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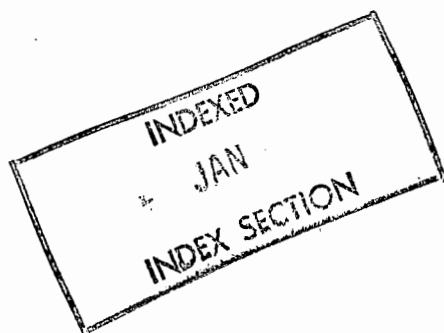
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PROSPECTS FOR ELECTRONIC DATA PROCESSING METHODS

IN AFRICA

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I. INTRODUCTION

1. It was agreed at the Second Conference of African Statisticians in Tunis that the ECA Secretariat should follow up developments in data processing problems in close consultation with the Conference of European Statisticians (which has set up an expert working group to study problems relating to the application of electronic data processing equipment in statistical offices in Europe) and other interested organizations. It was suggested, as a first step towards regional co-operation in this field, that a report should be prepared by the Secretariat on the development of mechanical data processing in Africa and its possible future growth. In view of the fast and far reaching advance in electronic computers and their use for statistical data processing over the past decade the scope of this study was limited to studying the potential role of electronic computers in the context of expanding statistical activities in most African countries.

2. A staff member of the ECA Statistics Division visited ECE headquarters in Geneva and a number of European statistical offices to inquire into the latter's experience in the use of computers and other electronic equipment. This was followed by a case study in an African country, Ghana, which has had long experience in the use of conventional punch card equipment and which, it was felt may have a large enough tabulation programme to justify installation of a small or medium sized electronic computer. The case study was designed to review the various jobs which were being performed on the punch card equipment installed at present and compare the merits and demerits of conventional machines and electronic computers in terms of flexibility, versatility, accuracy, speed and cost of operation. Likely expansion in tabulation work was also to be taken into account. An experienced consultant from the Central Bureau of Statistics in Norway was associated with this study.

3. The European experience and the results of the case study are summarized in Sections II and III of this paper. In Section IV suggestions are made for further studies and for possible co-operation amongst African countries in the skilful use of electronic processing techniques.

II. Statistical Applications of EDP[1]
in Europe

4.   Electronic data processing systems are a post-World War II innovation.   In 1952 the U.S. Bureau of Census became the first statistical office in any country to acquire a computer for statistical data processing.   It was followed by the Central Statistical Offices in the Netherlands, Norway and Sweden which acquired their first computers between 1958 - 1960.   In 1962 11 other countries in Europe were using EDP equipment for processing of current statistics and census and survey data.   These included Austria, Czechoslovakia, Federal Republic of Germany, Finland, France, Hungary, Italy, Switzerland, U.S.S.R., United Kingdom and Yugoslavia.

5.   The type of computer installed varies from one statistical office to the other.   In each case selection was made after a careful and prolonged consideration of characteristics of various types of computers in the market in a selected price range followed by a series of test applications. Such feasibility studies and other preparatory work took as much as five years in many cases before conversion to EDP was finally accepted.   While the first computers installed in the European statistical offices such as IBM 650 (Sweden), DEUCE (Norway) and X-1 (Netherlands) were punch card oriented and were aimed at more efficient calculations, the later trend has been in favour of magnetic tape computers such as IBM 705 and 7070 which are also able to perform data ordering operations, including collation and sorting.

Major applications of EDP

6.   Recent reports on electronic data processing from the European statistical offices indicate that computers are applied in the following statistical fields:

[1]/ EDP stands for Electronic (or automatic) Data Processing.

Population statistics

Criminal statistics

Cultural statistics

Agricultural statistics

Fishery statistics

Industrial production statistics

Building statistics

Stock statistics

Internal trade statistics

Foreign Trade statistics

Price statistics

Income statistics

Tax statistics

Financial statistics

Labour statistics

Consumer expenditure statistics

Housing statistics

Traffic statistics

Transport statistics

National account statistics

The above list indicates that the applications cover most statistics and that EDP, once installed, may be efficient even in a small and rather unimportant branch of statistics. The major applications, however, are in foreign trade statistics and population censuses; in these two sectors the contribution of EDP is probably larger than in all the other fields together.

7. Perhaps it is more interesting to consider application of computers at different stages of statistical processing. The first applications were connected to those stages which traditionally were processed by conventional processing equipment, particularly counting and tabulating. Computers were able to do more tabulations in parallel than the conventional tabulators. This application also

required less pre-sorting because of the large internal storage and the selective power of the computers compared with conventional tabulators. Besides, this stage had already been described in detail and very little system analysis was required for the application of the computers. Most of these applications were, therefore, simulation by the computers of the previous punch card tabulator work.

8.   Another stage in which European statisticians very soon applied their computers was analysis and computation. Suddenly, they found themselves equipped with a new instrument permitting analysis of variance, regression analysis, etc., to a degree which was thought impossible before because of the large computational work involved. The computers have probably made statisticians in European statistical offices much more analytically minded than before.

9.   Application of computers to the control and correction of primary data represented a stage previously performed manually. The computers were well fitted for this tiresome, but very important work, and were in certain cases able to perform control to an extent considered impossible by manual methods. Many European statisticians consider this as the most important application of computers in statistical data processing so far, as it has resulted in increased accuracy and speed and a reduction in clerical staff.

10. With the introduction of magnetic tapes even preparatory processing stages, such as sorting, collating, copying and filing, have been transferred to computers. Some of these applications, e.g., some types of sorting, may be questioned as inefficient use of costly computer time. But by performing these operations along with the rest, the important advantage of a higher degree of integration in one automatic process may be obtained, thereby increasing speed, saving scarce manpower and eliminating errors due to the many manual interruptions necessary in a conventional data processing system. It should be mentioned that even the coding of collected information is in special cases now transferred successfully to electronic data processing.

Some problems of conversion from conventional methods to EDP.

11.   Introduction of electronic data processing is ordinarily a
revolution for statistical processing and must of course create certain
problems. Whether the conversion is directly from manual methods to
EDP or from conventional punch card methods, the character, if not the
extent, of the problems seems to be the same. These problems may be
classified as preparatory and operational. The preparatory problems
are the most serious but also the most frequently overlooked.

12.   The first preparatory problem, which presents itself when the
decision is made to acquire a computer, is the staff problem. As
computers are rather complex equipment, their use has to be planned by
specialists with specific aptitudes and with adequate training in this
field. In Europe this problem has been solved in two different ways.
One approach is to train the best amongst the mechanical data processing
staff in computer programming. This solution had the advantage that
the people thus selected were well acquainted with mechanical data
processing techniques. But usually, they did not have the necessary
statistical background for choosing the best of several processing schemes.
The second approach to the staff problem was based on the American
thesis that it is easier to make a good programmer out of a statistician
than a good statistician out of a programmer. The planning staff was
selected from amongst the professional statistical staff. This is
certainly the better of the two solutions. But with already too few
professional statisticians it is not always a practical solution as
part-time work is not recommended. Many of the smaller European
countries have thus chosen the first mentioned approach, or a compromise
between the two.

