serve to indicate more concretely what can be achieved with linear programming:

Linear programming is a mathematical technique for determining the optimum allocation of resources (such as capital, raw materials, manpower, plant or other facilities) to obtain a particular objective (such as minimum cost or maximum profit) when there are alternative uses for the resources. Linear programming can also be used to analyze the economics of alternate availability of resources, alternate objectives, and so on.

LINEAR PROGRAMMING:

Linear programming is a powerful tool of research and tables and PERT theorem, etc. and application of techniques like simulation, input/output and introduction of computers has made possible the development and application of techniques like simulation, input/output and application of techniques like simulation, input/output must be kept in mind when attempting to design systems to improve the performance of a part of the organization. The introduction of computers has made possible the development and application of techniques like simulation, input/output

4. Another manufacturer uses a large number of raw materials in the production of a line of products. The prices of his raw materials are subject to market fluctuations, and in some cases there are significant price breaks for large orders. He has a choice of which raw materials to use. One of the materials he is not using at the moment might profitably be used if the price were lower. How much would the price have to drop before he could make a greater profit by using it instead of something else?

5. This same manufacturer is faced with another problem one of the raw materials he is now using will be unavailable for a while because of a fire at the plant of one of his suppliers. Of the various alternative raw materials that he could use to replace it, which one will cause the least decrease in profit, considering that the introduction of a different material may change the mixture of other materials he uses?

These examples emphasize the importance of linear programming. When a large number of inter-related choices exist, the best choice may be far from obvious. An intuitive solution may never uncover the best approach, and there is seldom any guarantee that what appears to be a fairly good policy is really the best.

Such problems often involve large amounts of money. A rational approach to the problems requires:

- \* A systematic way to represent the goal, or objective, of the system under study
- \* A systematic way to describe the limitations, or constraints, under which the system must operate—for instance, the limited amount of production resources in the first example given, and the minimum nutritional requirements in the second example.
- \* Some way to arrive at one policy out of the many possibilities, and to be sure that it is the best.
- \* Some way to explore the ramifications of changes in the stated problem (assuming, of course, that the best, or optimum, policy for the original objective and the original constraints has been determined).

The developed countries are making use of the simulation methods in almost every branch of human life whether it may be engineering or medicine; it may be production or the supply of services; it may be space administration or flight scheduling. In Pakistan, linear programming techniques need to be applied in all areas of research in general but particularly by PIA for its flight scheduling, seat reservation, inventory control; by Shipping Authorities for scheduling of its ships both in terms of routes and frequencies. The road transport organizations can schedule for the frequency and timing of their fleet in various directions and the Railway in the same manner can benefit a lot by the application of research techniques both in production and supply of services to the public.

changes. The optimum policy), and the exploration of the effects of includes the formulation of the problem, the solution (finding "Linear Programming", as the term is used today,

In the third example, the refinery manager needed to know which capacity limitation could most profitably be relaxed. In the fourth example, the manufacturer needed to know the effect on his best policy of a change in the costs of materials. In the fifth example, the manufacturer needed to know how the non-availability of one raw material would effect his profit and how to choose a new policy that would minimize this effect.

B I B L I O G R A P H Y

1. Design of Sample Surveys  
by  
DES RAJ
2. An Introduction to Automatic Computer  
by  
NED CHAPIN
3. Automatic Data Processing  
by  
ELIAS M. AWAD
4. Introduction to IBM System/360  
by  
IBM WORLD TRADE CORPORATION
5. Cobol Programming Guide  
by  
D. D. MCCRAKE
6. Comprehensive Transport Planning  
by  
G. R. WELLS
7. Introduction to Transportation Planning  
by  
M. J. BRULON
8. An Introduction to Linear Programming  
by  
IBM WORLD TRADE CORPORATION

GOVERNMENT OF PAKISTAN  
MINISTRY OF COMMUNICATIONS  
(CENTRAL ROAD ORGANIZATION)

+++

ROAD MILEAGE SURVEY 1976-77  
HIGHWAY DEPARTMENT

1. Name of the Department:
2. Districts in which roads under the jurisdiction of reporting agency are located:
3. Name, designation and corresponding address of Officer reporting the information:
4. Telephone Number
5. Telegraphic Address:

SECTION - I (ROAD NETWORK)

Question No. 1 : PLEASE GIVE TOTAL ROAD MILEAGE STATISTICS  
UNDER YOUR JURISDICTION UPTO 30 - 6 - 77

Road Mileage Upto	Name of the District	Bituminous	Cement Concrete	Macadam metalled	Brick	Shingle or Gravel	Earth	T O T A L
1	2	3	4	5	6	7	8	9
30 - 6 - 19								

i) District

ii) District

iii) District

T O T A L:

30 - 6 - 19

i) District

ii) District

iii) District

T O T A L:

Note: Please justify increase or decrease in composition of Road Mileage over the preceding year. Road Mileage for 30-6-19 as provided by you has been given, which may be confirmed as correct.