13.   Training of the staff may also be a problem. The computer
manufacturers usually provide training courses in programming, but are
not of course able to give training courses in solving statistical
processing problems. From this point of view, the possibility of having
at least one professional statistician among the programmers has been

found to be of great value for experimentation and in-service training within the statistical office concerned.

14. Whatever the sources of recruitment selection of staff for training as programmers can also present problems. The experience of statistical offices in Europe seems to indicate that the value of aptitude tests developed by manufacturers is not in identifying those who will be good programmers, but in weeding out those who are not likely to be good programmers. This is not of much help to a statistical office with a limited staff.

15. The extent of the necessary preparatory work required before installation of a computer was under estimated in many cases. Such work includes a series of operations of which one needs special mention because it is the most difficult to perform, i.e. testing of the programmes worked out. Testing is the procedure in which a programme or a part of the programme is brought to the computer together with test material in order to locate all errors in the programme. Till all parts of all programmes have been tested and necessary corrections made, no application can be run on the computer. And the testing should normally be done before the computer is installed. This problem may, however, be solved by careful desk-checking of all programmes followed by visits, where possible, to a computer installation for short testing sessions.

16. The introduction of a computer may also create some operational problems. It has been found preferable to process data on the old and the new system in parallel for some time to avoid the pressure of converting all processes at once and to be sure that the new processing system works as expected. This was not found possible in many countries in Europe because of the costs of running two systems in parallel. On the other hand, a total conversion imposes heavy burdens on staff and equipment and there is always a great risk of failure. It is therefore absolutely necessary to plan conversion in as much detail as possible.

17. With EDP a particular queue problem has been observed in
most statistical offices in Europe. While the conventional processing
of different statistics could often proceed independently of each other
due to multiplicity of equipment, with EDP all jobs must be processed
on the same computer, resulting in a queue of processing jobs. This
does not necessarily mean that some statistics are processed later than
was the case with conventional equipment; it does mean, however, that
some statistics cannot obtain the full advantage of the computer's fast
speed unless the processing schedule and priorities can be suitably
adjusted. As a result of this, introduction of EDP has been accompanied
by important changes in the organizational set-up of many European
statistical offices. Data processing operations are now generally
centralized in a separate major department with a large hand in determining
priorities as between different processing jobs. EDP has also led to much
closer co-ordination between various sections involved in the collection,
scrutiny and analysis of a statistical series to avoid a cluster of
processing jobs during peak periods. Statisticians concerned are also
obliged to plan the operation in its totality much more carefully to
avoid interfering with the tabulation plan during processing. This is
made very necessary due to lesser flexibility of EDP vis-a-vis conventional
methods.

Evaluation of EDP in statistical work in Europe.

18. The organization, objectives, scope of operations and types of
computers installed vary so much among the European statistical offices
that a general evaluation of merits and demerits of EDP compared with
conventional processing methods is rather difficult. By discussing EDP
under the following separate headings it may be possible, however, to
draw some broad conclusions.

a) Cost of EDP

19. Total cost of EDP comprises capital cost for the acquisition of
the computer, site preparation cost, conversion cost and current opera-
tional cost, including maintenance. The capital cost of the computers

used by the European statistical offices is roughly within the range of US $200,000 - 1,500,000. The depreciation period used by European offices varies from about 4 to 10 years. Experience indicates that a 10 year old computer may be in good working order, but becomes economically obsolete because of the very fast technical developments. Probably the most economical depreciation period when taking the fast development into account is 6 years. Utilization is of course a very important factor and European experience indicates that the computer ought to be utilized in at least one full shift to be economical. In order to achieve this some statistical offices have chosen to co-operate with other government offices to obtain an economical work-load on the computer.

20. The reported costs of site preparation vary between US $8,000-150,000, depending on the size of the computer and whether a special building had to be set up. As a rough measure site preparation can be estimated at 5-10% of the computer price. Several European offices reported that they under-estimated the site preparation cost up to 50%.

21. Conversion cost includes preparation of the programmes and training of staff. In general, the statistical offices have under-estimated the programming effort necessary. Available information indicates that on an average a programmer managed about 7 complete programmes in one year. As programmes may vary from only 100 instructions to several thousands and the time needed per instruction depends on the programming system used, the above figure should be used with care. Statistical offices in Norway and Sweden, who were amongst the first in Europe to consider EDP, reported that conversion costs in their case were over-estimated.

22. The current operating cost is usually not so difficult to estimate because it comprises factors which can be easily costed, e.g., electricity, wages, maintenance, punch cards and magnetic tapes. It was stressed by several offices that correct estimates and economy very much depend on a steady flow of processing work so as to avoid inflating staff requirements due to a few peaks in the work-load. This may require some re-organization of the work also outside the processing department.

Some offices reported savings in punch cards as EDP did not restrict utilization of the punch cards as much as the conventional equipment. The need for magnetic tapes is very often under-estimated because people seem to calculate the need on basis of the theoretical tape capacity forgetting that it may be very inconvenient to store information of different kinds on the same tapes so as to utilize their full capacity. The maintenance cost can roughly be estimated to about 5% of the purchase price per shift-year.

23. Some European countries have reported net savings in data processing costs after introduction of EDP, while others reported no savings. In no case, however, the costs were reported to have gone up. In general, it is probably more correct to conclude that the lowering of cost is not a distinct advantage of EDP compared with the cost of the previous conventional processing.

b) Speed of EDP operation

27. Electronic computers are indeed much faster than conventional equipment, but the experience in Europe has shown that such a comparison can be very misleading. It is sometimes forgotten that processing time is not determined only by the theoretical speeds of the electronic computers. There are at least two important factors which have to be considered. First, there is the handling time independent of the computer speed, i.e. the time needed for loading cards, mounting magnetic tape reels, changing paper on the printer, setting switches, etc. On very large and fast computers handling time accounts for about 25% of the processing time. Second, there is again the problem of unsteady flow of work. As already pointed out all processing jobs have to pass the computer and if the processing jobs are concentrated too much around certain points of time, some jobs may wait and the overall processing time for these may be no shorter than before. Punching and verification of cards also account for a very large proportion of overall processing time and except for some economy in verification there is no relative saving of time or effort in the use of EDP on these accounts. In spite of these limitations, most

European offices reported savings in processing time and emphasized that faster processing was one of the definite advantages of EDP over conventional methods.

c) Scope of statistical processing

25. The outstanding features of electronic computers, i.e., stored programme logic, electronic speed and large storage capacity for immediate and automatic access to information have broadened the scope of statistical processing immensely. This is an experience confirmed by all European offices which have introduced EDP. The broadened scope comprises mathematical statistical computations, computation of complex indices, econometrics, large scale seasonal adjustments as well as more detailed and new tabulations which were found impossible or cumbersome or too costly with conventional equipment.

d) Flexibility in planning and execution

26. This wide scope of EDP applications is largely due to the very high degree of freedom and flexibility in planning the processing on a computer which make it possible to take into account more statistical specifications than was possible before. On the other hand, the planning and programming for EDP is a long job which has to be completely spelled out before processing can commence. Even a very small change in specifications subsequently may require reprogramming of a large part of the programme and thus delay processing seriously. Several European offices have learnt from experience that merits of EDP are seriously undermined if processing specifications are modified often during programming. This inflexibility in execution of processing is probably one of the most serious disadvantages with EDP. With greater experience leading to better appreciation of the limits of EDP and recent technical advances in computer design and programming techniques, this shortcoming may be expected to become less potent in the near future.

e) Accuracy of EDP

27. There are two types of accuracy to be considered when discussing
EDP and its merits. One is the technical performance of the computer
and the auxiliary equipment, and the other statistical accuracy of the
collected data. The technical performance of computers has now reached
a very high level. In the statistical offices which were among the first
to apply EDP and have the most old-fashioned equipment, instances of
reading and punching errors, errors due to unsuccessful internal
transfers and information lost because of transfer to bad spots on the
magnetic tapes, are not unknown. These offices had to programme special
checks which would signal if the computer did not work satisfactorily.
The new computers, however, are largely self-checking. Standard security
routines in the programmes further eliminate the risk of inaccuracies
which may arise due to malfunctioning of the computer. Compared with
conventional equipment this is an absolute advantage. Far more encourag-
ing is the experience of the European statistical offices in the efficacy
of the computers in detecting and even correcting errors in the statistical
data. Most of the statistical offices reported that in this field the
computers had been extremely successful and that the degree of accuracy
control obtained through EDP methods would not be possible by any other
known methods. This view was confirmed at a recent meeting of the ECE
Working Group on EDP.

f) Maintenance of electronic computers

28. Electronic computers require frequent maintenance by trained
engineers for effective operation. Some European offices employ their
own engineers, but smaller offices ordinarily get their equipment
maintained by the manufacturer. In places where the manufacturer is not
able to guarantee full maintenance, and it is not possible to employ a
fully trained engineer or have easy access to spare parts a computer
could become a serious liability.

g) Staff recruitment and training

29.   European experience with regard to staff recruitment and training indicates that more qualified people are required for planning EDP than planning conventional processing and that the training period necessary for even well qualified recruits will be from 6 to 12 months. On the other hand, mechanical operation of EDP equipment does not require any special qualifications.

30.   Recruitment is often more difficult for EDP than for conventional processing due to relatively higher qualifications required. It is necessary that all staff members be able to read the language of the computer manuals. Shift work, often necessary with a computer, also tends to render jobs in an EDP installation less attractive without compensatory benefits in salary and terms of service.

31.   The requirements as to staff recruitment and training therefore seem to be amongst the disadvantages of EDP. This may be changed if more co-operation and exchange of processing plans and programmes can be arranged.

    To summarize, the advantages of EDP in statistical work in European offices are in general increased processing speed, wider scope in processing applications, accuracy and flexibility at least in planning while the disadvantages have been the requirements with regard to staff recruitment and training and rigidity in execution to a certain extent. As to the cost, no definite increase or decrease has in general been observed. On balance, though the experience of the European statistical offices, with electronic computers is not many years old, most statisticians now regard EDP as indispensable and believe it will be even more so in the years to come.

III. EDP Prospects in Africa
- A Case Study

32. A few national statistical offices in Africa (the United Arab Republic, Senegal, Ivory Coast, Congo-Leopoldville, the East Africa Statistical Department and Madagascar) are already either in the process of acquiring electronic data processing equipment or are seriously considering the feasibility of doing so. On the other extreme there are still a few independent countries in Africa (Ethiopia, Somalia, Sierre Leone and Mauritania) where statistical offices are without even a conventional punch-card installation. The majority of the national statistical offices in Africa, however, have had some years' experience in the use of conventional mechanical data processing equipment and are in need of guidance with regard to future plans for the expansion or replacement of such equipment. Keeping in view (a) the projected expansion of statistical activities in all African countries, (b) delays and problems encountered by many countries during the processing of current statistics and results of recent censuses and household surveys, (c) near-revolution in data processing techniques and equipment since punch-card equipment was first installed in most African countries, and (d) the extent of exploratory and preparatory work required (3 to 5 years in some cases) for the selection and installation of new equipment, especially electronic computers, and long delivery time (2 years) for such equipment, it seems highly prudent for African countries to review the prospects of EDP in connection with their future data processing requirements before acquiring further conventional equipment. Such a review at this stage may help in a judicious planning of future expansion resulting in substantial economies.

33. In order to provide some guide lines for such a review the ECA Secretariat undertook a case study of data processing requirements and possible EDP applications in Ghana early this year. The aim of this case study was to collect information about data processing requirements

in the Central Bureau of Statistics as a typical representative of the African statistical offices, and based on this information to investigate whether the workload and general conditions are or will be such in the coming years as to justify detailed feasibility studies for possible substitution of conventional punch card equipment by EDP equipment. It is not a feasibility study which can and must only be undertaken by the statistical office itself, if it is convinced of the need for such a study.[2]

Statistical Requirements and Processing Work-load.

37. The Government of Ghana had set up a "Committee on Creation of Central Bureau of Statistics" in 1959-60 to review the activities of the then Office of the Government Statistician and to make recommendations for its future expansion. The following recommendations made by the Committee are of particular interest in connection with this study:[3]

"8. (Staff Requirements). The number of junior clerical staff should be kept to a minimum by making the fullest use of mechanical processing equipment."

"22. (External Trade). The principal requirement is greater speed in the processing of trade statistics and secondary considerations are a more detailed item classification, improved accuracy in the basic documents and provision for additional analysis of ad hoc nature."

"24. (Public Accounts)....Processing should as far as possible be carried out mechanically and should be aimed at producing detailed annual publications on these groups of accounts....."

"30. (Population Statistics). A separate committee is being formed to consider an extension of birth and death registration but the Bureau should take an active part in the technical development of this subject and should provide processing facilities."

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[2] The information on which this study is based was collected through meetings with the Government Statistician and members of his staff during a 10 days' visit to Ghana by a staff member of the ECA Statistics Division and an EDP Consultant from the Central Bureau of Statistics in Norway. The authors of this report are, however, responsible for any incorrect information as well as the conclusions drawn from it. The Government of Ghana is in no way committed to these conclusions.