Question No. 3 : WAS ANY ROAD UNDER CONSTRUCTION ON  
30TH JUNE, 19 , IF SO, PLEASE STATE

Sl. No.	Name of the road	Length of Road on which work was carried	Previous type of surface, if any.	Present type of surface	Nature of work carried out.	District in which Road exists.	REMARKS, if any
1	2	3	4	5	6	7	8

Question No. 4 : WAS ANY ROAD IMPROVED DURING THE YEAR 19  
IF SO, PLEASE STATE NATURE OF IMPROVEMENT

Sl. No.	Name and location of the road	Name of District in which road located	Total length of a road improved	I M P R O V E M E N T (In miles)		
				Widening	Reconstruction	Resurfacing
1						
2						
3						
4						
5						
6						
7						

SECTION - III (ROAD TRANSFERS)

Question No.5: WAS ANY ROAD MILEAGE TRANSFERRED FROM AND TO OTHER DEPARTMENTS DURING THE YEAR 19 , IF YES, PLEASE STATE:

(d) ROADS TRANSFERRED TO OTHER DEPARTMENTS:

Sl. No.	Name of the Road	Miles transferred to other agency.	To whom transferred	District where the road located	Type of Surface	Any other R E M A R K S

(b) ROADS TAKEN OVER BY YOUR DEPARTMENT FROM OTHER DEPARTMENT:

Sl. No.	Name of the Road	Miles taken over	From whom transferred	District where the road located.	Type of surface	Any other R E M A R K S

SECTION - IV

ROAD EXPENDITURE DURING THE YEAR 19

SOURCE FROM WHERE THE EXPENDITURE MET

ACTUAL EXPD. DURING 19	Own Source	Aid from Centre	Sugar-cases Programme	Rural Works	Any Other
------------------------	------------	-----------------	-----------------------	-------------	-----------

1. CONSTRUCTION EXPENDITURE

- i) Expenditure on construction of roads.
- ii) Expenditure on construction of bridges.
- iii) Expenditure on purchase of machinery and equipment.

TOTAL:

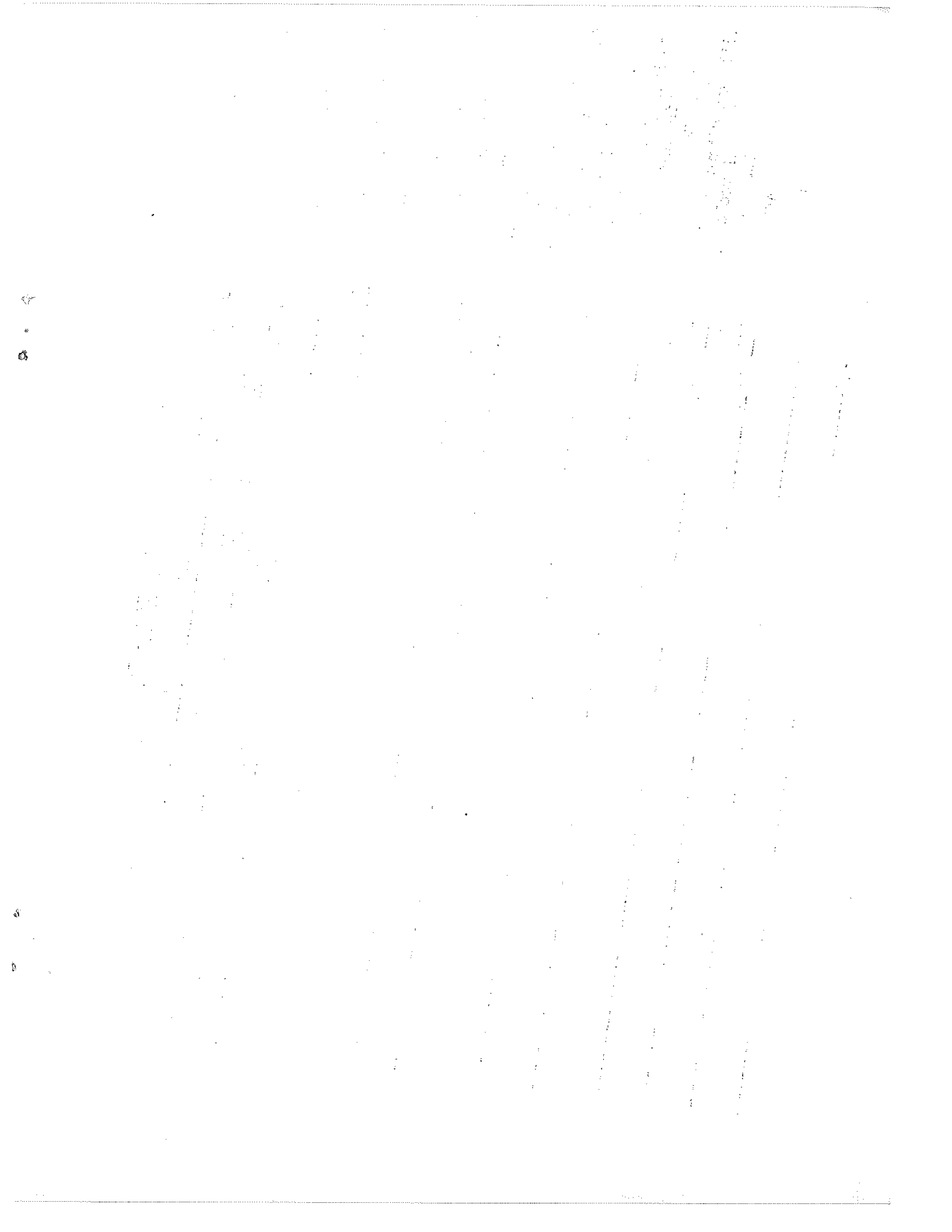
2. MAINTENANCE EXPENDITURE

- i) Expenditure on normal maintenance of roads and bridges.
- ii) Expenditure on major repairs charged to maintenance.
- iii) Expenditure on maintenance of tools and equipments.

TOTAL:

3. ANY OTHER EXPENDITURE NOT COVERED ABOVE.

TOTAL EXPENDITURE:



GOVERNMENT OF PAKISTAN  
MINISTRY OF COMMUNICATIONS  
(CENTRAL ROAD ORGANIZATION)

\*\*\*\*\*

ROAD MILEAGE SURVEY 1976-77  
MUNICIPAL/TOWN COMMITTEES

Name of Municipal/Town Committees:

District:-

Note:- Please strike out any question or column of a question which is not applicable in your case.

2. It must be returned to the above mentioned address before 19 .

QUESTION NO. 1:

Is there any road under your control, if 'YES' please give the names.

Sl.No.	Name of Road	Length in miles	Type of surface
1.			
2.			
3.			
4.			
5.			

TOTAL:



QUESTION No. 2

Was any road constructed/upgraded or strengthened during the year 1973-1977, if "YES" please state.

Sl. No.	Name of Road	Length in miles upgraded/constructed or strengthened 1973 - 74 - 1975 - 76	Was road existing if "YES" state type or surface 30-6-77.	New type of Surface
1.				
2.				
3.				
4.				
5.				

QUESTION NO. 3

Was there any Road under construction/under upgradation on 30 - 6 - 73 to 30 - 6- 77, if 'YES' state in detail:

Sl. No.	Name of Roads	Length in miles under construction	Was road existed on 30-6-77 if "YES" state type of surface.	New type of surface
---------	---------------	------------------------------------	---	---------------------

1.

2.

3.

4.

5.



QUESTION NO. 5.

Was any road transferred to other Department during 1975 - 76 and 1976 - 77, if 'YES' State :-

Sl. No.	Name of Road	Miles transferred	Year of transfer	To whom transferred	Type of Surface
1.					
2.					
3.					
4.					
5.					

QUESTION NO. 6.

Was any road taken over by you during 1975 - 76 and 1976 - 77 from other agencies if 'YES' state:-

Sl. No.	Name of Road	Miles takenover	Year of transfer	Type of surface	From whom taken over
---------	--------------	-----------------	------------------	-----------------	----------------------

- 1.
- 2.
- 3.
- 4.
- 5.

QUESTION NO. 7.

Was any expenditure incurred on construction and maintenance of roads if 'YES' state:-

Y E A R	Expenditure on Construction of Road	Maintenance of Road	Total expenditure incurred by the organization on all spheres. Developmental as well as non-Developmental.
1975 - 76			
1976 - 77			

1976 - 77

Name of Reporting Authority

Dated: \_\_\_\_\_

SIGNATURE