[3] See "Report of Committee on Creation of Central Bureau of Statistics", July, 1960, pp. 28-33.

"34. (Mechanical Data Processing)..... In the future a careful watch should be kept on new developments in order to keep the machine installation up-to-date." (The Committee expressed the opinion that "at some stage in the future, electronic computing equipment may become necessary" and set up a working party to advise Governments on the possible applications of such equipment. The Working Party had made no progress till early this year).

35. The Committee also drew up a comprehensive "Statement of Statistical Requirements" listing all series which the Central Bureau was required to implement progressively to meet the increasing demands for statistical data for development planning. It is estimated that as a result of proposed expansion of statistical activities the volume of statistical data to be collected and processed would increase 20-30 per cent per annum. Thus, even with a conservative estimate of 20% annual increase, the volume of current statistics will double in about four years.

36. The basic requirements listed in the preceding paragraphs indicate that higher processing speed, accuracy and more tabulations are wanted even though the availability of both professional and clerical staff will continue to be a limiting factor.

37. At present, mechanical data processing in the Central Bureau of Statistics is organized in two separate units: Mechanical Processing Section for current statistics, and Census Office for processing of 1960 population census data. The staff position and the type and composition of equipment in the two units in December 1962 are shown in Tables 1 and 2. The position with regard to the Census Office is incomplete as punching and verification of data had been completed earlier.

38. In addition to the Central Bureau of Statistics three other Government departments (Ministry of Foreign Affairs, Office of the Accountant General and Local Self Government Department) together had 5 tabulators, 4 sorters and collators, 4 reproducers, 1 interpreter and 24 punches and verifiers. The character and volume of data processing operations of these departments could not, however, be studied due to lack of time and other difficulties.

Table 1. Composition of the mechanical processing staff

Grade	No. of employees
Mechanical Processing Section:	
Senior Officer	1
Processing Officer	4
Senior Processing Assistant	5
Processing Assistant	6
Machine assistant (punching personnel)	21
Total	37

Census Office:
Unspecified[a]   20

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a/ Excluding punching and verification personnel

Table 2. Data processing equipment in
Central Bureau of Statistics in 1962.

Type of equipment	Number of machir		
	Mech.Proc.Sec.	Census Office	Total
Punch	17	—	17
Verifier	9	—	9
Sorter	5	2	7
Collator	1	1	2
Reproducer	1	1	2
Interpreter	1	1	2
Tabulator	2[a]	2	4
ESM 101 (with Summary punch)	—	3	3

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a/ One of the tabulators is equipped with a multiplying device
which permits some calculation at low speed.

39.   Measured by the volume of data processing input, i.e. number of
detail cards, the processing requirements in 1962 were rather modest.
In current statistics the number of detail cards was about one million,
of which Foreign Trade Statistics accounted for almost one third
(See Table 3).   In addition to current statistics the 1960 Population
Census which was being processed in a separate mechanical unit (also under
the control of the Government Statistician) accounted for another 7-8
million detail cards.

Table 3 : Volume of data processing input in 1962
Number of Detail Cards

A. CURRENT STATISTICS:

Foreign Trade statistics	312,000
Labour statistics	90,000
Migration statistics	80,000
Civil aviation	20,000
Government accounts	80,000
Exchange control	134,000
Education statistics	28,000
Import licences	36,000
Social survey	20,000
Hospital statistics	16,000
Local council statistics	66,000
Income tax	52,000
Shipping and aircraft	10,000
Transport facilities	4,000
Motor registration and licences	114,000
University answers	12,000
Estimates	8,000
Total, Current Statistics	1,082,000
Population Census	6,700,000

40. Taking into account the present stage of statistical development in Ghana and assuming an annual increase of about 20% in the volume of data collected, current statistics will represent about 2.1 and 4.3 million detail cards to be processed in 1966 and 1970, respectively (See Table 4). As to census statistics, it is not unlikely that there will be other censuses and surveys in progress (e.g. industrial census, agricultural census, household surveys etc.) which together will account for the same number of detail cards in 1966 as the population census did in 1962. In 1970 there will probably be another population census. Assuming a 2% annual increase in population, the number of cards to be processed for the 1970 census may be of the order of 7.7 million. The total number of input cards for current and census data will thus increase 50-60% between 1962 and 1970.

Table 4 : Estimated data processing input volume in 1962, 1966 and 1970

Number of Detail Cards

	1962	1966	1970
Current statistics [a]	1,100,000	2,100,000	4,300,000
Census statistics [b]	6,700,000	6,700,000	7,700,000
Total	7,800,000	8,800,000	12,000,000

[a] 20 % estimated increase per year rounded off to nearest 100,000

[b] Data processing input volume for census and survey statistics in 1966 is assumed to be the same as in 1962. In 1970 a new population census is assumed and the volume is based on 2 % annual increase in population.

41.   The number of detail input cards does not, however, give a satisfactory measure of the data processing workload since some statistics are intensively processed within a short period while others are less intensively processed or processed over a longer period. Table 5 shows the data processing workload in 1962 in terms of card passes through the machines. It appears that the number of card passes per detail card is much less for census data than for current statistics indicating that the latter should be assigned a greater weight when estimating future data processing requirements.

Table 5 : Data processing workload in 1962
Number of Card Passes

	Current Statistics	Census Statistics a/	Total
Sorter	53,943,081	52,000,000	105,943,081
Collator	2,413,893	3,500,000	5,913,893
Reproducer	1,562,835	650,000	2,212,835
Interpreter	708,886	27,000	735,886
Tabulator	22,367,826	6,000,000	28,367,826
ESM 101	---	33,000,000	33,000,000
All equipment	80,996,521	95,177,000	176,173,521

42.   Future statistical needs would also require a more intensive processing of current statistics in order to obtain more tables as well as greater details in the existing tabulations. Precise specifications were not stated, but as the present tabulations are relatively simple it may not be unreasonable to assume that future requirements in this respect will increase about 10 % per annum. This, together with card input, gives an overall annual increase of about 30 % which also was the actual increase

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a/   Card passes for census statistics are estimated from preliminary reports on utilized machine hours, Jan.-Nov., allowing for about 30 % handling time in addition to the machine speeds for the different types of equipment

during 1962. On the other hand, the population census tabulation plans seem to be well developed and there is no basis for assuming that future census work will be more intensive than the 1960 population census.

43.   Table 6 is based on these assumptions and shows that the current statistics workload in 1970 will increase to about 9 times the workload in 1962 while the total processing workload including census data processing will increase 5 times during the same period.

Table 6 : Estimated workload in 1962, 1966 and 1970
Number of Card Passes

	1962	1966	1970
Current Statistics [a]	80,996,521	235,000,000	730,000,000
Census Statistics [b]	95,177,000	95,000,000	110,000,000
	76,173,521	330,000,000	870,000,000

44.   These estimates do not allow for any change in processing methods to improve accuracy of data processed. One way of increasing the accuracy of the statistical results is to invest more effort in the collection and recording of primary data. Another method is to increase the accuracy control in the processing stages through the application of more thorough editing of the collected data. Both methods require increased manual effort which is incompatible with the requirement that the clerical staff should be kept to a minimum. The accuracy can, however, be raised by extending the application of mechanical processing equipment to statistical operations which at present are manually performed, e.g., editing of computations and

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a/   The workload for current statistics is based on the assumption of 20% annual increase in input volumes and 10% annual increase in number of passes per detail card due to increasing tabulation requirements

b/   The workload for census statistics is assumed unchanged from 1962 to 1966 while the load for 1970 is increased to correspond to 2% annual increase in population from 1960 to 1970. The number of passes per card is assumed unchanged.

preparation of manuscript tables. This will, if course, increase the future processing workload even beyond the figures shown in Table 6. It is, however, not possible to make a quantitative estimate of such increase.

45.   Another requirement of the Bureau for data processing is faster results. This is partly a question of available capacity. But it also depends on the extent to which manual processing operations can be substituted by mechanical processing since the overall processing speed today seems to be largely determined by the number of manual interruptions. Foreign Trade Statistics, which, in Ghana as in most other countries, have processing priority over other current statistics, are processed according to the time schedule shown in Table 7.

<u>Table 7 : Time-schedule for processing of</u>
<u>Monthly Foreign Trade Statistics</u>

Processing stage :	Target dated for Completion of operation [a]
1. Manual preparation	20 of 1st month
2. Punching, verification	23 of 1st month
3. Mechanical sorting and control	26 of 1st month
4. Manual correction	2 of 2nd month
5. Mechanical sorting	7 of 2nd month
6. Manual check and correction	9 of 2nd month
7. Mechanical processing	16 of 2nd month
8. Manual check and correction	23 of 2nd month
9. Layout for printing	26 of 2nd month
0. Printing	3 of 3rd month

[a] The target dates are typical for those used in 1962. The months indicated are those following the month to which the data relate.

It will be seen that out of about 60 days from the end of the month for which data are to be processed until printing starts only about 25% of the operations are mechanical (Nos. 3, 5 and 7); the rest are manual and, therefore, unrelated to the speed or capacity of the machines installed.

Utilization of present equipment

46. Based on the material available, it was difficult to evaluate the utilization of the present data processing equipment installed in the Central Bureau of Statistics. The figures in Table 8 must therefore be interpreted as rough indicators and need some comments.

47. In the Mechanical Processing Section 2 shift working was reported and the potential number of hours per machine unit for one month is therefore assumed to be 280 hours(@ 35 hours per shift per week). All units are assumed to have been in use all the twelve months. Number of card passes, which is the only significant information available regarding utilization of different types of machines, have been converted into machine hours by dividing with two-thirds of the machine speed. This means that the estimated machine-hours in Table 8 allow for 50% of the real running times for card handling, machine control, etc.. Even with untrained operators this is a wide margin.

48. For the Census processing only one shift has been assumed and the potential number of machine hours is estimated as 140 hours per unit for each month the unit has been reported actually in use. The number of machine hours used is based on preliminary reports prepared by the processing section in the Census Office for January-November 1962.

49. The estimated utilization percentages are relatively low for all types of machines. This does not necessarily mean that there is an excess of equipment. Considering that foreign trade statistics are the most important single job in the Mechanical Processing Section, and that the work on this job must be concentrated within a short period each month, the need for all the equipment installed becomes evident. However, by co-ordinating the work of this section and the census office it would probably have been possible to save some machine units.

Table 8 : Utilization of data processing equipment in 1962

Type of equipment	Number of units	Potential no. of machine hours available a/	Estimated number of hours in use b/	Utilization percentage
Mechanical Processing Section				
Sorter	5	16,800	2,023	12
Collator	1	3,360	181	5
Reproducer	1	3,360	390	12
Interpreter	1	3,360	304	9
Tabulator	2	6,720	3,729	55
Census Office				
Sorter	2	3,080	1,740	55
Collator	1	980	234	24
Reproducer	1	840	162	19
Interpreter	1	420	12	3
Tabulator	2	2,100	1,018	49
ESM 101	3	3,220	1,088	34

a/ Potential number of machinehours available is assumed to be 280 hours per machine unit per month in the Mechanical Processing Section which works 2 shifts. In the Census Office the potential is assumed to be 140 hours per machine unit per month in the months in which the unit has been reported used.

b/ For the Mechanical Processing Section the number of machine hours used is estimated by 1.5 x number of card passed/speed of the machine unit, which allows for 50% handling time in addition to running time.

Computer Systems considered

50.   Before relating the present and the future processing workload in
the Central Bureau, it seems prudent to emphasize once again that this is
not a feasibility study on which the decision for acquisition of a computer
system or otherwise can be based. The purpose of the study is merely to
present some considerations which may lead to a more thorough study of the
problem in Ghana and in other countries in which the data processing problems
are of similar character. As stated earlier the Central Bureau of Statistics
in Ghana had already envisaged the necessity of studying this problem care-
fully and had set up a separate working party to advise the Government on
the possible applications of electronic computing equipment. Data presented
in the following paragraphs should serve as a useful starting point for the
deliberations of this working party.

51.   At the present time there are several hundred different electronic
computer systems in the market most of which can be acquired with different
combinations of ancillary equipment. To select one or several systems out
of these would be rather arbitrary with the information available for this
study. Instead of using some specific computer system this study has,
therefore, been based on considerations of cost and computer characteristics
which seemed relevant for a data processing workload of the size and
composition found in the Central Bureau of Statistics in Ghana. Two systems
were examined. First, a medium sized computer with an internal storage
capacity of about 5000 characters which is adequate for building up standard
tables, making simple calculations and editing controls. The internal speed
is supposed to be fast enough to do these simple type of operations between
each card read. The card reader and card punch are assumed to work with
speeds of 800 and 250 c.p.m. while the printer is assumed to work at the same
speed as the card reader. It is also assumed that input and output operations
can proceed simultaneously. This system is characterized by items a,b,c and
d in Table 9. Alternative two, representing more expensive tape computer
system, was assumed to have an internal storage capacity corresponding to
10,000 characters, and 4 magnetic tape stations with a maximum speed of 20,000
characters per second. In all other respects, this system was assumed to be
identical with the first.

52.   It will probably not be possible to find a system with exactly
these characteristics. Conclusions based on these assumed characteristics
however should not differ much if some real computer system of corresponding
characteristics had been used. Examples of such systems include IBM 1401,
ICT 1500, RCA 301 and Gamma (Bull) 30. The card computer system will
perform the work of tabulators as well as reproducers when used as summary
punches connected to the tabulators. The tape computer system can in
addition perform the operation of sorters and collators.

Table 9 : Description of the features of a medium
cost computer system for data processing

Computer Units	No. of Units	Capacity	Speed	Monthly Charge_a/ US $	Purchase price and 5 year maintenance US $ b/
a) Central Processing Unit	1	5000-10000 characters	Stor. Cycle 10 microsec.	1500	90,000
b) Card Reader	1	80 col.	800 c.p.m.	} 600	36,000
c) Card Punch	1	80 col.	250 c.p.m.		
d) Printer	1	130 ch.p.l.	800 l.p.m.	700	42,000
e) Tape Unit	4	500 ch.p. inch	20,000 ch. p.s.; 15 millisecond start-stop time	2000	120,000

a/   The monthly charge is average charge for one shift utilization
b/   The purchase prices include about $1\frac{1}{2}$ to 2 shifts maintenance cost

Machine utilization

53.   Following the procedure employed in Table 8 to estimate the degree
of machine utilization for the workload in 1962, the likely utilization of
different types of conventional equipment at present installed in the Central
Bureau on the basis of the estimated workload in 1966 and 1970 is shown in
Table 10 as percentage of theoretical capacity of each machine. In practice
it is not possible to attain 100 per cent utilization of theoretical capacity
because of varying workload from one period to the next and stoppages due
to maintenance requirements. However, in order not to exaggerate the need
for additional conventional equipment to process increased workolads in
subsequent years full utilization has been equated to theoretical capacity.
Subsequent estimates are accordingly weighted in favour of conventional
equipment in comparison with EDP.

54.   Table 10 indicates that even with maximum use of tabulators for current
statistics in two shifts, a substantial increase in the number of tabulators
must be expected.

55.   In order to make comparisons with EDP the workload and capacity of
the computer systems for statistical processing must be estimated. It is
convenient to convert the workload expressed in Table 5 as number of card
passes into a number of standard operations. The standard operation has
been defined here (after considering the character of foreign trade processing)
as comprising a sort, collation and tabulation of 25,000 cards with 80 column
information and on a data classification key of six digits in the case of
sorting. The reproduction work is assumed to be mainly summary punching
which can be performed simultaneously with tabulation. A standard tabulation
operation speed is assumed to be only limited by the card reading speed. This
is of course only true with the simpler kind of tabulations which are performed
by tabulators. On a computer more sophisticated tabulation will usually be
performed in which the internal speed may be the limiting factor. In this
case the number of operations will, however, be reduced with an overall effect
of probably less processing time. Table 11 shows the data processing work-
load for a computer in 1962 in computer hours.

Table 10 : The Workload for conventional machines
expressed as utilization percentage [a]

	1962		1966		1970	
	Utiliz. %	No of machines	Utiliz. %	No. of machines required	Utiliz. %	No. of machines required
Mech.Proc.Section[b]						
Sorter	12	5	35	5	108	6
Collator	5	1	15	1	45	1
Reproducer	12	1	35	1	108	2
Tabulator	55	2	160	3	495	10
Census Office						
Sorter	55	2	55	2	64	2
Collator	24	1	24	1	28	1
Reproducer	19	1	19	1	22	1
Tabulator	49	2	49	2	57	2

[a] Only conventional machines which may be replaced by a computer system
are considered

[b] 2 shift operation with 280 hours per month

[c] 1 shift operation with 140 hours per month

Table 11 : Data processing workload in 1962

for a computer

Type of operation	Speed per standard operation in hours a/	No. of standard operations b/	Workload in hours
Current Statistics :			
Sorting	1.5	360	540
Collation	—	97	—
Tabulation	0.6	895	537
Card-to-tape c/	0.6	40	24
Total	—	—	1101
Census Data :			
Sorting	1.5	346	519
Collation	—	140	—
Tabulation	0.6	240	144
Card-to-Tape	0.6	240	144
Total	—	—	807

a/ 20% handling time is assumed. As this is no real computer the times
   are of course only indicative. Time required for collation of data
   is negligeable

b/ A standard operation comprises 25000 cards of 80 ch. records with 6 digit
   key incase of sorting. The number of operations is deduced directly
   from Table 5.

c/ When applying tape, transcription from cards to tape must also be taken
   into account.

56.   Assuming a two-shift working or 280 hours per month (diregarding the need for maintenance etc.), the utilization percentages for the two computer systems for the estimated workloads in 1962, 1966 and 1970 are shown in Table 12. This table indicates that in the case of a card computer system it will be necessary to retain the sorters and collators (besides the interpreters and 101's which are not considered at all here). The computer will fill one shift in 1966 and exceed two shifts some time between 1966 and 1970 thus requiring the introduction of a third shift which is not unusual in EDP. As to the tape computer system it only illustrates that cheap card sorters have been substituted by expensive tape sorting which would overload the two-shift system even before 1966. This is a very common finding implying that if no new methods are introduced to reduce necessary sorting or if no special advantages are gained such as higher accuracy, faster processing, etc., it is difficult to consider a tape system if the whole processing load is not greater than in Ghana.

Table 12 : The workload for computer systems
Expressed as utilization percentages [a]

	1962		1966		1970	
	Utiliz. %	No. of Machines	Utiliz. %	No. of Machines	Utiliz. %	No. of Machines
(i) Card Computer System						
Current Statistics:						
Sorter	12	5	35	5	108	6
Collator	5	1	15	1	45	1
Census Data						
Sorter	55	2	55	2	64	2
Collator	24	1	24	1	28	1
Card Computer	20	1	50	1	150	1
(ii) Tape Computer System						
Tape computer	57	1	120	1	330	2

a/ 100% utilization corresponds to two shift working (280 hours per month) while 150% is equivalent to three shift work or 420 hours per month.

EDP vs. Conventional Equipment

E   (a) Scope, accuracy and processing speed

57.   We have so far only considered the mechanical processing workload in the Central Bureau of Statistics in Ghana as it can be observed today and made projections on the assumption that its character and composition would remain unchanged. It is reasonable to expect that the Central Bureau will be increasingly involved in the coming years in such operations as index calculations, control ratios, and more sophisticated editing. These operations can be performed more or less in conjunction with other computer processes without requiring much extra time. With conventional equipment, however, they will require other equipment such as punch card calculators. This was recognized in the Central Bureau of Statistics where one tabulator had been provisionally equipped with multiplying device and the acquisition of a calculator was being seriously discussed. There are also other fields which in a few years will require computational aids e.g., seasonal adjustments, analytical research and forecasting. For these at least a small card computer may be indispensable. A tape-computer system, if sufficiently planned, will in addition facilitate storage of data as the information is kept in a much more compact form. The more important advantage of a tape computer will, however, be a system of statistical readiness which will make possible a much faster retrieval of stored information to meet ad hoc requests.

58.   Modern computers are now reputed to be very reliable and the leading manufacturers do not seem to be afraid of backing computer installations with full maintenance contracts. The supremacy of computers as regards technical accuracy has already been underlined in para 27. Through automatic editing and integrated data processing made possible with EDP, accuracy is improved with controls built into the programmes and by reducing the number of errors due to manual handling. The last fact may justify the use of even a small tape computer as manual handling is much less with such a system as compared with a card computer.

59.   The speed of the computers considered here are essentially higher than the speeds of conventional equipment. Table 13 which indicates the speed ratios between a computer system of the type considered here and conventional equipment, shows that the real processing time will be much less by EDP,

but on the other hand the queuing problem is likely to be more serious than with conventional equipment. Only one job can be processed on the computer at a time and some jobs may not, therefore, be finished earlier than before because they will have to wait till jobs with hifher priority are completed. The processing of foreign trade statistics might be faster by using a computer system which definitely would reduce both the mechanical stages No. 3, 5 and 7 mentioned in Table 7, but probably not as much as one is apt to expect because of the many manual operations involved.

Table 13 : Speed ratios between computer system
and conventional machines a/

Standard Operations	Speed ratio between computer system/conventional machines
Sorting	3.8
Collation (including card-to-tape)	2.4
Tabulation	5.3

(b) Cost and economy

60.   Even though it was never explicitly stated during the visit to Ghana, it was understood that any change in processing systems should not imply higher processing cost than with the present type of equipment. The two last columns of Table 9 show the approximate cost of the computer systems considered here. While conventional equipment is usually hired, computer systems are often purchased outright because they require much more investment in preparation and planning and must therefore be used for a minimum

a/ Theoretical maxima speeds are used both for the computer system and conventional equipment.

of five years. When using a computer more than one shift it will be less expensive to purchase than to rent. We shall here only consider the purchase cost of the computer system, which is then depreciated over a five year period to arrive at a comparable monthly charge.

61. Table 14 shows the estimated cost of the different processing solutions for 1962, 1966 and 1970. It should be noted that the rent of conventional machines is usually raised when they are in use for more than one shift. This has not been taken into account in Table 14. The costs shown do not include punches, verifiers, interpreters and other equipment which will be common to the two systems.

62. The figures indicate that the card computer solution will be the most economical as long as the processing will have the same character as in 1962. The difference in economy between the conventional solution and the tape computer solution is insignificant. Considering filing and the frequent need for retrieval of stored data a tape computer may actually be more economical. The wide divergence between the two computer solutions, one employing a tape system and the other a card system, may be reduced by considering a larger tape computer instead of two medium-sized computers in 1970.

63. There are other factors affecting cost including staff, the consumption of cards, tapes, electricity,etc.. Except for the staff required none of these factors will have any significant effect on the relative costs of the different processing solutions being considered.

(c) Staff, training and organization

64. The most difficult obstacle to the introduction of computers in the Central Bureau of Statistics in Ghana was considered to be the lack of qualified staff. At the same time, the Bureau is required to keep its data processing installation up-to-date to limit clerical staff to a minimum.

Table 14 : Monthly Cost of Equipment for
different data processing solutions [a]

Equipment	Monthly Cost in US $		
	1962	1966	1970
Conventional equipment			
Sorter	385	385	440
Collator	200	200	200
Reproducer	250	250	375
Tabulator	2,800	3,500	8,400
	3,635	4,335	9,415
Card Computer System			
Sorter	385	385	440
Collator	200	200	200
Card Computer	2,800	2,800	2,800
	3,385	3,385	3,440
Tape Computer System			
Tape computer	4,800	4,800	9,600

65.   As the introduction of EDP means reduction in machine units, better
organization and more efficient use of the operators, the number of machine
operators required should be less with a computer system than with conventional
equipment. The operation of the computers itself is not more difficult to
learn than the operation of conventional punch card machines.

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[a] The cost of punchs, verifiers, interpreters and statistical machines
is the same for each solution and is therefore not included in the figures.

66.   The real staff problem with EDP is the need for system analysts
and programmers. For these people higher qualification than those
represented in mechanical processing today, are required. As long as
the computer is used to simulate the conventional machines no serious
system design will be necessary. Standard programmes may be worked out
by the manufacturers.   Still much preparatory work will remain to be
done and it will be necessary to recruit two-three more qualified persons
at least 2 years ahead of the planned installation of the computer.

67.   The University in Kumasi has already acquired an IBM 1620 computer
since January 1963. Another is expected to be installed in the Ghana
University, Accra, in the near future. Facilities available at these two
Universities can be used for training of staff and for feasibility studies
by the Central Bureau. The staff trained at these two installations may
profit by study-tours to countries applying EDP in statistical work. Due
to lack of personnel, training of other programmers may be performed
within the Bureau by the two-three trained people by selecting staff members
who have proved their interest and abilities for such types of work.

68.   The staff problem will, however, be much more difficult if the
computers are also to be used on fields which are not mechanically
processed today. This will require extensive system designs and programming
by qualified people who also need statistical knowledge, and this is probably
impossible to satisfy with the limited personnel resources in Ghana today.
The problem may, however, be resolved by having recourse to technical
assistance programmes or by recruiting qualified expatriate staff.

69.   Introduction of EDP will also require certain organizational changes.
First, it will be uneconomical to consider the Census work separately from
current statistics. In this connection it would be prudent to explore the
possibility of centralising data processing activities of all other govern-
ment departments e.g., the Accountant General's Office, the Bank of Ghana,
and the Ministry of Finance in order to obtain advantages of a large-scale
operation. The higher and special qualifications requirements will need
a review of manning table and salary grades. From an operational point of
view the most necessary changes are introduction of thorough time scheduling
and work control in order to obtain the necessary efficiency of the computer,
establishment of a satisfactory shift-system, appointment of shift leaders

who are personally responsible for computer efficiency in their respective shifts and working instructions for each type of personnel. In short, a computer requires a discipline of a much higher order than conventional equipment due to a much higher cost per machine-hour and the risk of complete stoppage of work in the event of a breakdown.

To summarize, the results of the case study indicate that even with the present size of the processing operation in the Central Bureau of Statistics (including the processing of census and survey data) a medium sized card computer and other ancillary equipment may prove to be more economical than the conventional equipment installed at present. With a further increase in processing load as a result of the implementation of the longterm programme of statistical development drawn up by the Bureau the difference in relative costs of conventional equipment and a card computer system will increase progressively in favour of the latter. Besides, a computer system will make it possible to broaden the scope of processing so as to include more detailed tables in the existing tabulation plans, index calculations, control ratios and seasonal adjustments. If the Central Bureau is required to assist the planning authority in making projections, input-output analysis and undertake other analytical research a computer system would appear to be indispensable. A computer system will also reduce to the minimum technical and statistical errors arising from malfunctioning of equipment and manual handling of data. A computer system, however, raises staff and organizational problems, which though not insurmountable, wouldneed careful investigation before the introduction of EDP in Ghana, or in other African countries similarly placed, can be definitely recommended. The problem of maintenance of electronic equipment also needs much closer scrutiny than was possible during the short period available for this case study. The results of the study nevertheless have established a strong case for a detailed and carefully planned study by the Central Bureau of Statistics to determine the feasibility of introducing EDP for the present as well as the anticipated workload in the future. Actual change-over from conventional data processing methods to EDP may take 5-7 years due to extensive preparatory work required and a 2-year delivery period usually stipulated by manufacturers of computer equipment. If, therefore, the consideration of EDP is postponed further, it may result in great losses in future statistical efficiency.

IV. CONCLUSIONS

70.   It was observed in Section II of this paper that only after 5-6 years' experience with electronic equipment statistical offices in Europe have accepted EDP as indispensable for accurate and fast processing of statistical data and for analytical research. The installation of electronic computers was also reported by statistical offices in India, Japan Korea, New Zealand and the Phillipines at the last session of the Conference of Asian Statisticians. Thailand is to have a computer shortly, and Malaya and Pakistan have provided for computers in their long-range programmes.

71.   Amongst statistical offices in Africa, arrangements are well underway for the establishment of an "Electronic Computing Centre" in Cairo, attached to the Department of Census and Statistics. The purpose of the project is to establish a complete multi-purpose electronic digital computer with all ancillary equipment required for input and output of data in order to :

(a) enable timely processing of data in various fields, particularl agriculture, in view of its importance in the economy of the UAR;

(b) facilitate planning, implementation and follow-up of developmen in the agricultural sector and related fields;

(c) provide training in the mechanical processing and checking the quality of data.

The Centre (which is being sponsored jointly by the Government of the UAR, the Government of the USSR, the United Nations Bureau of Technical Assistan Operations, and the Food and Agriculture Organization as part of the Expanded Programme of Technical Assistance in the UAR) will be established in two stages. In the first stage which is scheduled to be completed in the course of three years, it should meet the requirements of the UAR alone In the second stage the centre will be expanded to meet the requirements of other countries in the "Near East" region [5], particularly for processing

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5/ Including Afghanistan, Iran, Iraq, Jordan, Kuwait, Lebanon, Libya, Pakistan, Saudi Arabia, Somalia, Sudan, Syria, UAR and Yemen.

data of the 1970 world censuses. FAO, it is understood, plans to consult
with Member Governments and suppliers of computing equipment for the
establishment of similar centres in other regions, if feasible.

72.   No precise information is available regarding plans for installation
of EDP equipment in other African countries. The results of the case study
in Section III, however, suggest that EDP can make a great contribution
towards reorientation and expansion of statistical activities in most
African countries. Each country will have to undertake a detailed feasi-
bility study to determine if it should acquire a computer of its own,
and of what size and type. Even countries which are unable to consider
acquiring a computer of their own in the near future may wish to take
advantage of EDP through "transferred processing" i.e., processing at
installations outside the countries where data originate, on a regional or
wider geographical basis. The experience of Libya with the processing of its
1960 Agricultural Census data by electronic computer in the Federal Republic
of Germany may be of interest in this connection 6/. The technical and logistic
problems faced in this experiment and the solutions brought about have
constituted an important step towards the centralized processing of census
results and other statistical data.

73.   Statistical Offices in Africa will need competent and continuous
technical advice in the initial stages, first, in the carrying out of
feasibility studies, and subsequently in systems analysis and preparation
of programmes. The establishment of such advisory services on regional or
sub-regional basis may prove helpful as recruitment of competent statisticians
with thorough knowledge of EDP to advise individual countries is likely to
present serious difficulties due to acute scarcity of such personnel at the
present time. It may also be possible to establish one or two more computing

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6/   The tabulation of the complete Libyan agriculture census data (involving
     947,000 punched cards) was finished in seven months from the start of
     punching work. See "Report on the Pilot Project for Central Tabulation
     of the Agricultural Census data for the United Kingdom of Libya by
     Electronic Computers", prepared by C.K. Dilwali and published by the
     International Computation Centre, Rome, 1962.

centres like the one proposed in the UAR in order to assist smaller
countries in the expeditious processing of census and other data, to
assist national statistical offices in the carrying out of feasibility
studies and preparation and testing of programmes, and to provide training
facilities in the use of electronic computers and ancillary equipment for
statistical data processing.

74.   Significant development are expected in the near future in EDP
equipment and techniques which may add to the efficacy of EDP. The first
field in which progress may be expected in the coming years is the trans-
cription of data from original documents, such as completed questionnaires,
to machine oriented media (punched cards, paper tape, magnetic tape, etc.).
At present such transcription is usually effected through manual punching
of cards which is slow as well as expensive. Experiments are now being made
to develop equipment which will "read" original documents and transfer the
relevant data automatically to magnetic tapes or other machine media.

75.   Technical progress designed to improve and accelerate the printing
of final results is also in the offing. At present statistical tables are
transcribed manually from results printed by the computers. This procedure,
apart from being time-consuming, often leads to serious copying errors. It
is, however, possible to print the results from the computer printer directly
on off-set printing paper which is then fed into the off-set printing machine
for reproduction. This has been tried with great success particularly in
connection with trade statistics and population censuses. The printing by
this method islimited to the fount of type fitted to the computer printer
which is usually in the form of capital letters. According to a new method
now being developed the results will be punched on paper tape which is then
used for control of ordinary printing equipment to print the results in any
type required.

76.   Both these developments are of particular significance to statistical
offices in Af ica in view of long delays encountered at present in the pre-
paration of punched cards as well as printing of final results. Another field

in which further developments may be of interest to African statisticians
is the use of magnetic tapes for filing of historical as well as current
data by statistical units. All informationpertaining to specified statistical
units can thus be hooked together and automatically fed into the computer
for instantaneous cross-reference, accumulation or tabulation. Several
European statistical offices are now busy establishing population and
establishment registers onmagnetic tape files.

77.   In so far as resources permit, theECA secretariat will keep track of
such developments for the benefit of the national statistical offices in
Africa. In this task ECA may collaborate with other Regional Commissions
and interested UN Specialized Agencies. In this connection it may be of
interest to note that the Economic Commission for Europe has set up a Working
Group on Electronic Data Processing which reviews the progress of EDP in
European Statistical Offices from time to time and also organizes discussions
on specific problems relating to statistical applications of EDP. Similarly
the Economic Commission for Asia and the Far East was asked by the Conference
of Asian Statisticians this year to undertake a study of data processing
equipment and to provide advisory services to national statistical offices
in this field